Measuring organizational complexity and its impact on organizational performance – A comprehensive conceptual model and empirical study

vorgelegt von

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von der Fakultät VII (Wirtschaft und Management) der Technischen Universität Berlin zur Erlangung des akademischen Grades Doktor der Wirtschaftswissenschaften (Doctor rerum oeconomicarum)
genehmigte Dissertation

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Berichter: Prof. Dr. Ulrich Steger
Berichter: Prof. Dr. Dodo zu Knyphausen-Aufseß

Tag der wissenschaftlichen Aussprache 20. Juli 2009

Berlin 2009
D83
“Out of intense complexities, intense simplicities emerge”
(Winston Churchill)
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<td>AMOS</td>
<td>Analysis of Moment Structures</td>
</tr>
<tr>
<td>AVE</td>
<td>Average explained variance</td>
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<td>CAS</td>
<td>Complex adaptive systems</td>
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<td>cf.</td>
<td>Confer</td>
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<td>CSR</td>
<td>Corporate Social Responsibility</td>
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<tr>
<td>CULT1</td>
<td>Strength of organizational culture</td>
</tr>
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<td>DEL1</td>
<td>Intensity of delegation, measured by the number of decisions made on lower levels of the organizational structure</td>
</tr>
<tr>
<td>DEL2</td>
<td>Intensity of delegation, measured by the importance of decisions made on lower levels</td>
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<td>DEL3</td>
<td>Number of subsidiaries</td>
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<tr>
<td>e.g.</td>
<td>Exempli gratia (lat.) for example</td>
</tr>
<tr>
<td>EE</td>
<td>Emerson Electric</td>
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<tr>
<td>EFA</td>
<td>Exploratory Factor Analysis</td>
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<tr>
<td>et al.</td>
<td>Et alii (lat.) and others</td>
</tr>
<tr>
<td>et seq.</td>
<td>Et sequence or the following one</td>
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<tr>
<td>EVA</td>
<td>Economic value added</td>
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<tr>
<td>F1</td>
<td>Structural formalization</td>
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<td>F2</td>
<td>Formalization of role of performance</td>
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<td>Formalization of information passing</td>
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<td>FA</td>
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<td>FDI</td>
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<td>M&amp;A Sales volume</td>
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<td>Proportion of new employees</td>
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<td>GE</td>
<td>General Electric</td>
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<td>Assets per employee</td>
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<td>LISREL</td>
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<td>Market value added</td>
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OECD Organization for Economic Co-operation and Development
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PAA Principle axes analysis
PCA Principle component analysis
PD1 Number of business segments in the portfolio
PD2 Size of the dominant segment
PD3 Sales of the dominant business segment in relation to total sales
PD4 Entropy index of the portfolio diversification
PLS Partial Least Square
Q² Prediction validity
R&D Research and development
RD1 Entropy index of the regional diversification of sales
RD2 Volume of sales in foreign countries in relation to total sales
RD3 Volume of international assets in relation to total assets
Ref. Referring
S1 Total volume of sales
S2 Number of employees
S3 Volume of total assets
S4 Volume of total foreign sales
S5 Volume of total international assets
SD Diversification of shareholders
SEM Structural Equation Model
SPECI1 Role variety
SPECI2 Personal interchangeability
SPECI3 Number of members of the corporate management or board
SPECI4 Cost of goods sold to sales
STAND1 Number of given standardized processes
STRA1 Clarity and visibility of the organizational strategy
STRUC1 Organizational structure
VIF Variance inflation factor
WWF World Wide Fund for Nature
1 Introduction

“Understanding complexity seems to be the only possibility for escaping this evolution in which everything seems to become more uncertain, more complicated and more changeful.”

Complexity is too often misused as an excuse in the business world. Despite their attempts to understand complexity, most managers, journalists, analysts, and in some cases even researchers base their explanations and rationale of how to cope with complexity on simple cause-and-effect chains. As a result, it is often argued that the success produced by own strengths and weaknesses is caused by complexity.

Of course, it is appropriate to state that the business environment is characterized by growing dynamics and diversity. Increased ambiguity and the rapid development of a largely unimpressionable business environment call for the managements’ continual reevaluation of strategies and methods in order to cope with this external complexity.

What these strategies and methods look like, however, cannot be easily and universally discerned, and it is particularly unclear when the parties involved adhere to simple cause-and-effect chains and reductionist mindsets.

For decades there has been general consensus among organizational researchers’ that organizations must adapt to their environment. Meaning, if a business wishes to succeed it must adjust to the complexity of its external business environment.

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4 Based on Newton’s third law of classical mechanics “actio et reactio”, researcher and managers often follows a reductionsitic approach, which means that they try to split systems or task into parts, answer or study them separately and afterword reassemble the parts to the system to understand the overall behavior. This approach is not appropriate to cope with and understand complexity.
Determining what kind of response is appropriate when organizations are faced with growing environmental complexity is one of the central questions in practice and science. Therefore, it is essential to understand complexity and its intrinsic characteristics.

### 1.1 The core dilemma of complexity

"Awareness did not start with cognition or collection of data or facts, but with dilemmas"  

The core dilemma of complexity that will be discussed in this thesis is whether organizations should respond to growing business environmental complexity by increasing organizational complexity for being successful, as exemplarily proposed by ASHBY, or by responding with simplicity, as suggested by LUHMANN. The dilemma emerges in that decision makers are faced with multiple conflicting goals. Hence, not all of these goals can be reached in the given time frame and with given resources. Priorities need to be set while not losing sight of other goals. In his “Law of Requisite Variety”, ASHBY postulates that only variety can handle variety. He states that a system can only cope with a level of complexity that is equivalent to its own complexity. He understands system complexity as potential or structural complexity – the capability to show different behaviors and assume different states. In other words, this structural complexity must be as high as the environmental complexity in order to appropriately match all possible states of the environment.

As shown in Figure 1, following Ashby’s approach, an increase in structural complexity will lead to a decrease of control of complexity. As BLISS states, this can result in a situation where the system exceeds the level of manageable complexity and ultimately gets “stuck in the complexity”.

In contrast, LUHMANN proposes that a system will never be as complex as its environment and therefore needs to use patterns of selectivity to cope with the discrepancy. In his understanding system complexity is situation-related. Contrary to Ashby’s structural complexity of the system – more relationships or interconnections between a greater numbers

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13 cf. Keuper, F. (2005), pg. 211.
of elements – Luhmann defines the degree of freedom of the system as an attribute. By doing so, he asserts that fewer relationships, less control and structure are necessary to increase the degree of freedom in the system, which ultimately leads to more sophisticated patterns of selectivity. According to this theory, undetermined systems with less structural complexity should be able to cope with environmental complexity more effectively. If environmental complexity grows, increased selection pressure leads to a situation where patterns of selectivity become simpler until they are mechanistic. This implies that they are based on oversimplified cause-and-effect relations. As a result of high selection pressure and mechanistic decisions, the system complexity decreases.\textsuperscript{16}

As shown in Figure 1, these fundamentally different and competing approaches of coping with rising environmental complexity lead to an inconsistency in theory.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Competing theories in responding to rising environmental complexity and the resulting inconsistency.\textsuperscript{17}}
\end{figure}

Theoretically, both approaches are correct. Managers often experience that both options can lead to success.\textsuperscript{18} The existing theoretical inconsistency is present in most organizations. Practical relevance is given in that nearly every organization faces growing complexity in its business environment, often caused by characteristics of globalization.\textsuperscript{19} It can be stated that adapting to and coping with business environmental complexity leads to an increased need of managing these dilemmas within the organization.\textsuperscript{20} One prominent example is the existence of conflicting goals within quality and cost efficiency. Managers have been facing this dilemma for decades and have found that it often leads to a cycle of quality improvement, cost

\begin{itemize}
\item \textsuperscript{16} cf. Bandte, H. (2007), pg. 76.
\item \textsuperscript{17} cf. Ibid., pg. 73.
\item \textsuperscript{19} In chapter 2.1.3 the main characteristics of globalization will be discussed.
\item \textsuperscript{20} cf. Steger, U., Schwandt, A. (2009), pg. 8.
\end{itemize}
increase, cost reduction, quality decrease, quality improvement, and so on.

As ADLER, et al., O’REILLY/TUSHMAN, PETTIGREW/WHITTINGTON and RAYNOR/BOWER state, the dynamic switch of priorities between conflicting goals, e.g. focusing or expanding the product portfolio, can be seen as a direct response of organizations to contingency variables like e.g. growing business environmental complexity. Managers try to balance permanent complexity reduction and complexity increase in their organizations. As a result, organizations find themselves in an unstable situation between centralization and decentralization, standardization and differentiation, as well as continuity and adaptation. This unstable situation is sometimes called “management on the edge of chaos”. This interplay emerges on the one hand through the actions of the management itself, and on the other by the influences of the environment.

While some organizations generally try to avoid growing organizational complexity by focusing on single business segments or customers, others attempt permanent adjustment and incorporate environmental complexity. As a result, the latter has to cope with high levels of organizational complexity. Apparently organizations can suffer from too much complexity, which leads to a decrease in profits, reduced organizational flexibility and dissipating energy. Organizations that are too inflexible due to their simplicity, however, might not be able to meet the changing requirements of the market. The interesting questions are (i) whether an optimum of organizational complexity does exist and (ii) how important the level of complexity is in terms of explaining organizational performance. Naturally, examples of all possibilities can be found in real life: simple-unsuccessful and highly complex-unsuccessful, simple-successful and highly complex-successful organizations are all existent.

General Electric (GE) is an appropriate example. With more than 300,000 employees and 500 mergers and acquisitions in five fiscal years (between 2002-2007), it is one of the most complex organizations and also one of the most successful. In contrast, EasyJet demonstrates that highly focused yet simple organizations can be very successful as well.

Studying the fundamental dilemma of complexity by examining the phenomenon, its characteristics and influences on and within organizations is important to improve understanding and, ultimately, the quality of management and performance of organizations.

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23 cf. Lewin, R. (1999), pg. 188.
26 cf. Thomson Onebanker.
27 Thomson Onebanker.
1.2 Goals and structure of this thesis

The main goal of this thesis is to resolve the theoretical inconsistency and to explain and empirically test how organizations should respond to growing environmental complexity. By hand of an empirical study the thesis aims at adding to existing complexity theory literature – where empirical studies are still rare – and establishing a reliable basis for further research. As a result it will strengthen the operational relevance and acceptance of complexity theory in business science (Figure 2).28

To achieve these goals the thesis is broken down into two major parts, the conceptual framework and the empirical study.

Following the introduction (chapter one), PART I – Conceptual framework – starts with the “Theoretical basis” (chapter two), which includes the definitions of the central terms of this thesis: organization, complexity and globalization. Afterwards the theoretical framework of complexity science is explained. First, the roots of complexity theory, system theory and chaos theory are examined. Subsequently, complexity theory itself will be discussed along with different approaches and their development in business. Of particular interest is the question whether complexity theory is already a commonly established theory. The discussion of complexity theory ends with its adaptation to the research object – organization – by discussing and explaining the concept of “organizations as complex adaptive systems”. The chapter “Theoretical basis” closes with an integrative approach to complexity and globalization. In this section, the major resulting dilemmas for organizations are extracted and the reasons for continuously growing business environmental complexity are studied. In doing so, the whole section offers a deep insight into the characteristics of complexity, globalization and their interconnectedness. Furthermore, it clarifies the practical dilemmas for organizations and their management caused by these two phenomena.

The third chapter presents the research questions and hypotheses. In order to define the parameters, the aforementioned theoretical inconsistency is discussed in detail. By distinguishing between two different qualities of organizational complexity it will be possible to define specific hypotheses in order to most appropriately test Ashby’s and Luhmann’s theories.

In the fourth chapter the appropriate research method for testing the hypotheses is defined.

PART II – the empirical study of the thesis – starts with chapter five, in which the empirical model is developed.

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Figure 2: Structure of the thesis.²⁹

²⁹ Own source.
At first a theoretical measurement model of organizational complexity is established. Second, an Exploratory Factor Analysis is applied to test the theoretical assumptions and to develop a reliable measurement model for organizational complexity. It will also be possible to test if organizational complexity is a multi-dimensional construct.

Third, different perspectives of performance are discussed before developing a measurement model for organizational performance. Fourth, both measurement models are combined and the relationship between both latent constructs is defined in a Structural Equation Model. In sum, the chapter presents the model, the test algorithms employed and the model's evaluation.

The sixth chapter discusses the advanced statistics – the testing of the hypotheses. In this context, the model is tested three times: first for the total sample, second for two subgroups being divided by median, and third for subgroups divided by quartiles. With this it will be possible to test an inversely u-shaped correlation between organizational complexity and organizational performance. The sixth chapter ends with a discussion of the findings.

The seventh chapter summarizes the findings of the empirical study and discusses both the implications for theory – How this thesis could improve complexity theory – and implications for management – How organizations should respond to growing business environment complexity.

The thesis ends with the findings’ implications for further research.
PART I Conceptual framework

2 Theoretical basis

This chapter discusses the theoretical basis and nature of complexity theory. The main question this chapter addresses is: What is complexity science? In general the opinions differ greatly. While some research concludes complexity theory to be one of the major new theories in business science, others dismiss its relevance entirely. In the following section, the strengths and weaknesses of existent complexity theory research are discussed in detail. Here the aim is to deepen the understanding of the different approaches to complexity science.

The chapter begins with the definition of the main elements of this thesis. The second part presents the theoretical framework, the roots of complexity science and complexity science itself. Here the theory of organizations and the complexity theory are merged with the concept of organizations as complex adaptive systems (CAS). At the end of the chapter a synthesis of the complexity and globalization phenomena leads to the discussion of six major dilemmas for globally acting organizations.

2.1 Definitions

The following section presents the essential terms and definitions used, in order to adequately discuss the topic in full. In light of this works’ focus, the terms organization, complexity and globalization are explained in detail.

2.1.1 Organization

A universal definition of organization and organizational studies can hardly be found, as these are multilayered concepts: “organizations as empirical objects, organizations as theoretical discourse, and organizing as social process…” 30

In general, existing definitions of the terms mainly focus on the characteristics of organizations from either a structural or a procedural point of view.

The theoretical discourse approach bases its definition of organizations on bureaucracy (BLAU, et al.) or simple structures (MINTZBERG) and defines them as systems with more

30 Clegg, S., et al. (1996), pg. 3.
than one person, different levels of hierarchy and a division of labor. Structuralists such as WEBER and BLAU, et al. study organizations by focusing on span of control, layers of hierarchy, decentralization etc.

Similarly, the field of organizational studies defines organizations as a social process, like BLAU/SCOTT, BARNARD and NELSON. In particular, they define organizations as a system with two or more interacting persons. Their research focuses on studying the interaction of these people or agents (individuals, partners, groups, parent organizations).

An example of such a social process-driven definition is given by CLEGG, et al.:

“Organizations are (…) sites of situated social action more or less open both to explicitly organized and formal disciplinary knowledge such as marketing, production, and so on, and also to conversational practices embedded in the broad social fabric, such as gender, ethnic and other culturally defined social relations, themselves potential subjects for formally organized disciplinary knowledge, such as anthropology, sociology, or even, organization studies”.

In addition there are a number of definitions, which combine characteristics of both the structural and the procedural viewpoint. The definition offered by MACHARZINA/OESTERLE proves to be particularly suitable in the context of this thesis:

“Organizations build the structural basis for the cooperation of persons, material resources and information between the corporation and its environment, which consequently results in a certain mode of interaction between the environment and the corporation”.

Interactions with the environment and the process of organizational response and adaptation to environmental contingencies and changes have been of great interest to a number of researchers in the field.

Many contingency researchers like BURNS/STALKER, LAWRENCE/LORSCH, THOMPSON argue that organizations’ structures and decision-making processes must fit the demands of their external environments. The organization is not self-contained in that it can act

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37 cf. Macharzina, K., Oesterle, M.-J. (1999), pg. 349.
independently of its competitors and its general business environment.\textsuperscript{39}

The contingency theory suggests that there is no optimal way of structuring or operating organizations. Key forces or drivers in the environment determine appropriate configurations.\textsuperscript{40} Whether an organization adapts or fails to adapt to its environment can make or break the business.\textsuperscript{41}

In summary, it can be concluded that organizations are defined and shaped by their structure, their processes and their environment. Therefore all these aspects will be considered in the following study of organizations.

\textbf{Figure 3: Characteristics of different definitions of organization.}\textsuperscript{42}

\textsuperscript{39} cf. Robertson, D. A. (2004), pg. 73.
\textsuperscript{41} cf. Robertson, D. A. (2004), pg. 77.
\textsuperscript{42} Own source.


2.1.2 Complexity

Complexity can be generally defined as an attribute of a system. The term "complexity" derives from the Latin term “complexus” which means interwoven, networked and connected. In today’s parlance complexity is a frequently used, abstract and multidimensional term. The interpretation of the word tends to be rather subjective, making the process of consideration and the context of the examined system crucial. Particularly the context of the contemplator, his point of view and his perception are important and determine the understanding and definition of complexity. It is therefore essential to thoroughly set the parameters in which the term complexity is used in this thesis’ discussion.

The term complexity originated in the field of natural sciences. Due to the interdisciplinary investigation of the phenomenon, there is neither a universally accepted definition nor any prevalent opinion about what constitutes complexity.

Even though existing definitions of complexity cannot be readily applied to organizations, they are still helpful in understanding the problems complex organizations face.

There is a large spectrum of definitions ranging from superficial, as for example provided by LEWIS, to fairly comprehensive, as for instance mentioned by YATES. YATES defines five attributes of complexity: significant interaction, great number of parts, nonlinearity, broken symmetry and non-holonomic constraints, from which one or more have to interact to create a complex system.

The origins of organization and management research in the German-speaking region can be traced back to Hans Ulrich’s “St. Gallener Schule” and Werner Kirsch’s “Münchener

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50 cf. Burnes, B. (2005), pg. 81; Backlund, A. (2002), pg. 38; a clear and distinctive description of different definitions is given by Stüttgen, M. (1999), pg. 16 et seq.; Lewis, R. (1994) state: Complexity is defined as that zone between stability and predictability, on one side, and chaos and unpredictability, on the other.
51 A nonholonomic constraint is defined as constraint that can not be described by a function of influencing elements. Thus the constraint does not only depend on the determinants of a system and time, but also on other non system inherent factors.
Definitions

They discussed questions of how to cope with complexity, system evolutionary management and complex adaptive systems. In the Anglo-Saxon region the approaches are closely related to the works of Beer. Some researchers emphasize the need for more specific definitions and characterizations of complexity in order to be able to apply them to business administration more effectively. One radical position in this context is held by Van Gigch who states: “Given the difficulty of finding a unique, all-encompassing definitions of complexity, we must resort to an ad hoc case by case approach that depends on the problem at hand”. This thesis argues for specific definitions of complexity that are in accordance with the research field they apply to. Nonetheless it is crucial to establish a common understanding and general definition within these fields. An ad hoc case-by-case approach will hardly lead to valid and generalizable results.

Therefore a common definition of complexity is used in the following section. Due to the order-generating approach intrinsic to organizational science the aim is to define complexity by the constituting elements.

There is general consensus in the literature that the number and diversity of the elements and their relationships as well as system-inherent dynamics constitute complexity. This general definition, established by Ulrich/Probst, was advanced and improved upon by Lane, et al. and Steger, et al. among others. The following conceptualization is based on the ideas of Steger, et al. and defines four dimensions that constitute complexity: diversity, ambiguity, interdependence and fast flux, as shown in Figure 4.

57 For a detailed discussion of organizational science and its approaches please refer to section 2.2.2.


2.1.2.1 Diversity

Diversity, defined as plurality of elements, encompasses the physical and structural elements of organizations, as well as their environment. In many cases, Global companies face diversity from inside and outside the organization. Diversity is one of the key elements of complexity and therefore crucial for the understanding of complexity and complex structures.

Diversity is based on a quantitative understanding of complexity. Plurality of elements covers two major aspects of diversity: the number of elements (multiplicity) and the dissimilarity of elements (variety). In general, diversity determines the ability of a system to incorporate a certain number of different states in a given time span. Therefore, diversity is inherent in complexity and illustrates the complexity of organizations. Within the organization, diversity is present in the human resource pool, in different mind-sets, cultures and behaviors, in distinct management systems, leadership and control systems, business models, products and processes, goals, strategies and structures.

The external complexity, which can affect a company, is represented by heterogeneous

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60 cf. Ibid., pg. 4; Lane, H., et al. (2006), pg. 3 et seq.
64 cf. Maznevski, M., et al. (2007), pg. 4 et seq.
costumer needs, globally acting stakeholders and shareholders with a wide range of demands, multiple competitors with different strategies, diverse political systems, economic and legal environments and an overwhelming amount of contradictory trends.65

### 2.1.2.2 Ambiguity

Another major element of complexity is ambiguity. This phenomenon is related to the available information regarding the business environment and the internal flow of information. Ambiguity broadly covers the richness, predictability, accuracy and availability of information.66 Increased ambiguity is caused by the declining predictability of relevant aspects inside and outside the organization.67 Ambiguity can be defined as “too much information with less and less clarity on how to interpret and apply findings.”68 Thereby ambiguity evolves e.g. from the need to cope with a large amount of information that might be incomplete or invalid.69

As DAFT/WEICK state, managers are forced to “wade into the ocean of events that surround the organization and actively try to make sense of them”.70

External ambiguity as a dimension of complexity has been the basis of much scientific research, even though researchers may use different terminology in their work. DUNCAN, DESS/BEARD, FOMBRUN/GINSBERG, JURKOVICH, PERROW and TUNG have investigated uncertainty in terms of unpredictability and variation of change in industry variables. Uncertainty is an ambiguity component of the complexity concept as mentioned above.71

Especially with respect to the internal organizational perspective, ambiguity can be defined as the existence of multiple, conflicting interpretations of situations, goals and processes. Hence, it is an important driver of organizational complexity.72

### 2.1.2.3 Interdependence

In general it can be stated that, “as a model’s elements become increasingly interconnected, it becomes increasingly complex.”73 The construct of interdependence has two dimensions. On

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65 cf. Ibid., pg. 4.
68 Maznevski, M., et al. (2007), pg. 5
the one hand, internal interdependencies, which are mainly shaped by organizational structure. On the other hand, relations with stakeholders and shareholders or even outsourcing partners, which cause external interdependencies. As a result, interdependence or coupling, which can take place either inside the organization or in relation to the organization's environment, can be low and loose or high and tight.\textsuperscript{74} As \textit{FISS} points out, organizations can best be understood as clusters of interconnected structures and practices instead of regarding them as modular or loosely coupled entities whose components can be analyzed apart from one another. \textit{ALDRICH} defines loose coupling as status “when structures and activities in various parts of an organization are only weakly connected to each other and therefore free to vary independently.”\textsuperscript{75}

\textit{AXELROD/COHEN} define a system as being complex if “there are strong interactions among its elements, so that current events heavily influence the probabilities of many kinds of later events.”\textsuperscript{76}

In practice managers have to take the effects of local and non-local events into account, as high numbers of internal and external relationships exist. Sometimes these events are totally unknown, which can obscure any clear cause-and-effect relationship.\textsuperscript{77}

Despite the challenges brought about by growing interdependencies, there are also positive effects, which result in a dilemma with respect to the management of this complexity driver. Connections and especially high interdependence in organizations enable the elements to transmit information more effectively and lead to opinion making among subunits. Therefore they strengthen the organizational ability and capability to learn.\textsuperscript{78} Dense connections are important inside the organization for the creation of ideas and the synthesis of goals. They can also lead to a better interpretation of the externalities and therefore facilitate the co-evolution with the environment.

Interdependencies are crucial for the information flow inside organizations; an oversimplification would narrow the view of what is happening inside and outside the organization.\textsuperscript{79}

Another important aspect of organizational complexity is given by the interdependency of goals. From a strategic point of view, interdependence is also reflected by dependencies

\textsuperscript{73} cf. Brewer, G. D. (1973), pg. 7.
\textsuperscript{74} cf. Aldrich, H. A. (1979), pg. 76 et seq.; Glassman, R. (1973), pg. 83.
\textsuperscript{77} cf. Maznevski, M., et al. (2007), pg. 5.
\textsuperscript{78} cf. Ashmos, D. P., et al. (2000), pg. 579.
\textsuperscript{79} cf. Weick, K. E. (1979), pg. 86.
between different corporate aspects such as reputation, financial flows, value chain flows, top management and corporate governance.\textsuperscript{80}

### 2.1.2.4 Fast flux

The fourth driver of complexity related to organizational and business environmental change is fast flux.\textsuperscript{81} Generally fast flux describes the transient nature of the organization and its environment.\textsuperscript{82} It is a major component of complexity since complexity could be defined by the number of different states that a system can have within a given span of time.\textsuperscript{83}

Fast flux or change encompasses the occurrence of events and their impact on the organization and its environment by providing a description of the timing, duration, speed and frequency of the change.\textsuperscript{84} It includes governmental and politically induced change, market-related change, as well as organizationally and individually initiated change.\textsuperscript{85}

Inside the organization, change can be defined by the degree of its dispersal, radicalism, required reorientation, novelty, divisiveness and forcefulness.\textsuperscript{86} As MCKELVEY argues, a consideration of these components of change will enable firms to allocate resources appropriately and manage complexity.\textsuperscript{87}

Due to the fact that change affects – though to different extent – all parts of organizations and environments, it also significantly influences the other drivers of complexity. All three above mentioned drivers are subject to change at any time. Change or dynamic is defined as variation of elements of a system. The variation of their characteristics in the course of time\textsuperscript{88} is part of complexity.\textsuperscript{89} Therefore, strategies to cope with increasing complexity need to be improved continuously at a high pace.\textsuperscript{90}

If all four drivers are combined with their individual elements and interconnections to each other, the complexity phenomenon substantiates. The given differentiation and identification of the particular dimensions and drivers of complexity should help to concretize the understanding of the term. This concept will constitute the basis for the construct of

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\textsuperscript{80} cf. Maznevski, M., et al. (2007), pg. 5.
\textsuperscript{82} cf. Woodward, D. (1993), pg. 5.
\textsuperscript{84} cf. Woodward, D. (1993), pg. 5.
\textsuperscript{85} cf. Ibid., pg. 5.
\textsuperscript{86} cf. McKechnie, G. (1976), pg. 165 et seq.
\textsuperscript{87} cf. Ibid., pg. 165.
\textsuperscript{88} cf. Grossmann, C. (1992), pg. 18.
\textsuperscript{89} cf. Keuper, F. (2005), pg. 18; Reuter, J. (1998), pg. 134 et seq.
\textsuperscript{90} cf. Maznevski, M., et al. (2007), pg. 5.
complexity as employed in the context of this thesis. In sum, complexity as a term utilized in this work is defined as being constituted by its drivers, diversity, ambiguity, interdependence and fast flux. The higher the value of these drivers the higher is the complexity.\(^91\)

### 2.1.3 Globalization

Globalization is strongly related to complexity in a business science context and proves to be one of the core challenges for organizations.\(^92\) In this section, globalization will be defined and discussed due to its marked influence on the drivers of complexity and the resulting complexity of organizations.

Over the last decade, globalization has been a prominent buzzword, responsible for political controversy and the downfall of many companies.\(^93\) However, there are several reasons to assume that globalization is different from the variety of trends and fashions known since World War II.\(^94\)

Globalization has influenced the social sciences since the beginning of the 1990s. Both sociologists and economists have discussed and debated its meaning, which has resulted in several definitions of globalization in business science.\(^95\)

As ROBERTSON states, globalization can best be understood as the process of how the world becomes “united”.\(^96\) The integration happens on different levels of society, for example in the realms of economics, politics and culture.\(^97\) Sometimes such integration can cause a harmonization of rules and behaviors, but also of customer’s needs and tastes.\(^98\)

Another definition is given by GIDDENS: Globalization can be defined as the “intensification of worldwide relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa. This is a dialectical process because such local happenings may move in an obverse direction and form the much distanced relations that shape them. Local transformation is as much a part of globalization as the lateral extension of social connections across time and space.”\(^99\)

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\(^91\) At this point it should be mentioned that it is not possible to assess the total value of complexity. As shown in figure 4 the drivers are overlapping and therefore not perfectly additive. Additionally the impossibility of dividing complexity into parts and reassembling it once again will be discussed later.


\(^93\) cf. Steger, U. (2003), pg. 8; Knyphausen – Aufseß, D. z. (2000), pg. IX.


\(^96\) Robertson, R. (1992), pg. 51.


\(^99\) cf. Giddens, A. (1990), pg. 64.
These definitions of globalization make the close relationship to complexity apparent, but do not yet cover all aspects of globalization. Generally, globalization is a multi-dimensional process with various, dynamical, cross-linked and non-linearly interacting elements.\textsuperscript{100} The key elements, which can be considered as major characteristics of globalization, are briefly considered in the following discussion to underline their relationship with complexity.\textsuperscript{101}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{Characteristics of globalization.\textsuperscript{102}}
\end{figure}

**Boundary Erosion:** A major factor of globalization is the erosion, or even elimination, of boundaries in all spheres of life.\textsuperscript{103} Boundary erosion, the blurring of the boundaries or mitigation of distinction between “in” and “out”, and “us” and “them”, has been evident within business, social cultural and even political environments, which are faced with the growing intensity and volume of global interactions.\textsuperscript{104}

A once prominent political boundary – the “Iron Curtain”, symbolized by the Berlin Wall – crumpled, along with many boundaries within societies (e.g. between genders in educational systems). Due to this development, society and the national and global political environment, which was once dominated by the East-West confrontation, have become increasingly independent and diverse. In the economic sphere, financial markets are almost completely integrated\textsuperscript{105} (as observed with the recent US-subprime mortgages crisis and its effect on financial markets around the globe), followed by markets for industrial goods, based on

\textsuperscript{101} The following characteristics were firstly introduced by Steger, U. (1998), The following discussion refer to Steger, U., Schwandt, A. (2009); Steger, U., Kummer, C. (2002), pg. 183 et seq.
\textsuperscript{102} Own figure reffering to Steger, U. (1998)
\textsuperscript{103} cf. Appadurai, A. (2001), pg. 27.
\textsuperscript{105} cf. Ibid., pg. 8.
effective logistic chains.\textsuperscript{106} However, the process of boundary erosion is neither complete nor irreversible. Boundaries have two important functions: first, they define identity, and second, they help to keep the negative influences outside and limit the impacts of events.\textsuperscript{107} In a national economy, a mortgage crisis elsewhere on the globe would be inconsequential, as the domestic economy would not be affected. In a global world, however, this is different. And it has additional unforeseen consequences: from the resurgent expression of Muslim identity, as well as anti-immigration and protectionist sentiments, the increasingly borderless world puts identity and (perceived) security at risk. In response to this, new barriers are being established. Until now, the dynamics of globalization have over-compensated with the creation of new boundaries, and the benefits seem to outweigh the disadvantages.\textsuperscript{108} Furthermore, companies have learned: the “Corporate Social Responsibility” (CSR) movement is obviously a response to the sharper edges of globalization which it aims to soften.

\textbf{Factor Mobility:} During the 1980s, globalization gained momentum and was strongly supported by sinking transaction costs. This resulted in a first wave of globalization, characterized by the rise of so-called world productions, which were aimed primarily at the realization of economies of scale. As a consequence, the number of cross-border transactions experienced a dramatic increase, which indicates that the mobility of capital and other resources was one of the main characteristics of the globalization phenomenon.\textsuperscript{109} The deployment of financial resources abroad allowed many companies to benefit from specific regional advantages in foreign countries. The amount of foreign direct investments (FDI) is one of the most frequently used indicators for the degree to which a country engages in globalization. Today, even know-how becomes increasingly mobile, as people tend to be more cosmopolitan and are willing and able to accept work almost anywhere in the world.

\textbf{Heterarchy:} Hierarchies, or in other words, vertically-structured forms of power, that are typical for the national state or military, are replaced by heterarchies, which are horizontally-structured and consist of entities that have a high self-reliance and rather equal amounts of power. Heterarchies are typical for the second major wave of globalization.\textsuperscript{110} This wave resulted in higher degrees of individualization and freedom and gave rise to an increase of cross-border services. Therefore, multiple types of organizations with internationally

\textsuperscript{107} Steger, U., Schwandt, A. (2009), pg. 23.
\textsuperscript{108} cf. DTI (2004), pg. 10 et seq.
\textsuperscript{110} cf. Ibid., pg. 10.
Definitions

operating suppliers, competitors and even customers have been established. They often cooperate in networks of various kinds of partnerships that no longer constitute clear hierarchies.

Legitimacy Erosion: As a consequence of growing heterarchy it can be difficult to clearly assign tasks and responsibilities. The decline of organizational authority and responsibility in heterarctic networks has created legitimacy crises for both economic and political authorities. Due to cultural differences, the legitimacy erosion is a major challenge, especially for international networks that constitute partnerships. The central control of governments or traditionally (hierarchically) organized companies, are substituted by decentralized control and distributed nodes of power to overcome this erosion.111

Past-Future-Asymmetry: The past no longer gives clear indications for the future. Globalization has broadened the options for production and marketing, which can lead to severe changes in the process of value generation. To maintain competitive advantages, companies must respond to these changes quickly and often to find new solutions.112

Variety of Options: The mobility of resources and heterarctic structures offer new opportunities to organizations. However, there is often a high degree of uncertainty about these options and the appropriate decisions that have to be made accordingly.

These major characteristics of globalization cause growing business environmental complexity for most organizations. Following the discussion of the theoretical framework of this thesis, both concepts – complexity and globalization – are consolidated to analyze their practical impact on organizations.

111 cf. Ibid., pg. 10.
2.2 Theoretical framework

“\textit{The difficulty lies, not in the new ideas, but in escaping from the old ones, which ramify for those brought up as most of us have been into very corner of our minds.}”\cite{113}

As implied in the definition of complexity, managing it requires a way of thinking, acting and organizing that transcends the typical control mentality.\cite{114} The following section introduces complexity science as one approach to this new way of thinking. As \textit{BURNES} states, complexity theories and the idea of simple, order-generating rules have an attractive elegance, especially when they are combined with the understanding of the complexity of the organizational world.\cite{115} While complexity theory has made significant progress and has attracted a lot of attention, the practical application has not been commonly established and is often viewed as an elusive concept.\cite{116} Nevertheless, linear management principles are not appropriate to deal with complexity and discontinuous change. Hence, it is necessary to incorporate new theories like complexity theory to develop a new understanding of organizations and their interaction with their environment.\cite{117}

The following section presents the theoretical framework of this thesis, the complexity science, and discusses its approach as well as its value for the analysis of organizations. In order to test its applicability, the nature of complexity science will be discussed and the question whether the theory is a definite established theory will be addressed.

It will be concluded that it may be too early to discern whether complexity theory is truly established due to a lack of objectivity regarding the construct of complexity itself, as well as the missing substructure of reliable empirical studies.

\begin{flushright}
\footnotesize
\textsuperscript{113} Keynes, J. M. (1936), pg. vii; furthermore Knyphausen – Aufseß, D. z. (1992), pg. 159. \\
\textsuperscript{114} cf. Maznevski, M., et al. (2007), pg. 4, 6. \\
\textsuperscript{115} cf. Burnes, B. (2005), pg. 80. \\
\textsuperscript{117} cf. Daneke, G. (1997), pg. 249.
\end{flushright}
2.2.1 Roots of complexity science

Complexity science has its historical roots in theories such as cybernetics, catastrophe theory, system theory, chaos theory and many others, as shown in Figure 6.\textsuperscript{118}

![Figure 6: Roots of complexity science.\textsuperscript{119}]

In the following section the system theory and chaos theory, as the two central and most influential theories, are discussed in detail. They must be integrated into the theoretical discussions, because the underlying philosophy, principles and laws of anti-reductionism, holism and interconnectedness are partially similar in nature.\textsuperscript{120}


\textsuperscript{119} Own source. reffering to Bandte, H. (2007), pg. 48; Goldstein, J. (1999), pg. 55.

\textsuperscript{120} cf. Richardson, K. A. (2004), pg. 75; Phelan, S. E. (1999), pg. 237.
2.2.1.1 System theory

The system theory is a fundamental theory dating back to Greek philosophers who assumed that there has to be a rational order in the world.\textsuperscript{121} The general system theory attempts to elucidate essential principles that can be found in all types of systems whose components are linked by feedback loops.\textsuperscript{122} Cybernetics explains the world in a similar way. A differentiation between both theories is therefore difficult and they are often used interchangeably.\textsuperscript{123} However, slight discrepancies exist. Cybernetics is technology-oriented while system theory focuses on natural and social systems.\textsuperscript{124} Thereby, systems theorists adopted a holistic approach, where any given phenomenon has to be studied within the entire context in which it is embedded.\textsuperscript{125} In general, several system theory approaches exist, which are uniquely adapted to their research field.\textsuperscript{126} Due to the focus of this thesis, the following section on systems theory concentrates on its applicability to social systems (organizations).\textsuperscript{127} The system theory evolved over time and induced several changes of paradigms.\textsuperscript{128}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{systemTheoryChanges.png}
\caption{Paradigmatic changes of systems theory.\textsuperscript{129}}
\end{figure}

Initially, systems theory utilized the reductionistic approach of breaking a system down into its components to study their behavior in relation to the larger whole.\textsuperscript{130} A considerable

\begin{flushright}
\textsuperscript{121} cf. Bertalanffy, L. (1972), pg. 407.  \\
\textsuperscript{123} cf. Heylighen, F. (1997), pg. 33.  \\
\textsuperscript{125} cf. Phelan, S. E. (2001), pg. 132.  \\
\textsuperscript{127} For a detail discussion of cybernetics see Bandte, H. (2007), pg. 63 et seq.  \\
\textsuperscript{128} cf. Bertalanffy, L. (1972), pg. 25; Bandte, H. (2007), pg. 67.  \\
\end{flushright}
difference of the general systems theory's approach was the preference for modeling interactions rather than simplifying them. The first paradigmatic evolution resulted in an approach in which systems are defined as being open with regard to their relation to the environment. Systems are therefore defined by their differentiation from their environment and their relationship to this environment. Since the different parts of a system are defined as a small system in the larger environment, this theory includes the whole-part approach. In the 1950s and 1960s, general system theory introduced the notion that occurring phenomena have a variety of complex causes, since they are interrelated, nonlinear, and difficult to determine. Therefore, the whole is more than the sum of its parts, and the analysis of discrete elements will not be sufficient to understand the system.

The next paradigmatic change takes a step further in that it defines a system by its self-referencing identity and distinction from another system. These systems were called autopoietic, meaning that they are able to regenerate the elements and relationships of the systems on their own.

Complexity is a central theme in systems theory, which makes it possible to differentiate between simple, complex and very complex systems. Furthermore, systems theory plays an essential role in the development of complexity theory, with one mayor theoretical distinction being the system theory’s relative disinterest in the identification of regularities with respect to complexity.

The system theory can be applied to examine organizations at any level. Within the boundaries of an organization or system, an infinite number of subsystems exist. Hence, it is possible to break down the research object (organizations) into different parts, analyzing some more than others. The theory, however, promotes an integrated and holistic point of view and postulates the simultaneous consideration of both the micro and macro-

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132 cf. Prümm, P. (2005), pg. 27 et seq.
142 Jokela, P., et al. (2008), pg. 198.
organizational levels.\textsuperscript{143}

\textit{BUCKLEY} summarizes the fundamentals, approaches and concepts provided by system theory for studying organizations in the following way:

System theory provides:

- A common vocabulary unifying the diverse behavioral disciplines.
- A technique for analyzing large complex organizations.
- A synthetic approach where an individual analysis cannot be accomplished due to the intricate interrelations between elements that may not be treated in an isolated context.
- A point of view that is strongly related to sociology because it perceives the socio-cultural system in terms of information and communication nets.
- The study of relations rather than entities, with an emphasis on process and transition probabilities as the basis of a flexible structure with numerous degrees of freedom.
- An operationally definable, objective non-anthropomorphic study of purposiveness, goal setting, system behavior, symbolic cognitive processes, consciousness and self-awareness, socio-cultural emergence and dynamics in general.\textsuperscript{144}

As discussed by \textit{ULRICH}, the system theory defines organizations and their environment as being interdependent, complex and dynamic systems, with limited possibilities for the management to influence the behavior and characteristics of the system.\textsuperscript{145} Due to the definition of organizations as subsystems of bigger systems (business environments), the system theory is frequently used to study the fit between organizations and business environments.\textsuperscript{146}

In summary, it is reasonable to say that system theory provides a synthetic, holistic approach for the analysis of organizations. Because it postulates that monocausal ways of thinking are not appropriate for the understanding of these systems, however, the theory complicates the application to practical problems in business science.\textsuperscript{147}

\begin{flushleft}
\textsuperscript{143} Edwards, M. G. (2005), pg. 269.\\
\textsuperscript{144} cf. Daneke, G. (2005), pg. 95; Buckley, W. (1967), pg. 178.\\
\textsuperscript{145} cf. Ulrich, H. (1968), pg. 113.\\
\textsuperscript{146} cf. Knyphausen – Aufseß, D. z. (1995), pg. 303.\\
\end{flushleft}
2.2.1.2 Chaos theory

Complexity science is also closely related to chaos theory. Chaos theory illustrates the unpredictable behavior of deterministic rules.\textsuperscript{148} Even if there are fundamental differences in the underlying approach, similarities with regard to the consideration of organizations as chaotic or complex systems exist.\textsuperscript{149} Hence the purpose and content of the chaos theory are presented in the following section.

Chaos theory evolved in the field of mathematics and particularly in models of biological populations of nonlinear, dynamic systems.\textsuperscript{150} After that, it has been applied and adapted to different areas like the analysis of climate and weather, turbulences and fluid dynamic phase transitions, as well as molecular evolution.\textsuperscript{151} Additionally, chaos theory has been extended to apply to business cycles, finance, organizational structures, patterns of urban growth and more.\textsuperscript{152}

If organizations are treated as chaotic (non-linear dynamic) systems, they are characterized by
(i) a status of unstable equilibrium,
(ii) sensitivity to initial conditions,
(iii) irreversibility and
(iv) by the fact that they could create structures called strange attractors during their evolution.\textsuperscript{153}

(i) Theoretically, chaotic systems can demonstrate three different types of equilibrium.\textsuperscript{154} First, a stable equilibrium is caused by negative feedback, alleviating the influence of variables. Thus, after a change the system always comes back to its initial state.\textsuperscript{155} The second type is the situation of explosive instability. Here the change is accelerated through positive feedback and results in an exponential change of the system. The third type is a mixture of both abovementioned types and comprises realistic characteristics of organizations. Positive and negative feedback constitute counteracting forces commonly found in organizations: some of them push the system towards instability and disorder (e.g. innovation, initiatives and experimentation) and others drive the system towards stability and order (e.g.

\begin{itemize}
  \item \textsuperscript{149} cf. Russ, M. (1999), pg. 5.
  \item \textsuperscript{151} cf. Dubinskas, F. (1994), pg. 358; For further informations about applications of chaos theory to other disciplines refer to Lorenz, E. (1984); Miles, J. (1984); Kaufmann, S. (1991).
  \item \textsuperscript{153} cf. Thietart, R. A., Forgues, B. (1995), pg. 21; Liening, A. (1999), pg. 73.
  \item \textsuperscript{154} cf. Kiel, D., Elliot, E. (1997), pg. 21.
\end{itemize}
planning, controlling, structuring). The coupling of these forces leads to chaotic organizations.\textsuperscript{156}

(ii) These chaotic systems are sensitive to the initial conditions, making their behavior unpredictable in a long–term perspective.\textsuperscript{157} The impact a changed variable might have can only be predicted for a short time frame since small variations might have monumental consequences, which are impossible to predict beforehand.\textsuperscript{158} As a potential chaotic system, the organization’s evolution cannot be predicted. Even when only small changes are made, managerial actions can have grave and unintended consequences, which were outlined in section 1.1. As stated by THIETART/FORGUES, it is just a question of time before an unexpected behavior occurs.\textsuperscript{159}

(iii) Due to the counteracting forces, chaotic systems are continuously changing. Hence the probability of observing a system that returns to its initial state is extremely low.\textsuperscript{160} As such, the system behavior is considered to be irreversible when it is in a chaotic state. To organizations this means that corrective actions will not lead back to the initial state and the execution of the same action will not lead to identical results.\textsuperscript{161}

(iii) Nevertheless, in the course of this continuous change or chaotic evolution, where energy is exchanged with the environment, chaotic systems create new forms of order.\textsuperscript{162} These forms are called attractors.\textsuperscript{163} They create an implicit order within the chaos.\textsuperscript{164} Organizations, which also exchange information and energy with the environment, similarly create stable parts in the chaos in form of organizational configurations.\textsuperscript{165} Even if the internal processes are very distinct, an organization demonstrates regularities concerning its macro characteristics.\textsuperscript{166}
The concept of chaos found its way into management literature because it proves to be an applicable theoretical framework for the dynamic and complex interactions among actors within organizations or industries. Since organizations or industries, however, can hardly be defined as chaotic systems, this research field has lost some of its appeal to complexity science.

One major reason why organizations are not treated as chaotic systems is that this approach has not produced substantial results for management science. In contrast, complexity theory is growing in importance due to its diverse approaches. While chaos theory is concerned with unpredictability, complexity theory is concerned with order, which is expected to be within the range of managers. Chaos theory demonstrates that simple laws can have complicated, unpredictable consequences, whereas complexity theory is concerned with how complex causes can produce simple effects. Furthermore, complexity theory is more expansive in that it includes intentional relationships of systems with their environment and therefore defines systems as not externally dominated. Complexity theory combines the strength of the system and chaos theory with a new theoretical framework to search for order-generating rules.

### 2.2.2 Complexity theory

In general, the term “complexity theory” can be defined as a generic term for a number of theories and ideas that are derived from different scientific disciplines, as shown in Figure 6. The beginnings of complexity theory are closely related to the chaos and systems theory, as discussed above. The main principles of complexity theory were developed by the observations of natural sciences, in particular biology. Moreover, researchers of meteorology, physics, chemistry and mathematics discussed the phenomenon of complexity. In business science, a wide-ranging discussion about the practical value of complexity theory is in progress and it is questionable if the theory-building process has come to a conclusion.

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170 cf. Ibid., pg. 72; Morcöl, G. (2001), pg. 112.
In general, complexity theory deals with the nature of emergence, innovation, learning and adaptation.\textsuperscript{177} It is concerned with path dependencies of organizational change, self-organization as well as creativity and reflexivity.\textsuperscript{178} The goal of complexity theory is to describe, explain, and predict complexity arising from simplicity and development, and to identify its underlying rules and regularities.\textsuperscript{179} Consequently, complexity science postulates that generative rules and equations can be discovered.\textsuperscript{180} These are supposed to explain the observed complexity of the real world.\textsuperscript{181} In other words: complexity theory is concerned with the emergence of order in dynamic, non-linear systems.\textsuperscript{182} It tries to detect order in continuously changing systems where the laws of cause and effect are not applicable due to unpredictability and irregularities.\textsuperscript{183} As a result, similar behavioral patterns emerge through a process of self-organization, which are governed by a small number of simple, order-generating rules.\textsuperscript{184} As \textit{Phelan} states, complexity theory is a new science, especially because it has developed new methods for analyzing regularities, and not because it is a new approach for studying the world’s complexity.\textsuperscript{185} Science has always been about reducing the complexity of the world to (predictable) regularities.\textsuperscript{186} Consequently complexity science is defined by its research focus, which should be aligned with the methods applied during the search for regularities.\textsuperscript{187} The principle of studying a system as a whole is fundamental to the science of complexity.\textsuperscript{188} In 1938 \textit{Barnard} used aspects of complexity to describe organizations. He did not define organizations as a mechanic agglomeration of parts and functions, but rather as loosely coupled parts with elements of various relations and dependencies inside and outside the system.\textsuperscript{189} This early application of complexity-oriented thinking, however, did not lead to a continuation of adapting complexity theory to business science. Today's authors like \textit{Goldberg/Markoczy} and \textit{Houchin/Mac Lean} question the value of complexity theory and doubt that its principles can be applied in an organizational context.\textsuperscript{190} \textit{Ortegon-Monroy} and \textit{Smith/Humphries} also state that it is difficult to reconcile complexity

\textsuperscript{177} cf. Lissack, M. R. (1997), pg. 295; Weaver, W. (1948), pg. 536 et seq.
\textsuperscript{178} Wolfe, A. (1996), pg. 1073.
\textsuperscript{180} Knyphausen – Aufseß, D. z. (1995), pg. 332.
\textsuperscript{181} cf. Phelan, S. E. (2001), pg. 133.
\textsuperscript{182} cf. Burnes, B. (2005), pg. 77; Anderson, P. (1999), pg. 216.
\textsuperscript{185} cf. Phelan, S. E. (2001), pg. 130.
\textsuperscript{186} cf. Ibid., pg. 130.
\textsuperscript{187} cf. Ibid., pg. 130.
\textsuperscript{189} cf. Barnard, C. I. (1938), pg. 91.
Complexity theory

theory with practical matters.\textsuperscript{191} Herein they identified several inconsistencies like the tension between need for control and allowing self-organization\textsuperscript{192} As demonstrated in the following discussion, the applicability of complexity theory depends on the use of and fundamental approach to the theory.

Over time, different approaches to and interpretations of complexity theory offered by several authors created a rather incoherent body of work. It is therefore lacking a solid and robust theoretical framework.\textsuperscript{193} This has also been noted by GOLDBERG/MARKOCZY and ORTEGON-MONROY.

Many different approaches have been employed to adapt complexity theory to business science, especially within the analysis of organizations.\textsuperscript{194} Three different approaches to applying complexity science, studying complex systems, and searching for regularities, can be defined: reductionistic complexity science, soft complexity science, and complexity thinking.\textsuperscript{195}

\subsection*{2.2.2.1 Reductionistic complexity science}

The first approach often utilizes computers. It is not a truly holistic approach, even if the goal is to expose the totality of complex systems principles.\textsuperscript{196} Researchers try to reduce the diversity and richness of reality to a few powerful, all-encompassing algebraic expressions. This approach can be called reductionistic complexity science. As HORGAN points out, however “…the entire field of complexity... seems to be based on a seductive syllogism: There are simple sets of mathematical rules that, when followed by a computer give rise to extremely complicated patterns. And since the world also contains many extremely complicated patterns the obvious conclusion is, that simple rules underlie many extremely complicated phenomena in the world and with the help of powerful computers, scientists can root those rules out.”\textsuperscript{197} ORESKES notes that propositions that are, based on pure mathematics and logic, can only be verified if they are concerning "closed" systems. The logic behind this reductionistic approach is therefore not appropriate for the analysis of organizations.\textsuperscript{198} Organizational complexity has to be studied as a whole and research has to incorporate the internal and external relationship. It is not possible to cut complexity into small pieces in

\begin{thebibliography}{99}
\bibitem{192} cf. Ortegon-Monroy, M. C. (2003), pg. 393
\bibitem{193} cf. Houchin, K., MacLean, D. (2005), pg. 150.
\bibitem{195} cf. Richardson, K. A., Cilliers, P. (2001), pg. 5.
\bibitem{196} cf.Richardson, K. (2008), pg. 18.
\bibitem{197} Horgan, J. (1995), pg. 107.
\end{thebibliography}
order to study them independently.\textsuperscript{199} The reductionistic school of thought promises neat packages of knowledge and a universal language that is conveniently transferable to any context. It will not, however, deliver an answer to the majority of questions raised within social organizations.\textsuperscript{200}

### 2.2.2.2 Soft complexity science

The second approach to complexity science can be called soft complexity science. This approach supports the popular use of metaphor within managerial science.\textsuperscript{201} As \textit{Houchin/Mac Lean} point out, the best way of using complexity theory to understand organizations may be through an insightful metaphor, instead of trying to find common principles across a variety of very different systems.\textsuperscript{202} The consideration of this metaphor, and language in general, could shape the perception of the world through offering new cultural aspects, which making this approach useful and reasonable.\textsuperscript{203} In order to make sense of the word complexity, however, a context or frame of reference within which the term can be applied is needed. A new language will not function within an old context. It will only lead to an increased use of metaphors for its own sake.\textsuperscript{204} The use of metaphors is particularly prevalent in business studies.\textsuperscript{205} As a result there are many examples of analogical thinking and misuse of complexity science. Due to the fact that some writers do not examine, confirm or disprove their statements by empirical evidence, they end up undermining the credibility of complexity science.\textsuperscript{206} It is not surprising then that there is a fair amount of skepticism among researchers as to the applicability of complexity theory to business science.

How to cope with growing complexity is often only deduced metaphorically.\textsuperscript{207} Several authors like \textit{Stacey, et al., Shaw} and \textit{Kelly/Allison} use complexity metaphors and analogies to reconcile various complexity theory approaches with organizational research and practice. \textit{Brown/Eisenhardt} use metaphors, such as the “edge of chaos” or “continuously deforming landscapes”, to instruct managers in situations where strategy can be seen as structured chaos. Even if there is room for metaphors, however, there is a need for an

\textsuperscript{199} cf. Richardson, K. (2008), pg. 16.
\textsuperscript{201} cf. Richardson, K. (2008), pg. 19.
\textsuperscript{202} cf. Houchin, K., MacLean, D. (2005), pg. 152.
\textsuperscript{203} cf. Lissack, M. R. (1999), pg. 110.
\textsuperscript{204} cf. Richardson, K. A., Cilliers, P. (2001), pg. 6.
\textsuperscript{205} cf. Phelan, S. E. Ibid., pg. 134.
\textsuperscript{206} cf. Ibid., pg. 134.
\textsuperscript{207} cf. McKelvey, B. (1997), pg. 149.
empirical foundation within organizational and managerial science.\textsuperscript{208}

Going back to the roots of complexity science, it becomes clear that its principal aim is to: explain order creation and search for causes of growing complexity within organizations or business environments, and find solutions to how complexity can be managed.

\textbf{2.2.2.3 Complexity thinking}

The third approach, complexity thinking, is the least propagated in the wide field of complexity literature.\textsuperscript{209} This approach is focused on the epistemological consequences of assuming ubiquity of complexity. This view considers the limits of our knowledge in the light of complexity.\textsuperscript{210} According to this school, a fundamental shift in the way the surrounding world is interpreted is necessary.\textsuperscript{211}

Common scientific models reduce complexity in order to enhance understanding. Due to the incompleteness of these descriptions, a clear understanding of the limits of our knowledge has to be developed.\textsuperscript{212} Complexity science really is an order-creation science and even if it is not possible to understand all single aspects of the complexity of a system, one has to concentrate on the order-generating rules and underlying causes.\textsuperscript{213}

In agreement with the abovementioned definition of complexity, in particular, its four majors drivers, this thesis is in line with complexity thinking and aims at contributing to the body of knowledge. In this work, limitations to our understanding are accepted. It is therefore neither the intention to arrive at a holistic assessment of the total value of complexity in general nor of organizational complexity. The arguments made in this thesis do not allow the reductionistic approach, as they do not attempt to decompose complexity into its parts to subsequently merge them mathematically. Furthermore, it does not only use metaphors to study organizational complexity. On the contrary, it concentrates on the underlying causes and rules by adapting complexity thinking to organizations.

If the right approach is chosen, complexity theories will increasingly be seen as a way of understanding organizations and their behaviors by academics and practitioners.\textsuperscript{214} Hence, complexity thinking will be of growing importance for the management science.\textsuperscript{215} Authors

\textsuperscript{209} cf. Richardson, K. (2008), pg. 18.
\textsuperscript{210} cf. Ibid., pg. 21.
\textsuperscript{212} cf. Ibid., pg. 12.
\textsuperscript{213} cf. McKelvey, B. Ibid., pg. 139.
like *LYNCH/KORDIS* and *WULUN* already described complexity theory as an earth-shaking science, and there is no doubt that it is a scientifically well-established way of thinking.\(^{216}\) Over the past two decades, questions of interest to scholars of organizations have increasingly been viewed in the light of complexity science.\(^{217}\) The practical applicability and its application beyond metaphors, however, are challenging researchers in business science even today. Supporters like *WHEATLEY* state that theories established in complexity science are valid and can be transferred from natural to social sciences.\(^{218}\) Therefore, especially in recent years, scientists examine the structure and the behavior of organizations as complex adaptive systems.\(^{219}\) Complexity theory allows differentiated considerations and new perspectives to understand rapid change and to provide for example a basis for dualism of organizational forms, like the simultaneous presence of hierarchy and empowerment.\(^{220}\) Complexity science can be understood as a set of presuppositions that indicate a paradigmatic shift away from Newton's deterministic, reductionistic perspective.\(^{221}\) It questions the Newtonian notion of universal laws and recognizes the need for a modification of the reductionistic classical model of science. Nonetheless, complexity science is still rooted in scientific tradition and offers context-dependent, local generalization about natural and social phenomena, as determined by the applied approach.\(^{222}\)

### 2.2.2.4 Development of complexity theory in business science

Based on the discussion above, it can be assumed that complexity theory is an appropriate tool to studying organizations. The question addressed in this section is whether complexity theory is already commonly established or if the different approaches presented inhibit a general agreement about the terms.

By evaluating complexity science through theory assessment criteria such as clarity, explanatory power, reliability, intersubjective reliability and universality, it can be stated that there is a need for further research to establish a consistent complexity theory.\(^{223}\) In terms of clarity, aspects like path-dependency and self-organization become increasingly affirmed while other aspects, like creativity and reflexivity, are still subject to


\(^{221}\) cf. Luhman, J. T., Boje, D. M. (2001), pg. 158.

\(^{222}\) cf. Ibid., pg. 106.

\(^{223}\) For detailed descriptions of these characteristics of complex adaptive system please see chapter 2.3.Bandte, H. (2007), pg. 79 et seq.
Complexity theory

One general point of criticism is its broad focus and the lack of distinction with regard to other disciplines.\textsuperscript{224} If the accuracy of the hypotheses that explain practical phenomena and the premises of the use of the theory – explanatory power – is given, cannot yet be conclusively determined.

On the one hand, some researchers state that there is substantial theoretical explanatory power, particularly as complexity theory does not decompose the system, but focuses on the system as a whole.\textsuperscript{226} In response to this, \textit{BYRNE} points out that this does not mean that complexity theory is equivalent to holism.\textsuperscript{227} \textit{PRICE} states that: “General system theory focuses on the totality rather than its constituent parts, thus, it adheres to the holism in the conventional sense of the word. Complexity theory views this type of holism as just as problematic as the reductionism it nominally opposes – the conventional theory holism is reductionism to the whole. Holism typically overlooks the interactions of the organization, whereas complexity theory pays attention to them.”\textsuperscript{228} On the other hand, as stated above, the wide array of approaches to complexity theory has made it difficult to determine its explanatory power to this date.\textsuperscript{229}

Considering the scientific reliability it can be stated, by reviewing organizational studies on complexity science, that there is a shortage of reliable empirical studies.\textsuperscript{230} Aside from some case studies, as for example those performed by \textit{BROWN/EISENHARDT} and \textit{MACINTOSH/MACLEAN}, empirical evidence with regard to organizational science is lacking. This deficiency complicates the evaluation of reliability of the existent findings.\textsuperscript{231} Although further empirical studies in the wider field of business science exist, e.g. \textit{MILLER} and \textit{CANNON/ST. JOHN}, it is doubtful that the theory is built on an affirmed empirical basis. Intersubjective reliability is not given, as there is a lack of objective measures of complexity. Complexity is therefore a very subjective construct; the evolution of the theory depends on the objectification of the understanding of complexity.\textsuperscript{232}

Likewise it is impossible to evaluate the theory’s universality, since only a few studies exist in the young history of complexity science. It can be concluded then that the development of

\textsuperscript{224} cf. Wolfe, A. (1996), pg. 1073.
\textsuperscript{227} cf. Byrne, D. (2001), pg. 64.
\textsuperscript{228} cf. Price, B. (1997), pg. 10. As explained in chapter 2.2.1.1 the system theory evolved over the time and the criticism expressed by Price is only true for the first period.
\textsuperscript{230} cf. Houchin, K., MacLean, D. (2005), pg. 152.
\textsuperscript{232} cf. Ibid., pg. 82.
complexity science has by no means come to an end.\textsuperscript{233} 

\textit{HOUCHIN/MACLEAN} state that, “more empirical research is needed in organizations, as without this complexity theory is in danger of becoming a short-lived linguistic fashion statement.”\textsuperscript{234} Recognition of complexity-oriented research will therefore depend on the deductions made from the successful application of the concept.\textsuperscript{235}

To summarize the development of complexity theory in business science, it can be argued that the explanatory value of the complexity theory is more apparent than its implementation.\textsuperscript{236} Taking the current situation into account, this thesis will make explicit use of the explanatory value and will strengthen the applicatory value by the operationalisation of complexity as a multi-dimensional construct and the development of comprehensive measures for drivers of organizational complexity.

By hand of an empirical study, this thesis aims at improving the theoretical applicability in general business science.

\begin{itemize}
\item \textsuperscript{234} cf. Houchin, K., MacLean, D. (2005), pg. 164.
\item \textsuperscript{235} cf. Robertson, D. A. (2004), pg. 71.
\item \textsuperscript{236} cf. Smith, A. C., Graetz, F. (2006), pg. 852.
\end{itemize}
2.2.2.5 Organizations as complex adaptive systems

In line with the complexity thinking approach, this thesis defines its research object, organizations, as complex adaptive systems (CAS). In spite of this, management studies have regarded organizations as mechanistic systems and believed that considering isolated parts, specifying changes in detail and reducing variation will lead to higher performance.\(^{237}\) The system thinking approach suggests that relationships between the parts, i.e. the context, or the degree of freedom and the relationship of the parts with reference to the whole system, are of great importance.\(^{238}\) Hence, organizations are viewed as complex adaptive systems. This concept of CAS is in line with both the procedural and structural characterization of organizations in general, as presented in section 2.1.1.

To provide a deep insight into the concept of CAS, their major characteristics are discussed in the following section.

In general, a complex adaptive system is made up of a number of subsystems and sub-subsystems. Each of these subsystems execute distinct functions and respond to different clientele, while requiring different resources and a certain amount of stability to deliver the requested performance.\(^{239}\) A CAS shows layers of interdependent relationships capable of facilitating or inhibiting actions within the operational context of the whole.\(^{240}\) Furthermore, an organization within its industrial environment can be defined as a complex system within a complex system.\(^{241}\)

Complexity theory views an organization as a dynamic, non-linear, and non-equilibrated system delivering non-deterministic outcomes.\(^{242}\) Nonetheless, these outcomes follow a set of simple, order-generating rules, similar to the turbulences found in gases and liquids.\(^{243}\)

In general, six major characteristics can be used to describe complex adaptive systems. All of them should be considered when developing a potential measurement framework for organizational complexity. The six characteristics are defined as follows: a complex adaptive system is (i) open and (ii) sensitive to the initial conditions, (iii) shows non-additive (evolutional) behavior emerging from interactive networks (negative and positive feedback processes). The behavior of a complex adaptive system is characterized by (iv)

\(^{237}\) Plsek, P. E., Wilson, T. (2001), pg. 746;
\(^{238}\) cf. Houchin, K., MacLean, D. (2005), pg. 151; Boisot, M., Child, J. (1999), pg. 237 et seq; Richardson, K. (2008), pg. 15.
disequilibrium, which means that the complex behavior features a grey area, which is called edge of chaos. The edge of chaos neither reaches a fixed point nor a cyclical equilibrium. (v) Complex systems tend to demonstrate self-organizing behavior, where (vi) complex patterns can arise from the interaction among agents that follow relatively simple rules.244

The following figure depicts and summarizes the characteristics of CAS.

![Figure 8: Characteristics of complex adaptive systems.245](image)

### 2.2.2.5.1 Openness

Openness is a central characteristic of a CAS. Complex adaptive systems can be considered to be partially-autonomic or selectively open.246 On the one hand, complex systems are self-referencing and therefore create system boundaries and system identity.247 On the other hand, the systems interact continuously with their environment due to an essential adaptation process.248 Therefore, organizations need to gather information about their environment as well as about themselves, e.g. their own behavior.249 The system is balanced among its

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245 Own source.


conflicting priorities of self-organization without referring to the environment and adaptation.\(^\text{250}\)

2.2.2.5.2 *Sensitivity to initial conditions*

The behavior of complex systems is non-deterministic, since a small change of one or two parameters can drastically change the behavior of the whole system. Similarly, the whole is different than the sum of its parts.\(^\text{251}\) The activities, events, routines, behaviors, and human interactions that exist in the organization at a specific point in time form the initial conditions for the emergence of future order.\(^\text{252}\) A small variation of these initial conditions can result in severe deterioration of performance. Marginal changes can lead to forceful consequences.\(^\text{253}\) This sensitivity to initial conditions is a characteristic of CAS and is similar to chaotic systems. In other words, when analyzing a complex adaptive system (organization), its inherent history has to be considered as well.\(^\text{254}\)

2.2.2.5.3 *Co-evolution through feedback loops*

Co-evolution is a concept of complexity, based on natural sciences and particularly biological science.\(^\text{255}\) A description of this approach is given by *EHRLICH/RAVEN*, who introduce and defined the concept as “an evolutionary change in a trait of individuals in one population in response to a trait of the individuals of a second population, followed by an evolutionary response by the second population to change in the first.”\(^\text{256}\) Similarly, *MCKELVEY* defines organizations as quasi-natural phenomena caused by the conscious intentions of those holding formal positions and naturally occurring structures and processes emerging as a result of co-evolving individual employee behaviors in a selective context.\(^\text{257}\) The view of organizations as complex adaptive systems indicates that organizations need to gather information which is used for the adaptation to and co-evolution with the environment.\(^\text{258}\) Thus, complex adaptive systems are able to accomplish short-term exploratory activities when required and can invest into long-term exploration if need be.\(^\text{259}\)

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\(^{250}\) cf. Clegg, S., et al. (2006), pg. 166.  
\(^{252}\) cf. Houchin, K., MacLean, D. (2005), pg. 151.  
\(^{254}\) cf. Maguire, S., et al. (2006), pg. 166.  
\(^{256}\) cf. Ehrlich, P. R., Raven, P. H. (1964), pg. 606.  
The rationale of the co-evolution approach is that the key decisions about how to match organization’s resources with their environment evolve when managers respond to claims of their internal and external environment. Organizations are therefore transformed over time.

The fundamental processes of evolution and co-evolution are feedback loops. Authors such as MCKELVEY, VAN DEN BOSCH, et al. and EISENhardt/GALUNIC introduced the concept of co-evolution within organizational frameworks. As an example, they used the concept of co-evolution to apply it to synergies between different internal divisions of a firm. In addition to the internal dimension of co-evolution, organizations that encourage recognition, enhancement and creation of new connections with their environment are capable of co-evolving effectively. As KAUFmann states, organizations co-evolve both internally and externally and therefore “these systems co-evolve to the regime at the edge of chaos”. BROWN/Eisenhardt suggest that organizations situated at the edge of chaos are the most effective.

2.2.2.5.4 Disequilibrium

Complexity theory presumes that the adaptation of a system to its environment evolves from the adaptive efforts of individual agents who attempt to improve their own payoffs.

This local adaptation or interaction with the system environment leads to the formation of continually evolving niches. Hence, complex adaptive systems operate far from the equilibrium. Complex adaptive systems are not totally unstable or even explosively instable as the chaotic systems discussed above claim. CAS can rather be defined as dynamically stable. They are able to shift within a range of structures and behaviors without threatening their relative stability, while being capable of changing dramatically if needed, including a limited range of behaviors with focus on the required attempts.

As BARNARD states: “The survival of an organization depends upon the maintenance of an equilibrium of complex character in a continuously fluctuating environment of physical,
biological, and social materials, elements and forces which calls for readjustment of process internal to the organization”. The complex character of the equilibrium could best be described by the dualism of flexibility and stability. As WEICK argues, organizations can only continue to exist if they maintain a balance between flexibility and stability.

2.2.2.5.5 Self-organization and emergence

As first noted by physicists BAK/CHEN, self-organization constitutes an adaptation to changing conditions when a system seeks a better fit with its environment. Self-organization refers to the ability to reconfigure connections and activities and therefore being able to create a structure that is flexible and sensitive to the needs of the connected elements. This is a result of non-linear interactions. Organizations with a great number of connections, low degree of formalization and scarce centralization are able to self-organize. Self-organization only signifies that no central control is necessary. As result, a fundamental dismissal of the command and control philosophy of traditional hierarchical bureaucratic organizations is required.

Compared to traditional management standards, self-organizational behavior seems to be disorganized as behavioral patterns and decisions emerge from the situational context. However, this is not an accurate assumption, since emergence refers to novel and coherent structures, patterns and properties that arise during the process of self-organization in complex systems. Thus, self-organization does not lead to disorder or chaos; it leads to new dynamically stable structures.

There are two major preconditions for self-organization. First, self-organization only occurs in open systems that import and make use of energy from the outside. This is true for organizations as defined by BARNARD. He states that “the life of an organization depends

upon its ability to secure and maintain the personal contribution of energy (including the transfer of control of material or money equivalent) necessary to affect its purpose."

Second, self-organization only functions properly if the components of the complex adaptive system are only partially, and not fully, connected. Systems in which all elements are interconnected are completely unstable. Either these systems refuse to change (negative feedback loops) or demonstrate chaotic behavior (if positive feedback loops appear). Agents in complex adaptive systems therefore only utilize information available in their immediate environment. A few agents connected in a feedback loop create this information.

2.2.2.5.6 Simplicity of order-generating rules

One of the most significant findings of complexity theorists is that there are simple order-generating mechanisms even in the most complex systems. The search for such order-generating rules is one of the major objectives of complexity science. The identification of existing rules, as well as the definition of new order-generating rules for organizations helps facilitate a rapid switch from one organizational archetype to another.

In general, order-generating rules provide limited order and stability within disorder and instability. As STACEY acknowledges, however, natural systems seem to be different: order-generating rules do not directly or automatically generate self-organization within human social systems as individuals pursue idiosyncratic objectives and have distinct interpretations of events.
2.2.2.5.7 Summary of the theoretical framework

Complexity science is closely related to the systems and chaos theory. Due to different approaches of understanding and applying complexity science, the empirical basis is inconsistent and the development process of complexity theory has not come to a conclusion. Nevertheless, complexity science is of specific value to business science.

Complexity science in organizational and managerial contexts represents a nonlinear, system-oriented perspective that attempts to understand, conceptualize, and change organizational systems at multiple levels, while fully recognizing the dynamic linkages and influences that exist within and between several aspects of those systems in time and space. Additionally, the external constraints and opportunities that influence the system are integrated into the studies.

Organizations are viewed as complex adaptive systems because their characteristics aid in understanding and working within the nature of organizations.

The characteristics of CAS e.g. the openness of the system and the permanent interaction with the environment, leads to the conclusion that organizational complexity is induced by the system's environmental conditions.

In contrast to the contingency approach, the goal of the complexity theory is not to define organizational complexity settings that are appropriate for specific contingency factors (e.g. turbulent environments). The objective is rather to study the nature of the interaction of the organization with its environment. As discussed in chapter 2.3.2, complexity theory tries to explain how new patterns, structures and behaviors emerge from this interaction and co-evolution.

The theoretical framework of adaptive complex systems allows a deeper analysis of the co-evolution of both systems – the organization and its environment. It is possible to study e.g. the local response of organizational parts to changes of customer behaviors, the induced increase of decentralization, the consequences for the organization caused by positive and negative feedback loops and the emerging new structures inside the organizations. It is therefore possible to examine the continuous adaptation to environmental conditions, which lead to changes in organizational complexity. The theoretical framework presented is more appropriate than the contingency approach. As MILLER states in his article “Environmental fit versus internal fit”, some contingency factors lie on the outer limits of the organization,

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288 cf. Ibid., pg. 78.
which makes it hard to distinguish between internal and external factors. The theoretical framework allows us to consider all relevant drivers of complexity. Due to their openness, organizations are integrated in and adaptive to their environment. While the contingency approach defines a set of static configurations of organizations, the complex adaptive approach allows for dualism, e.g. both heterarchy and hierarchy in different parts of the organization. As a result, the organization is able to only partially adapt if needed. Furthermore, it is possible to experiment with different degrees of freedom. If the co-evolution within some domain is successful, positive feedback loops will amplify the effects for the organization. If the adaptation in one domain is not in line with the organizational culture or does not fit its history, negative feedback loops will eliminate the initiative. Treating organizations like complex adaptive systems is more realistic than the static and deterministic approach proposed by the contingency theory. Naturally, the complex adaptive systems approach incorporates basic ideas of the contingency theory, as the configuration of the organizational structure and behavior is also caused by several contingencies in the environment. However, the organization neither changes completely nor entirely consciously – by central command. In the following section, two contingency factors – complexity and globalization – and their influence on organizations as CAS, are discussed in detail.
2.3 Complexity and Globalization create dilemmas

“The growing complexity of our living conditions, especially the growing dynamic of change in our surroundings, raises the question if developments are still controllable by humans. This question is not only important in regard to the ecological or social environment but particularly influences the institutionalized systems (organization), which effect this growing complexity, too.”

The following section presents the major challenges and dilemmas for globally acting companies in a globalized business world, based on the definitions of complexity and globalization, found within the complexity thinking framework, and the definition of organizations as complex adaptive systems. The relevance of the drivers of complexity in organizations, their relation to the characteristics of globalization, and most importantly, the implications of inconsistent and competing theories, as specified in section 1.1, are discussed. In addition, the resulting qualitative understanding of the drivers of organizational complexity can be used to derive quantitative measures that represent organizational complexity to the highest possible degree. In other words: this discussion is essential for the establishment of a comprehensive framework for organizational complexity, which, within the second part of this thesis, will become empirically reliable and practically relevant.

The central aspect of boundary erosion was discussed before the other characteristics were incorporated. It is evident that boundary erosion, as a core characteristic of globalization, intensifies the effects of the complexity drivers. On the one hand, interdependence is increased due to the fact that impacts are without borders. Thus, interdependencies extend throughout the whole value creation process. On the other hand, boundary erosion increases the diversity of players in a market, and therefore the number of different competitive advantages, or business models/core strategies. While consolidation is a counteracting factor in many industries, globalization constantly increases the number of dominant industry players and thus enhances diversity. This also explains the occurrence of high fast flux. The strong interdependence of players, results in permanent pressure to react swiftly to strategic

292 cf. Ibid., pg. 11.
moves of other market players, changes in the regulatory framework and other factors. The diversity of information increases with a large amount of data, which can be processed instantly and may be interpreted in many ways. Since detailed information is widely available, boundary erosion leads to growing ambiguity, as the differentiation between different markets, industries and competing products is more difficult. International competitors challenge companies with substitute products they have not considered before.

Factor mobility is a result of boundary erosion. Knowledge transfer is profoundly impacted by information technology. The most important aspect of factor mobility for many organizations is given by the global financial sector, which acts in real-time. The total factor mobility of financial resources leads to a short-term focus and therefore a discontinuation of strategy and action. Since companies are competing for financial resources on a global level, they need to realize opportunities in various regional markets to improve their success. Hence, there is a small but significant influence on fast flux.

The factor mobility also increases interdependency, as it leads to a more fragmented value creation process through an international distribution of activities that were initially processed exclusively in the home country. This increases diversity through different national cultures and preconditions that influence the local value creation process. Cultural diversity and decentralization of power also increase the ambiguity of information flow.

Heterarchy, as the third characteristic of globalization, also influences the complexity drivers in various ways. As mentioned above, heterarchy implies – in contrast to hierarchy – a higher degree of freedom and interdependence.

A heterarchical structure with semi-autonomous units therefore calls for both high coordination needs and continuous adaptation processes, which help to respond to the numerous internal initiatives and changing external conditions. Since the decision-making process is more decentralized and is accomplished by specialized units that can interpret relevant information in a more reliable way, heterarchies reduce the ambiguity for decision makers and the entire organization. The decision maker is further removed from the core of the business – the uncertainty involved with pertinent goals and strategies, the freedom of interpretation and the ability to “frame” information in a certain way, leads to even greater ambiguity. Due to these opposing influences, the relationship between heterarchy and ambiguity cannot be estimated conclusively. It is certain, however, that heterarchy leads to a diversification of behaviors, which need to be carefully aligned.

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Legitimacy erosion has less impact on the complexity drivers. However, it creates a specific dilemma by the increase in individual accountability of managers and business units (driven by performance-related wages). In an independent system, results do not only depend on the performance of the responsible managers or specific teams, but also on the performance of players outside the measurement system. Therefore, the establishment of accountability is unrealistic to a certain degree. In general, legitimacy erosion leads to higher ambiguity in organizations, since clear decision processes are required to solve conflicts effectively. If multiple decision processes exist simultaneously, e.g. in a matrix organization with product and geographic differentiation, ambiguity grows within the affected business units with two or more reporting lines. Legitimacy erosion does not lead to more diversity or fast flux.

A characteristic with a largely significant influence on both ambiguity and diversity is the past-future-asymmetry. As dependable patterns of interpretation might no longer be valid (or even no longer exist) in numerous different circumstances, a variety of interpretations of data or (perceived) facts are possible, leading to a wide range of conclusions about appropriate strategic moves. This increases diversity, as one dominant business model or a clearly defined strategy might no longer exist. This event, in turn, increases fast flux, in that the players experiment with learning from their successful competitors and thus diminish their competitive edges. This leads to new strategic moves and experiments. The past-future-asymmetry also has a small influence on interdependence as the driver of organizational complexity. This characteristic requires closer collaboration among various departments in order to make sense of the presented facts and figures. As a result then, interdependence increases slightly.

Variety of options is not only caused by countless risks and opportunities within the global market, which obviously offers a wider range of choices, but is also a direct result of the past-future-asymmetry as mentioned above. Its influence on ambiguity, diversity and fast flux is therefore high, whereas an influence on interdependence has not been found. A growing amount and variety of elements can arguably lead to more potent relationships, but since it is only about the variety of options it is not sufficient to conclude that there is a direct influence. Table 1 summarizes the relationship between the characteristics of globalization and the drivers of organizational complexity and Figure 9 illustrates the findings.

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294 cf. Section 2.1.3.
PART I Conceptual framework

<table>
<thead>
<tr>
<th>Drivers of Complexity</th>
<th>Characteristics of Globalization</th>
<th>Interdependence</th>
<th>Diversity</th>
<th>Ambiguity</th>
<th>Fast Flux (as a result)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary Erosion</td>
<td></td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Factor Mobility</td>
<td></td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>0</td>
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<tr>
<td>Heterarchy</td>
<td></td>
<td>++</td>
<td>+</td>
<td>?</td>
<td>++</td>
</tr>
<tr>
<td>Legitimacy Erosion</td>
<td></td>
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<td>0</td>
<td>+</td>
<td>0</td>
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<tr>
<td>Past Future Asymmetry</td>
<td></td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Variety of Options</td>
<td></td>
<td>0</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
</tbody>
</table>

+++ : dominant strong  ++ : very strong  + : existing  
0 : neutral  ? : unknown /need for further research  
- : negative

Table 1: Relationship between characteristics of globalization and drivers of organizational complexity.295

Figure 9: Relationship between complexity drivers and characteristics of globalization.296

296 Own source.
Based on that junction, the main challenges and dilemmas for today's organizations can be derived. It is possible to identify six fundamental dilemmas for companies:

- Fragmentation of markets vs. economies of scale
- Multi-brand/channel conflict vs. internal cooperation
- Local leadership vs. standardized processes
- Short term profitability vs. long-term sustainability
- Strategic flexibility vs. dominant logic
- Core competencies vs. knowledge accumulation.

These will be discussed in detail in the following sections.

### 2.3.1 Fragmentation of markets versus economies of scale

The first dilemma, fragmentation of markets versus economies of scale, is, amongst others, mainly related to the complexity drivers diversity and factor mobility, which are characteristics of globalization. Nowadays, companies in high-level fixed cost industries have to balance the need for efficiency and financial success via economies of scale with covering the demand for a diverse product range across customer segments. New markets with different cultures and demand structures further increase fragmentation due to the fact that companies have to adapt to differences of local markets. The basis for this adaptation is that organizations as complex adaptive systems are open and therefore permanently co-evolve with their environment. They incorporate more and more diversity via new products or services, for example. By doing so, they change the static order in the organization to more complex structures.

As SCHWENK-WILLI confirms in his research, globalization and the growing individualization of demand enhance product diversity in many industries. Therefore, managers are challenged by a hard-to-solve paradox: on the one hand, actions that extend the organizational complexity can increase the market-based performance, since the demand of customers can be fulfilled in a superior way. On the other hand, a higher level of complexity often reduces the company’s operational performance. Nevertheless, the differentiation and increase of product and service diversity is needed to work permanently against the "commoditization" of nearly every unique selling proposition. Commoditization, generated by global competition, destroys the advantages of economies of scale and constantly increases

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297 The first four dilemmas are related to the discussion of Steger, U., Schwandt, A. (2009), pg. 16.
organizational complexity. As MILLER states in his discussion of internal fit versus external fit, it is difficult to attain both goals simultaneously.\textsuperscript{301}

2.3.2 Multi-brand/channel competition versus internal cooperation

The second major dilemma is also related to diversity and interdependence within an organization, as well as heterarchy. It is caused by a conflict between multi-brand/channel competition and internal cooperation. Studying global companies, it is often found that one company owns several brands and/or uses different distribution channels to cope with diverse customer needs. This dilemma is to some extent a result of the positive feedback loops inside the organization. They amplify the impact of incorporating more diversity so profoundly that ultimately the whole organization is affected.

With a relatively high degree of freedom and self-organization, each unit manager optimizes the results of this unit and is held responsible for the outcome; this creates an internal competition for resources. As a result, best practices, R&D-results etc. are not shared and the disassembly of products or services is not prevented. The internal fight in the context of transfer pricing is therefore more influential than the market performance. This might lead to suboptimal group performance. Top management wants an “own company first” behavior. Therefore it strives for shared services, economies of scale in purchasing, leveraging of R&D etc. Due to the often very high numbers of subsidiaries in global companies, this is a very challenging task. Additionally, the incentives are often set in the opposite direction and thus create dilemmas for the managers on different organizational levels. The fragmentation of an organization therefore leads to growing organizational complexity not only in globally acting companies. Organizations then suffer from too much complexity through declining profits and the senseless waste of energy.\textsuperscript{302}

2.3.3 Local leadership versus standardized processes

The third dilemma is closely related to the previous one and is defined by local leadership vs. standardized processes. It relates to heterarchy and legitimacy erosion as well as to interdependence, diversity and ambiguity.

Due to cultural differences and various customer needs, many global companies are confronted with several heterogeneous local markets – especially in the services industry and the consumer or retail industries.\textsuperscript{303} Because of regional differences, a local leadership with

\textsuperscript{301} cf. Miller, D. (1992), pg. 159; Lawrence, P. R., Lorsch, J. (1967); pg. 47
\textsuperscript{303} cf. Schwandt, A., Steger, U. (2007), pg. 3.
in-depth local market knowledge is needed to respond to the fast flux of the market. Hence, organizations, in particular global organizations, face the phenomenon of co-evolution in pockets.\textsuperscript{304} In other words, they are confronted with local adaptation in different parts of the organization, caused by the openness of the system and self-organizing behavior of the agents. The resulting dilemma is situated at the core of organizational complexity. Local leadership enhances complexity whereas standardized processes simplify the organizational structure and retain a status of static order. The composition of organizational structure in general is a fundamental variable that affects the organizational complexity.\textsuperscript{305} In line with the traditional management approaches, simplicity should be reached through specialization, detailed job descriptions, formalization and standardization.\textsuperscript{306} Organizations therefore try to avoid to be overwhelmed by incomprehensibility.\textsuperscript{307} Researchers have found, however, that trying to reduce complexity is inefficient in dynamically changing environments. These contingency theorists call for the creation of rather organic structures with decentralization and local leadership.\textsuperscript{308} \textit{BURNS/STALKER} and \textit{THOMPSON} state that environmental uncertainty requires delegation of authority, and \textit{LAWRENCE/LORSCH} and \textit{GALBRAITH} add that high environmental uncertainty demands organizational differentiation and specialization.\textsuperscript{309} Furthermore \textit{AGUILAR, FREDERICKSON, MILLER/FRIESEN} and \textit{MINTZBERG} state that flexible, informal decision-making is more suitable for an uncertain environment and that intensified scanning of markets is needed to cope with growing environmental ambiguity.\textsuperscript{310} Local leadership, informal networks and growing diversity should provide more flexibility to change, and facilitate the attempt to match internal variety with external variety, as stipulated by \textit{ASHBY} and \textit{WEICK}.\textsuperscript{311}

If an organization is invariant (centralized), nothing changes or only very slowly and the system is not competitive. If the organization is too absorptive and flexible, on the other hand, the system will be overwhelmed by change.\textsuperscript{312} This dilemma leads to a permanent rivalry between the subsidiaries that argue for their independence considering the local differences and the staff group that argues for the standardization across all units.

\begin{itemize}
\item\textsuperscript{304} cf. McKelvey, B. (1999), pg. 310, refer to section 2.2.2.5.
\item\textsuperscript{305} cf. Smith, A. C., Graetz, F. (2006), pg. 854.
\item\textsuperscript{306} cf. Ashmos, D. P., et al. (2000), pg. 580.
\item\textsuperscript{307} cf. Stacey, R. D. (1992); Ashmos, D. P., et al. (2000), pg. 577.
\item\textsuperscript{308} cf. Burns, T., Stalker, G. M. (1961); pg. 121 et seq.; Scott, R. W. (1981), pg. 90.
\item\textsuperscript{309} cf. Galbraith, J. R. (1973), pg. 16; Thompson, J. D. (1967), pg. 143; Burns, T., Stalker, G. M. (1961), pg. 121 et seq.; Lawrence, P. R., Lorsch, J. (1967), pg. 47.
\item\textsuperscript{312} cf. Burnes, B. (2005), pg. 74; Frederick, W. C. (1998), pg. 367.
\end{itemize}
2.3.4 Short term profitability versus long-term sustainability

The fourth dilemma has existed in the field of management for a long time and is defined as short-term profitability vs. long-term sustainability. Recent trends like growing factor mobility, variety of options and growing interdependence amplify this dilemma. As mentioned before, CAS and organizations in general are supposed to be selectively open or partially-autonomic. Hence, they normally balance short-term exploratory activities and long-term exploration. The modern focus, however, is shifting towards short-term activities to meet the expectations of shareholders. For example, the widespread introduction of the weighted average cost of capital, that considers risks of the company as the benchmark for financial performance indicators, has sharpened the contradictions and conflicts. These indicators increased the internal hurdle rates for investments of all kinds, shortening the time horizon for investments (in many industries the regarded time span is only 3-4 years). Since factor mobility of financial resources is nearly perfect, capital markets scrutinize financial performance and penalize low performance. As a result, fulfilling the expectations of shareholders in each quarter has become an increasingly dominant goal for the management. Despite the recently growing confidence in the competencies and capabilities of national governments in a global world, the public expects (global) corporations to solve a wide range of problems, especially with regard to the wider impact of business actions (“externalities”). Solving global challenges within social and ecological demands, as frequently illustrated by the expression Corporate Social Responsibility, (CSR) becomes an important topic for (international) corporations. On a day-to-day basis, CSR means that globally acting companies are confronted with a variety of stakeholders, and social and ecological demands, which cannot be ignored in the long-term perspective if the company strives to fulfill customers' demands and aims to maintain its competitiveness. The capital markets do not value this type of long-term investment, however. Therefore, companies are forced to communicate different dimensions of performance to different stakeholders. As SIGGELKOW/LEVINTHAL state, firms need to define activity configurations that are not only internally consistent, but also appropriate for the demands of different stakeholders.314

2.3.5 Strategic flexibility versus constancy

Strategic flexibility vs. constancy is the fifth dilemma and is caused by the complexity drivers and characteristics of globalization. Due to the fast flux of the business environment and the various relationships of the organization to the environment (openness), leaders of global companies are confronted with continuous change. The past-future asymmetry and the variety of options combined with the factor mobility result in the need for high strategic flexibility. Despite the growing speed of change, organizations have to be a reliable partner for their employees, suppliers and customers. Thus they have to ensure consistency and reliability.

At the same time, strategic flexibility is needed to cope with ambiguity and to realize valuable opportunities. Scenario-planning and continuous business reengineering are crucial methods to handle this challenge. Continuous change, however, is both a big challenge and a threat to organizations, since they also have to provide consistency and accountability for stakeholders like employees and shareholders.

Consistency, stable long-term relationships and a strong corporate identity are important for employees to feel secure and motivated. Hence, a dominant logic behind strategic actions is important and valued by shareholders. Successful business evolution leaves no room for adopting every trend or applying outdated business models. The organization’s leaders should moderate the pace of change, and the direction and logic behind the strategy should be transparent and stable.\textsuperscript{315} Such a dominant logic is to some extent similar to the order generating rules as defined in section 2.2.2.5.6. Organizations that follow a dominant logic enable self-organization in the system, while assuring that this enhanced degree of freedom still leads to the right decisions.

2.3.6 Core competencies versus knowledge accumulation

Globalization and complexity also account for the sixth dilemma, core competencies vs. knowledge accumulation. High global factor mobility of several resources, enhanced by optimized supply chains, lead to high labor division within organizations. Due to the strong competition most companies are facing, the next step was the concentration on core competencies and the outsourcing of certain activities. The intra-organizational division of labor was therefore transformed into an external division of labor, within which organizations gave away some of its specific knowledge. Simultaneously, the organization’s configuration shifted away from the edge of chaos to a more static order.

The dilemmas occur when ambiguity, past-future asymmetry and fast flux come into play. In a fast changing business environment, outsourcing aims at achieving short-term profits, as discussed above, but it limits the knowledge base of the organization as a whole.\textsuperscript{316} If companies like Arcandor (KarstadtQuelle) outsource acquisitioning within their value chain, it limits future options and significantly reduces the knowledge of one of the core processes within the organization. Another example is the outsourcing of the whole car assembly to first-tier suppliers or the outsourcing of R&D activities into networks and research alliances. Since organizations are sensitive to initial conditions – such as activities, events, routines, behaviors and human interactions that exist in the organization, as mentioned before – it is essential to find a balance between concentrating on core competencies and securing knowledge accumulation. Based on the richness of elements, connections and information, organizations can show emergent behavior.

Changes in the business environment can be challenging, especially if they affect companies with low value creation or minor know-how. The creation of new core competencies is very difficult and expensive.

Thus flexibility in global business environments means to endow the organizations with the appropriate resources, especially with knowledge about market-driven core processes.

Complexity and Globalization create dilemmas

So far, the definitions of organization, complexity and globalization were used to establish a better qualitative understanding of these constructs, their relationships among each other and their influence on organizations. The preceding discussion creates the basis for the following empirical study.

After specifying the research question and defining the appropriate research methodology in the following next two chapters, the major dilemmas and drivers of complexity, as discussed above, will guide the development of the measurement model of organizational complexity.

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317 Own source.
3 Research questions

Based on the abovementioned theoretical framework, this chapter presents the central research question, the hypotheses for the empirical study and discusses appropriate research methods to study organizations as complex adaptive systems.

The research field of this thesis is complexity, a 3rd level interdisciplinary science, as shown in Figure 11 and as discussed above. Since the research object is the objective-aligned social system, this thesis is also related to business science. As business science is related to real science and social science, this work is related to these sciences as well. The basic approach of this thesis can be derived from this assignment to and differentiation from the formal sciences.

The general purpose of real science is the description, explanation and composition of observable parts of reality. For this reason this work is dedicated to epistemological and methodological questions of the perspective of basic cognition, and therefore conforms to the social or action science related classification.

![Figure 11: Classification of sciences.](image)

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318 cf. Section 2.2.
321 cf. Ibid., pg. 305.
Action science is less interested in assuring established knowledge, than increasing understanding by developing models of a configurable reality.\textsuperscript{323} In the scope of business science, the system theory approach of Ulrich/Hill and the decision theory approach of Heinen constitute the basis of recent research concepts.\textsuperscript{324} As presented in chapter two, the system theory is also a fundamental basis for the research on organizational complexity presented here.

It can be stated that the central task of business science is the creation of action guidelines and design recommendations.\textsuperscript{325} The task field of business science, control, design, and development of these systems, will be applied to organizations as complex adaptive systems.\textsuperscript{326} By combining complexity theory and particularly complexity thinking\textsuperscript{327} with business sciences, new recommendations and action guidelines on how to cope with growing business environmental complexity will be derived.

In the last century, the theories have not incorporated fundamental changes in organizations and organizational contexts.\textsuperscript{328} The challenges presented by new information, communication and automation technologies, which change the nature of the organization and the work itself, were, amongst others, discussed by Casey, Davenport and Greider; however, organizational theory and business studies in general were slow to respond.\textsuperscript{329} By studying organizations as complex adaptive systems, this thesis contributes to the enhancement of the understanding of this development.

In general, four different practice-orientated kinds of statements could be discerned: \textsuperscript{330}

- Elaboration of content-related solutions for concrete problems
- Development of solution procedures for concrete problems
- Design of configuration models for the change of the social reality
- Conception of rules for the design of configuration models in practice.

In this thesis a configuration model for the change of the social system (organization) is designed. It is important, however, to keep in mind that despite this thesis’ application-oriented nature, each social system model is limited in its applicability to real life

\textsuperscript{323} cf. Kubicek, H. (1977), pg. 7.
\textsuperscript{325} cf. Stüttgen, M. (1999), pg. 11.
\textsuperscript{327} As special approach of using complexity science in research, see chapter 2.2.2.3.
\textsuperscript{328} cf. Walsh, J. P., et al. (2006), pg. 660.
\textsuperscript{329} cf. Ibid., pg. 661; Casey, C. (1995), pg. 5 et seq; Davenport, T. H. (2005), pg. 85 et seq.
A model is the conversion of a natural system into a formal system. It simplifies a detailed description into a shorter and more palpable construct.\textsuperscript{332}

Section 2.2.2.5 has defined organizations as complex adaptive systems. These systems can change as a consequence of internal change, external change, or both. Studying control parameters or drivers of this change is crucial for its analysis, while analyzing the organization as a whole. Considering the change of the system (organization), some aspects matter more than others, even if the drivers of change that matter are complex themselves.\textsuperscript{333}

As noted before, complexity is a holistic characteristic and cannot be subdivided into discrete parts only to be reassembled afterwards.\textsuperscript{334} The same is also true for complex adaptive systems. It is impossible to study only a few parts of an organization and draw conclusions from this reductionistic study. Disregarding the idea that there are analyzable components within complex systems, however, does not imply that there are no subsets or drivers that can be studied as to how they influence and change complex systems.\textsuperscript{335}

Due to the employed understanding of complexity, as noted in the framework discussion in chapter 2.1.2, it is possible to model the organization with its specific value of organizational complexity by means of its complexity drivers.

In line with this argumentation it can be postulated that organizational complexity is a multi-dimensional construct. It is unclear how many drivers of organizational complexity exist, but there are expected to be different facets of organizational complexity. It is possible to define the first proposition presented in this accordingly.

\textbf{P1: Organizational complexity is a multi-dimensional construct.}

A multi-dimensional configuration model can be designed that is suitable to explaining changes in and of the social organization.
The general research question of this thesis is:

**In order to be successful, how should organizations respond to growing environmental complexity?**

As noted in chapter 1.1, this is one of the central questions of complexity science. 

*ASHBY* postulates his “Law of Requisite Variety” and *LUHMANN* argues that complexity can only be managed by selection and simplicity. Addressing this research question will contribute to solving the existing inconsistency caused by these competing theories.

As discussed before, organizations are treated as complex adaptive systems that co-evolve with their environments. In general these organizations are embedded in a business environment with continuously growing complexity, as discussed in chapter 1.1 and 2.3, and it is possible to follow both fundamental approaches of responding to complexity. First, one can agree with Luhmann that there is a difference between environmental complexity and system complexity – the system can never be as complex as its environment.336 Thus, a process of permanent selection and simplification exists. Second, by incorporating Ashby’s Law of Requisite Variety, it can be argued that, despite of the gap between system complexity and environment complexity, organizations become increasingly complex. When organizations try to cope with environmental complexity, they frequently adapt and the organizational complexity grows in total. By adapting and changing continuously the internal complexity grows, even if no element or relationship is added. As mentioned above, however, diversity, ambiguity and interdependence are also increasing in most organizations. Based on the synthesis of Ashby’s and Luhmann’s assumptions, it is concluded that growing organizational complexity does not create organizations that are as complex as their environment.337 Rather, growing complexity is needed to maintain the size of this gap and to not lose contact with the environment.

Thus, growing organizational complexity is to some extent necessary to be successful. Organizational complexity cannot be increased indefinitely, however. If complexity exceeds a manageable level, e.g. interdependencies expand to the degree that all elements are connected with one another, the system behavior turns chaotic, as discussed in section 2.2.2.5. Hence, the relationship between organizational complexity and performance is hypothesized to be inversely u-shaped, as shown in Figure 12.

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H1:
There is an inversely u-shaped relationship between organizational complexity and organizational performance.

To study the inversely u-shaped relationship it is necessary to statistically define or extract different dimensions of organizational complexity in line with the first proposition. In general it is possible to differentiate the drivers of organizational complexity into two main categories. Based on an empirical study of 100 companies in ten different industries, STEGER/SCHWANDT identified that complexity can be categorized in value creating and non-value creating complexity. This is combined with the findings of KEUPER, who differentiates between correlated organizational complexity, where a direct link to the market or business environmental complexity exists, and autonomous organizational complexity, where no direct relationship exists.

The categorization used in this thesis is in line with both STEGER/SCHWANDT and KEUPER and classifies organizational complexity into market-driven and organization-driven complexity. Market-driven complexity is given when organizational complexity is induced by the market and being relevant for the customers or when there is real value-added for the company. Organization-driven complexity is given, when there is no direct link to the market.

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338 cf. Own source.
and when the complexity is induced by e.g. the organizational configuration in structure and processes, as discussed in section 2.1.1. In contrast then, organization-driven complexity is non-value-creating as it causes additional transaction costs. The classification into market- and organization-driven complexity seems to be appropriate since it contains a clear link to the fundamental system theory paradigm of system-environment differentiation and the organization as complex adaptive system that is selectively open or partially-autonomic.\textsuperscript{341} The following section provides some examples that will illustrate this differentiation.

Clearly, 165 different kinds of invoices (missing standardization) do not create any kind of value to customers or the organization in general. It is therefore an organization-driven complexity. Another example for useless organization-driven complexity is created by a weak organizational culture or poorly communicated, non-visible or vague strategy. The resulting growing degree of freedom leads to rising internal ambiguity and missing alignment and will not add value to the organization.

Unfortunately the differentiation between market- and organization-driven complexity is not always so obvious.

As noted before, complexity is generally driven by diversity, interdependence, ambiguity and fast flux. Each one of these drivers can cause both market-driven complexity and organization-driven complexity simultaneously. For example, product diversification creates market-driven complexity because it leads to the satisfaction of diverse customer needs and is a direct response to the market complexity. It also creates organization-driven complexity, however, which can be noticed by decreasing profitability when the degree of product diversification increases significantly.\textsuperscript{342} Only if an organization is able to enhance product diversity without increasing the internal organization-driven complexity, the profitability will not decrease as significantly. Organization-driven complexity in that case is e.g. given by low degree of standardization or low level of formalization. A low degree of standardization e.g. results in a strong increase of variants and parts and thus creates an undesirable amount of complexity, not directly linked to customers’ needs.

Global organizations are another example of how drivers of complexity can fall into both categories of organizational complexity. They face high degrees of ambiguity and fast flux in their business environment since they serve diverse markets with different dynamics and customer needs. An indicator of incorporated market complexity is given by the degree of


internationalization of the organization. Consequently, on-site employees and local presence are important to cope with the uncertainty and changes. Hence, the degree of internationalization of assets and employees is market-driven complexity. If all markets are identical and market complexity is low, the organization could be able to fulfill the customer’s needs by simply exporting products while operating at a low level of organizational complexity. On the other hand, the degree of decentralization of power within the organization is organization-driven complexity. This merely refers to the configuration of the organization, and its decision-making processes in particular, which determine the level of internal organizational complexity. According to this a centralized process is more complex than a decentralized process because more interdependencies and uncertainties exist. Hence decentralization can simplify and reduce organizational complexity.

Another good example of how market-driven complexity is closely related to organization-driven complexity is given by M&A activities. Growing complexity of the business environment, especially high levels of ambiguity, interdependencies and fast flux, frequently lead to the consolidation of specific industries. Organizations trying to cope with the increasing levels of complexity in the business environment, often respond to such growing market complexity with M&A. On the one hand, M&A activities can be categorized as market-driven complexity in terms of intensified organizational change, growing diversity of processes, products and cultures. On the other hand, lasting organizational complexity is often caused by the implementation of the M&A. Depending on the final configuration of the new organizations – standardization of processes is enforced or not, cultural alignment is given or not – the organizational complexity reaches different levels. If a strong organizational culture exists, the organizational complexity is reduced significantly, since the organization as a whole, and members of the organizations in particular, face e.g. less complexity drivers, diverse mindsets and a lower degree of ambiguity.

The inversely u-shaped graph presented in Figure 12 is based on the presented immanent characteristics of organizational complexity. Distinguishing between market-driven complexity and organization-driven complexity thus illustrates the curve’s shape. If organization-driven complexity, which causes additional costs and does not add value, exceeds market-driven complexity – which is value creating – the performance of the organization will decrease.

Differentiating complexity into market-driven and organization-driven complexity makes it possible to reconsider the discussion of chapter 1.1. The central dilemma of organizations – how to respond to growing environmental complexity – can be partially alleviated. Both
Ashby and Luhmann are partially right with their approaches of how to handle growing environmental complexity. Ashby makes a good point with regard to market-driven complexity – the goal for the organization is complexity equivalence between internal and external complexity. For the organization it is appropriate to enhance organizational complexity where a market complexity equivalent exits. It can theoretically incorporate market complexity till market-driven complexity and environmental complexity are equivalent. As discussed above, however, an increase of market-driven complexity is often inherently interrelated to the increase of organization-driven complexity. Hence, organizations are challenged to reduce such organizational complexity to limit the negative effects on performance. Luhmann's approach to a complexity incline is therefore valid in terms of organization-driven complexity. Nevertheless, whether this leads to organizational success cannot be conclusively addressed at this point. Based on this differentiation between market-driven and organization-driven complexity, however, as also shown in the following figure, two additional hypotheses can be defined. If market-driven complexity is analyzed separately for example, a different relationship is expected.

H2: There is a positive relationship between market-driven complexity and performance.

H3: There is a negative relationship between organization-driven complexity and performance.

![Figure 13: Framework of market-driven and organization-driven complexity.](image-url)

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343 Own source.
PART I Conceptual framework

As shown in Figure 13, it is important to effectively balance complexity. As a result, Ashby’s law has to be interpreted differently.\textsuperscript{344} It is not the goal to create increased complexity without distinguishing between the different kinds of organizational complexity. Responding to rising complexity in the environment implies an increase of market-driven complexity or the use of the complexity being already inherent within the organization – to make it work for and not against the organization -, and to keep control of the organization-driven complexity.\textsuperscript{345}

The presented relationships hypothesized above also reflect the core dilemmas discussed in section 2.3. All six presented dilemmas are examples of the challenge to balance market-driven complexity and organization-driven complexity in an adequate way.

As mentioned before, the influence of market-driven complexity, e.g. product diversification can differ between among levels of diversification. As several studies have shown, enhancing product diversification often has an inversely u-shaped relationship to the organizations’ performance.\textsuperscript{346} As mentioned, this is caused by the fact that enhancing market-driven complexity will always imply a simultaneous increase of organization-driven complexity. Hence, it is expected that growing market-driven complexity will become increasingly difficult to manage as the level of organizational complexity increases in total. Thus, it is possible to define hypothesis four and five analogous to H1.

\textbf{H4:}

“The positive relationship between market-driven complexity and performance varied between different levels of organizational complexity.”

\textbf{H5:}

“The negative relationship between organization-driven complexity and performance varied between different levels of organizational complexity.”

To sum up: five hypotheses have been defined to empirically-test and possibly offer a solution-oriented conclusion to the central research question at hand.

\textsuperscript{345} cf. Ibid., pg. 6.
\textsuperscript{346} cf. Palich, L. E., et al. (2000), pg. 155 et seq.
4 Research methodology

The following chapter briefly discusses different research approaches and presents the employed methodology.

As mentioned in section 2.2.2.3, this thesis is based on the complexity thinking approach, which offers a scientific explanation to why managers and researchers seem to be at a loss when it comes to coping with complexity. It also provides some tools that can assist in managing the inevitable shortcomings and limitations. As RICHARDSON states: “Accepting that we have limitations, and that we can never have complete control over the future evolution of our organizations, is rather emancipating. Complexity thinking is about the middle ground between extremes, and so although managers are to a degree helpless and at the mercy of the ‘system’, it certainly does not follow that there are not many opportunities to affect organizational behavior in desirable, semi-planned, ways.”

This thesis tries to identify the factors affecting organizational behavior, by studying the drivers of organizational complexity. It will therefore be possible to answer the question of how organizations should respond to growing organizational complexity without having to arrive at a full control of organizational complexity. This thesis therefore accepts the existing limitations of understanding related to studies of complexity.

One major concern when focusing on the drivers of organizational complexity is the general impenetrability and obscurity of complexity. As discussed in section 2.1.2 and 2.2.2, complexity is a holistic phenomenon that cannot be decomposed and reassembled. As RICHARDSON points out, however: “One must be careful in interpreting the importance of incompressibility. Just because a complex system is incompressible it does not follow that there are (incomplete) representations of the system that cannot be useful.”

In other words, incomprehensibility is no excuse for not studying complexity. On the contrary, it is rather important to study complexity. Although we have to accept that it is impossible to develop a holistic, ultimate theory, it is still better than having no theory at all.

The complexity thinking approach includes the understanding that complex systems are indivisible in an absolute sense, but also postulates that many of them are at least quasi-reducible in several ways. Due to this, as discussed in section 2.2.2.1, the reductionist methods are not absolutely appropriate to study complexity. Despite the fact that complex systems are incompressible, most of the methods are still capable of giving some explanations...

\[^{347}\text{Richardson, K. (2008), pg. 13.}
^{348}\text{Ibid., pg. 16.}
^{349}\text{cf. Ibid., pg. 16.}\]
of certain aspects of complexity.\textsuperscript{350} Although reductionism should be avoided, methods that are similarly unable address complexity in its entirety can still be useful. Researchers should rather develop an awareness of how their methods limit the potential understanding of such systems. Usually, complexity researchers utilize a mixture of different methods.\textsuperscript{351} Quantitative and qualitative data are both valuable in complexity science and can be aligned with particular needs and challenges.\textsuperscript{352}

In general it is possible to differentiate between inductive and deductive research approaches.\textsuperscript{353} While the first approach is used to analyze and discover unknown relationships between variables and objects, the latter is used to study theoretically substantiated relationships between variables that are already established. Such being the case, the focus of the deductive approach is to affirm pre-defined dependencies. The methodology of this study is deductive in that the theoretical hypotheses regarding the relationship between organizational complexity and organizational performance are tested. Hence, the methodology of this thesis refers to the positivist approach.\textsuperscript{354} For creating legitimate generalizations, positivistic research requires valid datasets whose results can be reproduced with the same or similar sets of data.\textsuperscript{355}

The methodology of this thesis is a three-step deductive process, with an Explorative Factor Analysis, Structural Equation Model and multi group comparison.

Initially, a measurement model for organizational complexity is developed. To establish a reliable measurement, an Exploratory Factor Analysis (EFA) is carried out in order to detect the relationships between different variables and to measure organizational complexity and extract underlying dimensions. Afterwards, a measurement model for organizational performance is developed and the relationship between organizational complexity and organizational performance is modeled in a Structural Equation Model (SEM). The SEM is used to test the presented hypotheses.\textsuperscript{356} The SEM is appropriate in this context because of the combination of regression and factor analytical methods.\textsuperscript{357} Correspondingly it is possible to simultaneously test the hypothesis and verify the defined proposition that organizational complexity is multi-dimensional construct.

\textsuperscript{350} cf. Ibid., pg. 16.
\textsuperscript{351} cf. Morcöl, G. (2001), pg. 115.
\textsuperscript{352} cf. Cooksey, R. W. Ibid., pg. 99.
\textsuperscript{353} cf. Backhaus, K., et al. (2006), pg. 7 et seq.
\textsuperscript{354} As compared to a phenomenological approach. Remenyi, D., et al. (1998), pg. 34-35.
\textsuperscript{355} cf. Ibid., pg. 34-35.
\textsuperscript{357} cf. Hildebrandt, L., Götz, N. (1999), pg. 2; SEMs are also called simultaneous equation models because, unlike the more traditional linear model, the response variable in one regression equation in a SEM may appear as a predictor in another equation. Fox, J. (2002) pg. 1.
After the analysis of the general relationships, a multi group comparison will be carried out to study the differences between diverse levels of organizational complexity. In this way it will be possible to verify the hypothesized inversely u-shaped relationship.

To perform this empirical study, two different data samples are used, which will later be examined in detail. The first data sample is needed to perform the EFA and the second to be able to test the hypotheses in the SEM.
PART II Empirical study

The following section encompasses the empirical study – the results of the Explorative Factor Analysis and Structural Equation Model operated with partial least square. Based on the presented theoretical discussion above, the empirical study will test both, the multi-dimensionality of organizational complexity and the impact of organizational complexity on organizational performance.

5 Empirical model

The following chapter presents the specification of the Structural Equation Model’s elements. A SEM generally consists of a number of measurement models (outer models) and one inner model, which contains the central relationships between the studied constructs. The development of both measurement models will be carried out presently. Subsequently, it will be possible to model the relationship and define the inner model.

[Diagram of the Structural Equation Model]

Abbreviation:

- $\xi$: Latent exogenous variable
- $\eta$: Latent endogenous variable
- $x$: Indicator for latent exogenous variable
- $y$: Indicator for latent endogenous variable
- $\zeta$: Residual variable for latent variable
- $\delta$: Residual variable for indicators
- $\gamma$: Path coefficient between exogenous and endogenous variables
- $\beta$: Path coefficient between exogenous variables
- $\lambda$: Indicator loadings
- $\pi$: Indicator weights
- $\varepsilon$: Residual variable for indicators
- $\zeta$: Residual variable for latent variables
- $\eta$: Path coefficient between exogenous and endogenous variables
- $\xi$: Residual variable for indicator $Y$
- $\eta$: Residual variable for latent variables

Figure 14: Structural Equation Model.\textsuperscript{358}

\textsuperscript{358} Own figure, referring to Landau, C. (2009), pg. 120.
5.1 Measurement of organizational complexity

The following section will first address the topic of measuring organizational complexity in general. Based on this theoretical discussion a conceptual framework for the measurement of organizational complexity is developed, before carrying out the first part of the empirical study.

The process of establishing a comprehensive measure model will include three steps as shown in Figure 15 above. At first, the reflective indicators for drivers of organizational complexity will be identified. Subsequently, the introduced differentiation between market- and organization-driven complexity is used to categorize the indicators. Third, an exploratory factor analysis will be used to test the theoretical specification and to identify underlying dimensions of market-driven complexity in order to design a comprehensive and reliable measurement model.

5.1.1 Assumptions for measuring complexity

The following section discusses the major problems and challenges of the measurement of complexity. Different options and approaches are analyzed, while giving an overview of approaches employed in different scientific disciplines.

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[359] Own source.
Empirical model

Based on the presumption that a verified measuring model has not yet been developed and is doubtlessly needed, the goal of this section is to establish such a comprehensive model.360 Initially, previous mistakes that have been made with regard to the measurement of complexity are discussed. Afterwards the development of the new measurement model is guided by the complexity thinking approach, as discussed in chapter 2.2.2.3.

The following seven misleading approaches to measuring complexity were identified by the examination of existing approaches found in the literature.361 While some of them can be easily avoided when studying organizational complexity, other less avoidable approaches, have to be mitigated as far as possible.

At **first**, the measurement model has to refrain from measuring “imaginary complexity” like Kolmogorov's complexity approach does.362 Avoiding imaginary complexity means that no imaginary measures may be invented to measure complexity.

Kolmogorov invented such a measure by defining the complexity K(x) of an object x as the shortest (binary) program describing x.363 For measuring the Kolmogorov complexity, an Universal Turing Machine – a basic abstract mathematical model of a computer – is needed.364 The complexity of the real object x is measured indirectly by the length of the program defined by the Universal Turing Machine. As criticized by PENROSE, the Turing Machine is only a piece of abstract mathematics and not a physical object and therefore an idea without any reference to reality.365 Since Kolmogorov assesses complexity by defining a virtual complexity, it is a misleading approach for studying complexity of organizations. As discussed in section 2.2.2.1, mathematic algorithms are only appropriate for studying closed systems; even then they should be designed to capture “real” complexity and not the complexity of the description of “real” complexity.

**Secondly**, measuring factors related to complexity without them being causal or central for complexity should be avoided. One example is the concept of logical depth. Logical depth is similar to Kolmogorov complexity in that it is a computation-based measure.366 The logical

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362 cf. Ibid., pg. 93.
364 The Turing machine was introduced by Turing, A. M. in 1936 as a mathematical construct to answer mathematical questions like the “decision problems”. Turing, A. M. (1936), pg. 230 et seq. For further explanation of Kolmogorov complexity see Li, M., Vitanyi, P. (1997).
depth of a system or organization is defined as the time required by a Universal Turing Machine to run a minimal program that reproduces it. Hereby, the approach does not aim at real complexity and measures something else. Even if there is a correlation between the complexity of a computer program or organization and the time that is required to simulate or describe this complexity, this measurement does not assess the original system complexity. Due to the fact that this measure is based on the Turing machine, it is only indirectly derived from the originally studied system complexity. Consequently, it would not be appropriate for this thesis to measure the time a computer program needs to describe the structure for measuring organizational complexity. Even if this would lead to generalizable results among different companies, the quality of this information is limited. It is possible to use this complexity measure to describe a structure, however, it does not provide information about the reasons for the existence. Due to the fact that it is not possible to prove if, for example, it is the number of departments, the high interdependencies between the elements, or the permanent change of the structure that causes the complexity, this reflective measure will not improve understanding. As mentioned before, it is only suitable for closed systems.

An example of such a misleading approach was published by MOLDOVEANU. He uses the concept of logical depth to measure the task complexity and decision complexity for managers. By doing so, he tries to establish a new approach for the economics of managerial cognition by the use of managerial algorithms – the computational study of managerial cognition. With his approach he measured an indicator that is only slightly related to “real” complexity. This is made clear when he defines one of his research questions as “what is optimality worth to the strategic manager in terms of the ‘computational complexity’ he is willing to tackle”.

His approach avoids measuring overall complexity and simplifies the decision-making process by splitting it into two sequential steps of choosing (a) a canonical algorithm of a family of algorithms that provide the basis for further thinking and (b) selecting the level of logical depth the algorithm executes. Furthermore, he excludes other components of complexity and relationships with contextual factors, which he discusses at the end of his paper.

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368 cf. Vesterby, V. (2008), pg. 94.
370 cf. Ibid., pg. 7.
371 Ibid., pg. 19.
372 cf. Ibid., pg. 19.
373 cf. Ibid., pg. 24.
Empirical model

The third avoidable mistake is deriving the measurement model derives from a low level of complexity. If only situations or organizations with low levels of complexity are studied, the results cannot be transferred to situations or organizations of greater complexity. If the focus is too narrow, important aspects are missed. On the one hand, Ashby’s law of requisite variety has to be kept in mind, which results in the challenge that any description of a complex system that claims to be complete must be as complex as the system itself. On the other hand, however, an abstraction from reality is necessary when modeling organizational complexity. Measuring simple stages can be avoided then by choosing a data sample with low medium and high complex organizations, and by maintaining as holistic an approach of measuring organizational complexity as possible.

The fourth mistake made while measuring complexity is caused by a limited research field. While developing a comprehensive conceptual model for measuring organizational complexity, ideas from different scientific areas have to be incorporated. Limiting the study to some particular fields of science would result in a simplistic or limited view of complexity, as already discussed above. Logical depth as measurement of complexity in informatics is a good example. Since it is highly specialized on information and computer sciences, it provides only a limited understanding of organizational complexity.

The integration of the findings of biology, and in particular of biological evolution, as described in the next example, makes the limitations obvious. Comparing the complexity of a human being to that of a one-cell organism through the concept of logical depth, will define them as equally complex. Meaning, as the evolutionary process that created both creatures is the same in length, both should have the same extent of complexity. Naturally, however, the system complexity of these two organisms differs enormously. As this study treats organizations as complex adaptive systems, as defined in section 2.2.2.5, ideas from different scientific areas are already incorporated. However, when searching for measures of complexity, additional specific measures that are derived from various fields of research, like physics, will be considered.

The fifth mistake occurs is that the research mindset is dominated by quantitative analyses and research tools. The results are questionable. The establishment of a measure for organizational complexity should not only be based on mathematics and computer algorithms.

Measurement of organizational complexity

or statistical methods for the extraction of factors or dimensions; it should be based on theoretical concepts. If these research tools dominate the measure, it is rather an aspect of the tool than the complex system itself that is measured.\(^{377}\) As mentioned in chapter 4, every method can explain the complexity phenomenon partially, even if it does not illustrate the complete essence of complexity. Both, qualitative case study research and statistical tests are appropriate to study organizational complexity. The fifth mistake can easily be avoided if the use of such research tools is theoretically justified and if the limitations of such approaches are studied and discussed.

The **sixth** possible mistake while developing a complexity approach is the attempt to measure complexity by a small number of quantities and qualities.\(^{378}\) There are a few examples of studies in which complexity was measured with a small number of indicators or even only one indicator. To measure complexity adequately, the measurement framework has to capture all relevant dimensions of the phenomenon. This does not mean that the measurement model of organizational complexity must consist of dozens of indicators; it should rather consist of relevant indicators that reflect as many dimensions and aspects of complexity as possible.

Following the approach of **WESTERBY**, there are six basic quantities, defining the complexity of organizations.\(^{379}\)

1. The number of components
2. The number of different kinds of components
3. The number of elements of each kind
4. The number of relations
5. The number of different relations
6. The number of each kind of relation

**WESTERBY** is in line with **KEUPER, GROSSMANN** and **SCHLANGE** who define complexity by two dimensions: firstly, the structure of a system given by the elements, and secondly, the links and the change of these elements and links in the course of time.\(^{380}\)

One example of an appropriate approach was developed, with some limitations, by **MEYER/LEHNERD**. They present a method of how to measure commercial product complexity by counting the number of parts, the different types of parts, and the interface (the

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\(^{377}\) cf. Ibid., pg. 92.

\(^{378}\) cf. Ibid., pg. 92.

\(^{379}\) cf. Ibid., pg. 91.

relations) of each part. The multiplication of these three indicators and the following calculation of the square root of the product represent the complexity factor.\textsuperscript{381} The limitation of this approach lies in the intrinsic reductionistic process. The fragmentation of complexity into three parts, which are analyzed and afterwards reassembled again, is not appropriate to study complexity. Even if it is appropriate to strive for an overall complexity factor, this process is misleading, as discussed in chapter 2.2.2.1. Following the approach of complexity thinking enables a deeper understanding of the phenomenon "commercial product complexity" and leads to the acceptance of the limited knowledge about the interrelation of the distinct dimensions. The addition of the number of parts and the multiplication of the quantities is a questionable procedure. Theoretically, there can be a polynomial relationship between the complexity drivers because power laws can be found in many self-organized complex adaptive systems.\textsuperscript{382} With regard to this, the calculation can only deliver limited results.

The seventh mistake that should be avoided is the use of subjective measures. As observed by CHECKLAND, subjective measures of complexity are not appropriate due to the generally existent difference between reality and its description.\textsuperscript{383} Similarly, the subjective description of complexity is rather a measure of a person’s ability to understand a system, which is complex itself.\textsuperscript{384} With help of some expertise or by an increase of understanding and mental capacity of the respondent, the perceived complexity of systems decreases without a change of system.\textsuperscript{385} GUIMAREAS, et al. provide an example of such a subjective measuring concept. Instead of measuring the complexity of the system, they asked managers, who were involved in the systems, to estimate, among other things, the level of supervisory task complexity, operator task complexity, and system complexity. With regard to operator task complexity, they asked the participants to rate the difficulty of tasks on a seven-point Likert scale ranging from (1) extremely simple to (7) extremely complex.\textsuperscript{386} Thus, they used the subjective cognition of the managers to assess complexity. Obviously, the cognition of complexity is strongly influenced by the level of education as well as by intelligence. Hence, the assessment of a complex situation or task can be different from one person to another. Additionally, system complexity

\begin{footnotesize}
\begin{enumerate}
\item cf. Bak, P. (1996), pg. 27.
\item cf. Guimareas, T., et al. (1999), pg. 1261.
\end{enumerate}
\end{footnotesize}
Measurement of organizational complexity

was assessed among the participants by asking them to rate their manufacturing system in comparison to other manufacturing systems of their organization on a seven-point Likert scale. As a result, their subjective understanding of the manufacturing system, as well as a blurred and unqualified assessment of other manufacturing systems influences the assessments.

It is therefore not surprising that Guimarea's findings are inconsistent. Firstly, they found that supervisory task complexity is inversely related to system performance. They did not, however, find a relationship between operator task complexity and system performance. Secondly, they found that system complexity is inversely related to system performance. It is obvious that supervisors and operators of a system, which perceive their manufacturing system as difficult, have a lower performance than those who can cope with the difficulties of their system.

Due to the fact that the description of complexity is very subjective, it is important to note the intrinsic error of this measure. The following table summarizes the typical mistakes of measuring complexity.

<table>
<thead>
<tr>
<th>Typical mistakes of measuring complexity</th>
<th>Examples</th>
</tr>
</thead>
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387 cf. Ibid., pg. 1261.
388 cf. Ibid., pg. 1265.
Empirical model

|---|---|

Table 2: Typical mistakes in measuring complexity.\(^{391}\)

Again, it can be stated that it is necessary to focus on the measurement of “real” complexity without applying subjective measures and to establish an approach that is as holistic as possible, guided by theoretical assumptions and based on an appropriate sample of complex organizations. Furthermore, it has to be accepted that the incompressibility of complex systems inhibits the development of a globally and permanently valid perspective or paradigm.\(^{392}\) This implies that a perspective, paradigm, or framework that can be applied to describe any subsystem in a holistic way while being embedded within the complex adaptive system is hard to define or even does not exist.\(^{393}\) As mentioned, however, in the beginning of this section, as well as in section 2.2.2.3, and chapter 4, the complexity thinking approach is aware of such limitations. It is obvious that the relationships between distinct components of complexity, which can only be studied if the holistic phenomenon of complexity is defined to be at least quasi-reducible, are hard to quantify.\(^{394}\) Nevertheless, the analysis of such parts can be very helpful to understand determinants of the behavior of complex systems, even if the overall complexity cannot be measured or calculated in a linear way.

That is why this thesis refrains from measuring organizational complexity holistically and instead focuses on the drivers of complexity. By measuring the drivers of organizational complexity – quasi-reduced complexity – it is possible to assess important aspects and dimensions of complexity, guided by theoretical assumptions and focused on immanent characteristics of complexity. By doing so, this thesis avoids central mistakes like the ones

\(^{391}\) Own source.
\(^{392}\) cf. Richardson, K., et al. (2001), pg. 9.
\(^{393}\) cf. Ibid., pg. 9.
\(^{394}\) cf. Richardson, K. (2008), pg. 16.
Measurement of organizational complexity

presented as number one, two, five and seven. Furthermore, the following empirical study will be based on organizations with different levels of organizational complexity. Moreover, it will incorporate the findings of different fields of research, utilizing the highest possible amount of quantities and qualities, and thus attenuates the other mistakes as far as possible.

Measuring the drivers of organizational complexity can be done reflectively or formatively. If the variable is measured reflectively, the direction of influence goes from the construct to the measures. Hence, the measurement indicators are expected to be correlated. Because all indicators are affected by the construct that they represent, the exclusion of one indicator does not alter the meaning of the construct and the results.\(^{395}\)

If the variables are measured formatively, the indicators directly affect the variable – they cause and form the construct.\(^{396}\) It is not necessary that the indicators are correlated since they determine the construct – and the exclusion of one indicator can change the whole construct.\(^{397}\) The selection of the measuring model is crucial as it determines the selection of the estimation procedure, which will be done in chapter 5.4.1. A misleading specification of the measuring model will distort the results.\(^{398}\)

As discussed in section 2.1.2, complexity is caused (or driven) by diversity, ambiguity, interdependence and fast flux. For that reason these dimensions constitute, and directly affect, the construct of complexity and have to be specified as formative measures. The alteration of the drivers does influence the latent variable organizational complexity. The drivers themselves are latent variables and cannot be measured directly; rather, it is possible to define distinct indicators, which reflect the value of these drivers. This being the case they are measured reflectively. This is important because reflective indicators are correlated and replaceable. It is not necessary to measure all possible indicators for the simple reason that each one reflects the value of the driver.

5.1.2 Quantifying IMD's organizational complexity framework

As basis for the empirical research, the following section presents a comprehensive concept of organizational complexity with measurable dimensions – the drivers of complexity, which illustrate the phenomenon in a holistic way.


The following framework of organizational complexity is based on the four complexity drivers diversity, ambiguity, interdependence and fast flux, which were introduced in chapter 2.1.2. Admittedly, there are a great number of different indicators for each driver as well as interdependencies between these indicators. The following chapter will extract the most relevant indicators and factors. The indicators and factors are analyzed independently and their relationships among each other are taken into account. During this development, different perspectives and approaches from various authors are combined. As a result, the following section might appear to be a bit fragmented, but like pieces of a large puzzle, the different opinions and statements are organized in the way that a comprehensive picture – a reflective measurement framework for the drivers of organizational complexity – will be defined at the end. As discussed above, these drivers illustrate the phenomenon of complexity in a holistic way. Even if it is uncertain whether the relationship between them is additive, multiplicative or exponential, this missing qualitative information does not influence the general findings, as confirmed by RICHARDSON. In line with his understanding that such a quasi-reduction of complexity does not change the functionality of the system, this thesis argues that the presented quasi-reduction of complexity does not change results in general – and it does not influence the described challenges for the management in particular. Independently from the level of the holistic organizational complexity they need to cope with and manage the challenges caused by the drivers.

In general BACKLUND defines a complex organization as an organization whose behavior is complex, or whose inner structures are complex, or whose processes are complex. Other interpretations of organizational complexity range from heterogeneity and diversity by LAWRENCE/LORSCH, THOMPSON and DESS/BEARD, effect uncertainty by MILLIKEN, analyzability by DAFT/WEICK and usefulness of information for decision-making by DUNCAN to geographic concentration and changes of market shares by SHARFMAN/DEAN.

As BACKLUND concretizes, an organizational structure is complex if one or several of the following characteristics can be found within the organization:

- the organization consists of many components or subsystems (Diversity),
- these components or subsystems are miscellaneous (Diversity),

399 cf. Richardson, K. (2008), pg. 16.
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- there are many relations and/or interactions between the components or subsystems (Interdependence),
- the relations are not symmetric (Ambiguity),
- the arrangement of the components and or subsystems is not symmetric (Ambiguity),
- the components, subsystems and relationships change over time (fast flux).  

On the basis of this general description of organizational complexity, the major challenge is to define a measurement framework that quantifies organizational complexity in a reliable and detailed manner. As pointed out above, some of these general characteristics of organizational complexity can be associated with the drivers of complexity intuitively. In the following discussion the focus lies on the kind of characteristics of organizations as complex adaptive systems that simultaneously determine both, the characteristic and strength of the complexity drivers, as well as the characteristics of the organizations. In doing so, it assures both the measurement of “real” – organization immanent – organizational complexity and the representativeness of as many facets as possible.

5.1.2.1 Organizational complexity – Diversity

The first driver of organizational complexity that will be quantified is diversity. Organizational complexity is shaped by diversity in several ways from inside and outside the system. Organizations are affected by their environmental complexity, which was defined by BURTON/OBEL as the number of relevant variables of the environment. MINTZBERG suggests that elements of an organization’s business, such as clients, products, services and geographic markets, all contribute to diversity. Likewise, DUNCAN examines the dimension of diversity within his early research and operationalizes complexity by the number and heterogeneity of factors in the decision environment, as mentioned above.

One major driver of organizational diversity is the organization's response to the external diversity and the co-evolution of the organization in relation to its business environment, as by customer orientation as the overall concept being applied by many organizations. This market-driven approach does not only affect the divisions that are close to the customer, but

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404 cf. Duncan, R. B. (1972), pg. 316.
also all resources and processes within the organization.\textsuperscript{405} If organizations try to cope with all the diverse needs of their business environment, they need to incorporate increasing complexity in terms of the number of goals, plans and amount of information, as \textit{FRESE} defines complexity of a system. As mentioned above, however, these actions result in dilemmas for the organizations. Accordingly, studies have discerned a curvilinear relationship between the extent of corporate diversification and firm performance.\textsuperscript{406}

As \textit{ASHMOS, et al.} state, “this incorporation [of business environmental complexity] is being reflected in the strategic complexity, which is given when organizations simultaneously pursue a variety of strategic activities”\textsuperscript{407}

Strategic complexity is defined by the number of its products and services, the number of countries involved and by the sources of competitive differentiation.\textsuperscript{408} In several studies strategic complexity was measured by the use of 17 industrial and 23 environmental subjective items that are identified by \textit{DESS/BEARD}. In their work, \textit{DESS/BEARD} define two components of diversity: first, homogeneity/heterogeneity and second, concentration/dispersion.\textsuperscript{409} Therewith they create a standard reference for the following research performed by, amongst others, \textit{BOYD, et al., LAWLESS/FINCH} and \textit{CANNON/ST. JOHNN}.\textsuperscript{410}

Further diversity related measures used in research are

- number of employees of the organization,\textsuperscript{411}
- number of resources or inputs,\textsuperscript{412}
- number of customer groups or outputs,\textsuperscript{413}
- number of products being produced within the industry,\textsuperscript{414}
- number of institutions with which the firm interacts,\textsuperscript{415}
- amount of scientific knowledge required to interact with constituents,\textsuperscript{416}

\textsuperscript{405} cf. Schwenk-Willi, U. (2001), pg. 47, refer to section 2.3.2.
\textsuperscript{408} cf. Heywood, S., et al. (2007), pg. 87.
\textsuperscript{416} cf. Mintzberg, H. (1979), pg. 268.
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- fragmentation versus concentration in the competitive landscape,\(^{417}\)
- level of technological complexity faced by industry incumbents that is measured as percentage of scientist and engineers,\(^{418}\)
- process complexity, which is related to the stage of industry life cycle and level of capital intensity, \(^{419}\)
- geographical concentration.\(^{420}\)

Due to the fact that the empirical research presented here should be based on objective and reliable data, strategic complexity is assessed objectively by the portfolio diversification.\(^{421}\)

A frequently used measure for portfolio diversification is the entropy index, which is based on a 4-digit SIC Code classification of different business segments.\(^{422}\) The entropy index is based on the general entropy concept that is introduced in the context of the second law of thermodynamics in physics.\(^{423}\) Entropy is a quantitative measure, illustrating the disorder of a system. It is appropriate to be used as a complexity measure in business science.\(^{424}\)

With this it is possible to clearly differentiate between the business segments and to assess the heterogeneity as well as the number and importance of each business segment. The Entropy index of the Portfolio Diversification (PD4) is calculated by:

\[
E_{PD} = \sum_{i=1}^{n} \frac{SBS_i}{SBS} \cdot \ln \left(\frac{1}{SBS_i}\right)
\]

Formula 1: Entropy equation for the portfolio diversification.

Here SBS\(_i\) is the volume of Sales in the Business Segment \(i\), classified by the 4-digit SIC Code.

ROBINS/WIERSEMA examined the validity of related diversification measures and found a correlation between the related component of the entropy index and the concentric index, and that they are strongly influenced by more fundamental aspects of diversification.\(^{425}\) These aspects are the number of business segments (PD1) in the portfolio, the sales volume of the

\(^{421}\) Ashmos, D. P., et al. (2000), pg. 587.
\(^{423}\) Crutchfield, J. P., et al. (2000), pg. 2996
\(^{424}\) Schneider, E. D., Kay, J. J. (1995), pg. 162
\(^{425}\) cf. Robins, J., Wiersema, M. F. (2003), pg. 58; Shin, N. (2003), pg. 5: The concentric index measures the degree of distance or relatedness between industries or business segments. The weight is given based on the business segment sales shares.
dominant segment \((PD_2)\) as well as the share of sales in the dominant business segment in relation to total sales \((PD_3)\).

Hence, the entropy index, as a valid measure of diversification, should be complemented with the number of different business segments in the portfolio and the size of the dominant segment.

In addition to the product dimension of portfolio diversification, it is possible to assess the geographical or regional diversification. Acting in significantly different regions of the world and serving the needs of customers with different cultures, varying economical and political standards and behaviors result in higher levels of organizational complexity. As a result, the degrees of the regional diversification are important indicators of organizational complexity. The regional segmentation of the World Bank, which divides the world into seven regions (East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, the countries of the Organization for Economic Co-Operation and Development (OECD), South Asia, and Sub-Saharan Africa), is a good basis for this measure. These distinct regions represent certain economical, political and cultural conditions. On account of this, the volume of sales in these regions can be used to calculate the Entropy index of the Regional Diversification of Sales \((RD_1)\). Additionally, it is possible to measure the volume of sales in foreign countries in relation to total sales \((RD_2)\) to estimate the diversity of the served markets. Furthermore it is important to assess the volume of international assets in relation to total assets \((RD_3)\) because, with respect to organizational complexity, it makes a significant difference whether a company is exporting to different countries or if it is manufacturing in other countries, as well.

Another aspect causing organizational complexity related to driver diversity is the structural size of an organization.\(^{427}\)

In general, due to the fact that diversity can be split up into a number of parts and heterogeneity of parts, it can be stated that diversity is a function of size to some extent.\(^{428}\) Referring to the definition of complexity it is evident that size, with regard to the number of elements, causes complexity.

\textit{WILLERT/KNYPHAUSEN-AUFSESS} give an example by quoting a statement of an interviewee: “Communication within the firm is very important for decision-making. The lines of communication get more complex as the number of offices grows.”\(^{429}\)

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Measurement of organizational complexity

Hence the number of elements is a part of the diversity definition; the size of the organization is defined as a measure of organizational diversity. Even if size as a measure of growing complexity is controversial in that organizational growth can be implemented without the alteration of other aspects of the business model and thereby business complexity or faced environmental complexity, the size itself is an approximation of complexity and a relevant dimension of the complexity examination. ⁴³⁰

As MILLER/CHEN argue, large organizations have to cope with a higher degree of external diversity and have to manage higher levels of complexity, as demonstrated by the number of markets served and the number of competitors faced by a single organization. ⁴³¹

This is also meaningful as a growing number of employees cause a higher heterogeneity of behaviors and mindsets analogically. ⁴³² This heterogeneity will be even be higher if the expansion of the organization is related to the process of internationalization.

To reflect the influence of size, the size of the company is calculated as an indicator of diversity by the total volume of sales (S₁), number of employees (S₂) and total volume of assets (S₃). Further facets of size, important for drivers and globally acting companies in particular, can be represented by the measures of total volume of foreign sales (S₄) and total volume of international assets (S₅). In addition to the indicators RD2 and RD3, which measure the proportion of foreign sales and assets as discussed above, the total volume measures reflect the structural size of these foreign activities. Since all of these indicators are reflective measures of the driver diversity, they are, by definition, redundant to some extent.

In terms of diversity, another important aspect that influences the shareholder’s power of and relationship with organizations is reflected by the number and relevance (percentage of held shares) of shareholders. The diversity of shareholders has an influence on their participation since fewer powerful institutional investors will have a higher influence than a large number of shareholders owning only few shares. By pooling the shareholders who hold less than one percent of the shares while taking all other shareholder independently into account, it is possible to assess the strength of shareholder's influence with the help of the Herfindahl index. The Herfindahl index measures the concentration of power and represents the distribution of held shares. Its value declines if the shares are equally distributed. By using the value of [1- Herfindahl index], it is possible to illustrate that a greater number of shareholders holding a significant proportion of shares put more diverse pressure on the management than

Empirical model

one dominant, major shareholder (especially in the case of a family-dominated organizations). The value of the **Diversification of Shareholders (SD1)** is calculated by:

\[
D_S = 1 - \frac{\sum_{i=1}^{n} PS_i^2}{\left(\sum_{i=1}^{n} PS_i\right)^2}
\]

**Formula 2: Equation for the shareholder diversification.**

PS\textsubscript{i} describes the Proportion of Shares held by the Shareholder or Shareholder group i.

To sum up, organizational diversity as part of organizational complexity can be measured by:

- number of business segments (PD\textsubscript{1}) in the portfolio,
- sales volume of the dominant segment (PD\textsubscript{2}),
- sales of the dominant business segment in relation to total sales (PD\textsubscript{3}),
- entropy index of the portfolio diversification (PD\textsubscript{4}),
- entropy index of the regional diversification of sales (RD\textsubscript{1}),
- volume of sales in foreign countries in relation to total sales (RD\textsubscript{2}),
- volume of international assets in relation to total assets (RD\textsubscript{3}),
- total volume of sales (S\textsubscript{1}),
- number of employees (S\textsubscript{2}),
- volume of total assets (S\textsubscript{3}),
- volume of total foreign sales (S\textsubscript{4}),
- volume of total international assets (S\textsubscript{5}),
- diversification of shareholders (SD\textsubscript{1}).

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433 Own source.
The indicators for organizational diversity that are defined above are mainly market-driven, as discussed at the beginning of this section. Nevertheless, the response to the market complexity causes organization-driven complexity, determined by the organizational configuration. Thus these indicators reflect both categories of organizational complexity and are expedient to test the hypothesis.

5.1.2.2 Organizational complexity – Ambiguity

The second driver of organizational complexity quantified in this thesis is ambiguity. This driver is present both within the organization and the external environment and influences the organization in various ways. Ambiguity as a driver of organizational complexity is strongly related to the frequently utilized term of uncertainty, which is defined by GALBRAITH as “the difference between the amount of information required to perform the task and the amount of information already possessed by the organization”. Uncertainty and ambiguity are often used synonymously in several studies, but the following discussion will highlight the differences to define consistent measures.

BURTON/OBEL determine uncertainty as the general lack of understanding and absence of

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434 Own source.
Empirical model

information about probability, distribution of the values of the variables and equivocality.\textsuperscript{436}

In contrast to probability in decision theory, uncertainty cannot be assigned.\textsuperscript{437}

Comparing uncertainty and ambiguity in detail, it can be stated that ambiguity is a more holistic concept. Uncertainty implies that the managers know that relevant information exists or that a certain event could occur, but the organization as a whole has only insufficient factual information to evaluate its importance or impact. Ambiguity, in contrast, includes the option that a complete lack of knowledge about events and entities in the environment is given.\textsuperscript{438}

As \textit{WOODWARD} argues, “ambiguity in its simplest state can be measured in terms of information that is absent or present. It can be further specified by analyzing whether this information is factual or conjectural, qualitative or quantitative, vague or precise, static or dynamic, isolated or part of a series or trend and according to the comprehensiveness, consistency and accuracy of the information.”\textsuperscript{439}

When organizations face rising ambiguity in their business environment that is caused by a great number of interdependent factors of influence as well as rapid change, linear extrapolations are no longer appropriate to predict the future. \textit{BEINHOCKER, COURTNEY, EPSTEIN,} and \textit{SCHOEMAKER} reflect upon these new circumstances and develop alternatives, like scenario planning, to cope with rising business environmental complexity.\textsuperscript{440}

The ability to adapt and the flexibility of organizations are crucial for their complexity absorption capability and the performance of the organization.\textsuperscript{441} One important aspect of this capability, which leads to a better co-evolution of the organization with its environment, is the use of early awareness systems and the continuing scanning of the environment, especially of the “competitive landscape”.\textsuperscript{442} Scanning therefore directly influences the level of ambiguity in the business environment and is thus able to improve the organizational performance.\textsuperscript{443}

Ambiguity in organizations is both organization- and market-driven. The market-driven complexity is strongly related to the diversification of the organization with regard to the product portfolio and the geographic diversification or internationalization.

Growing diversity generally results in the need to gather and process more information, such

\begin{footnotesize}
\begin{enumerate}
\item[441] For a detailed explanation of this expression and concept please refer to the discussion in section 7.3.
\end{enumerate}
\end{footnotesize}
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as information about competitors, trends, customer needs and political developments. In consequence, the ambiguity within the organization increases due to the direct response to market complexity. Furthermore, a growing number of employees and other indicators of size also reflect the level of ambiguity inside the organization, since, for example, the agents (employees or departments) in growing systems cannot be connected to all the others. Thus the ambiguity of the status, behavior and goals of other agents increases in large systems. According to this, the reflective measures of organizational diversity that were already introduced are also indicators (reflective measures) for ambiguity.

In addition to this kind of market-driven complexity, ambiguity is also caused by organizational configuration. The resulting organization-driven complexity can reflectively be measured by the levels of standardization, decentralization, specialization, and formalization.\(^{444}\) For example formalization as a core dimension of organizations refers to the codification of behavior.\(^{445}\) It can be defined as “the extent to which documented standards are used to control social actor’s behavior and outputs”.\(^{446}\)

These characteristics determine the level of ambiguity inside the organization in that they define how information is collected, interpreted and delivered to the decision makers. Due to the fact that the resulting complexity is not related to the market, but is only caused by the organizational configuration of power and interdependencies, it is organization-driven.

In general, many researchers confirm that highly centralized, standardized and formalized organizations can be seen as less complex than decentralized and informal organizations.\(^{447}\) However, due to a low level of informational exchange, they don’t even have great potential for self-organization or co-evolution. Hence BURTON, et al. states that highly formalized and structured processes or organizations do not match highly ambiguous environments.\(^{448}\) In contrast, decentralized and informal organizations can easily exchange information throughout the whole internal structure and reconfigure themselves spontaneously without being restricted by rules.\(^{449}\) As a result, they can use the openness of the system more efficiently to co-evolve with their environment through self-organization and to create new adapted structures. With this BURTON, et al. emphasize the importance of the correct

\(^{446}\) Bodewes, W. E. J. (2002), pg. 221.
organizational configuration, which determines the internal level of organizational complexity, and ambiguity in particular.

To measure the degree of formalization and therewith ambiguity inside the organization, it is important to differentiate between an objective measurement, as for example used by SAMUEL/MANNHEIM, and a subjective measurement, as used by HAGE/AIKEN or STOGDILL/SHARTLE. As discussed above in chapter 5.1.1, subjective measures are not only questionable for the holistic measurement of complexity but also for the measurement of the drivers of complexity and the correlating indicators. The concept of formalization is meant to be measured objectively and the following section presents different objective approaches.450

In general, it is possible to differentiate between three dimensions of formalization: structural formalization (who should do something), formalization of role-performance (what should or could an entity do) and formalization of information passing (how to interchange information).451 PUGH, et al. measure each dimension with a selection of related and formalized documents and the variety of their application.452

A more elementary approach to measure formalization was developed by BODEWES. He measures formalization with three classes and from two different perspectives. Firstly, he assesses the existence of formalized rules with: 0= no rule manual and no organizational chart, 1= the existence of either a rule manual or organizational chart, 2= the existence of a rule manual as well as an organizational chart.453 Secondly, he measures the degree of role observation by the references that are made to the documented standard (0= never, 1= occasionally and 2= frequently).454

The initial approach of measuring formalization, given by PUGH, et al., represents more facets of organizational complexity. Within this approach, ambiguity is assessed by structural formalization (F1), formalization of role-performance (F2) and formalization of information passing (F3).

The second important characteristic, decentralization, is closely related to the delegation of the authority of decision-making within the organization.455 With regard to the organizational complexity dimension ambiguity, the influence of decentralization is positive because it increases the level of complexity. At this point it can be mentioned that decentralization

451 cf. Pugh, D. S., et al. (1968), pg. 76.
452 cf. Ibid., pg. 76; Walton, E. J. (2005), pg. 574.
454 cf. Ibid., pg. 221.
referring to the dimension interdependency reduces organizational complexity. Thus a detailed discussion about the overall influence is necessary and will follow in section 5.2.

Here decentralization of decision-making leads to a higher degree of freedom at the lower level or at the periphery of the organization, which causes higher ambiguity inside the organization.\(^\text{456}\) Thus it is clear that the impact of decentralization on complexity is opposed to the effect of formalization. Even if it is evident that decentralization can create superior opportunities and capabilities to cope with the ambiguity of the business environment, it causes an increase of internal complexity. This increase is amplified when decentralized structures come along with high diversity of elements in the organization. In relation to this, the organization can, on the one hand, increase its information processing capacity, but has to manage higher internal complexity at the same time.\(^\text{457}\)

Formalization and decentralization have to be managed simultaneously to optimize the complexity absorption capacity. On the one hand, decentralization increases ambiguity due to the existence of multiple and conflicting interpretations of an organizational situation, on the other, however, formalization can align these interpretations.\(^\text{458}\)

One approach to measuring the degree of decentralization is given by DALE. The amount of delegation regarding the authority of decision-making grows if:\(^\text{459}\)

- the number of decisions made on a lower level of the organizational structure increases (\(\text{DEL1}\)),
- the importance of a decision made on the lower level grows (the disposed amount of money) (\(\text{DEL2}\)).

Despite of this, the number of subsidiaries of an organization can define a more applicable measure of decentralization for an external perspective of organizations.\(^\text{460}\) The organizational configuration gives hints for the delegation of decision-making and the intensity of informational collaboration.\(^\text{461}\) DAFT uses the number of subsystems and the number of activities to evaluate complexity.\(^\text{462}\)

Due to the fact that a high number of subsidiaries is strongly related to decentralized interpretation of information, situations and decision-making, this will cause a high level of

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\(^{456}\) cf. Malik, F. (2003), pg. 237.
\(^{461}\) cf. Pugh, D. S., et al. (1968), pg. 89.
Empirical model

Ambiguity inside the organization is caused.\textsuperscript{463} Hence, the number of subsidiaries (DEL3) is an appropriate measure for the dimension of ambiguity inside the organization.

Standardization of procedures is another basic aspect of organizational structure.\textsuperscript{464} It defines the extent of coverage and application of operating procedures as well as rules and regulations throughout the organization.\textsuperscript{465} Standardized rules and procedures provide guidelines for members to perform and coordinate differentiated and interdependent activities.\textsuperscript{466} Pugh, et al. measured the degree of standardization by counting the number of standardized process given in an organization (STAND1). Standardization is therefore complementary to formalization. While formalization visualizes and records behaviors, rules and procedures, standardization unifies and harmonizes them.

Furthermore, organization structures can be characterized by the degree of specialization.\textsuperscript{467} In general, specialization is concerned with the division of labor within the organization – the distribution of official duties among a number of positions.\textsuperscript{468} As Pattenaude states: “Given the current concern with organizational structure and its impact on organizational behavior in a complex and unpredictable environment, measures of organizational variables like specialization take on a critical nature and, as such, should be pursued.”\textsuperscript{469} Increasing division of labor leads to growing ambiguity inside the organization since knowledge is divided into several different parts.\textsuperscript{470} Specialization can be measured by counting different job titles or measures that evaluate the personal specialization, but as Tyler states, “neither of these two methods is particularly satisfactory”.\textsuperscript{471} These methods are only appropriate if the compared organizations have the same rules for the denotation of job titles. It is therefore limited in its applicability. Besides, it demands a very deep insight into an organization.\textsuperscript{472} Hage/Aiken utilize the number of work-related fields of expertise, degree of professional training, and the degree of professional activity to assess organizational specialization.\textsuperscript{473} As can be seen by these different measures presented in the following Table 3, organizational

\textsuperscript{463} cf. Tricker, R. I. (1984), pg. 54 et seqq.
\textsuperscript{464} cf. Pugh, D. S., et al. (1968), pg. 74 et seq. A procedure is take to be an event that has regularity of occurrence and is legitimized by the organization. Pugh, D. S., et al. (1968), pg. 74.
\textsuperscript{465} cf. Walton, E. J. (2005), pg. 573.
\textsuperscript{467} cf. Walton, E. J. (2005), pg. 572.
\textsuperscript{468} cf. Pugh, D. S., et al. (1968), pg. 73; Tyler, W. B. (1973), pg. 383.
\textsuperscript{469} Pattenaude, R. L. (1974), pg. 575.
\textsuperscript{470} Even if the ambiguity for each individual decreases, the effect for the organization in total is different.
\textsuperscript{471} cf. Tyler, W. B. (1973), pg. 383.
\textsuperscript{473} cf. Hage, J., Aiken, M. (1967), pg. 83.
specialization is a multi-dimensional construct. Mainly one has to differentiate between personal specialization and task specialization.\textsuperscript{474}

Only a combined measure that reflects both, the formal division of labor within an organization as well as the specialized training of each individual, is supposed to be appropriate. \textit{TYLER} defines role variety and personnel interchangeability as measure of specialization that covers both dimensions.\textsuperscript{475}

To measure the indicator specialization role variety (\textsc{speci1}) and personal interchangeability (\textsc{speci2}) are used.

As postulated by \textit{WEBER}, the four characteristics of organizational structure discussed above are positively related to each other.\textsuperscript{476} Amongst others, \textit{WALTON} confirms this postulation in his meta-analysis, which includes 68 primary studies discussed within 64 publications in the period between 1960 and 1999.\textsuperscript{477} Decentralization, formalization, standardization and specialization are important indicators for the overall ambiguity inside the organization. While decentralization and specialization enhance ambiguity, standardization and formalization reduce ambiguity inside the organization. All indicators need to be studied accordingly to establish a comprehensive measure for ambiguity.

\textsuperscript{474} cf. Pattenaude, R. L. (1974), pg. 575
\textsuperscript{475} cf. Tyler, W. B. (1973), pg. 391; Tyler, W. B. (1975), pg. 461.
\textsuperscript{476} cf. Weber, M. (1946), pg. 191 et seq.
\textsuperscript{477} cf. Walton, E. J. (2005), pg. 576 ; Meijaard, J., et al. (2005), pg. 90.
**Empirical model**

**Horizontal differentiation/Functional specialization**
Specialization refers to the division of labor within the organization, and has several aspects. *PUGH, et al.; PUGH, et al.*

Specialization – a mechanism to deal with task complexity. Division of labor. *BLAU, et al.*

Functional specialization – duties split into identifiable areas. *CHILD*

Functional specialization – the number of divisions. *CHILD*

Specialization – the division of labor within the organization/the distribution of duties among the total number of positions. *HOLDAWAY, et al.*

Functional specialization – the number of groups or departments. *LINCOLN*

**Line/Staff**
Specialization – the extent to which one or more individuals occupy non-work-flow functions full time. *PENNINGS*

Functional specialization – the number of support non-line positions. *HOLDAWAY, et al.*

**Person specialization**
Person specialization – is when the work done is less than routine – the results may be the specialization of a person who performs the task. *THOMPSON*

Number of specializations – a count of the number of those functions that are performed by specialists. *PUGH, et al.; PUGH, et al.*

Specialist – a basic knowledge of the whole profession is indispensable. *PUGH, et al.*

Professionalism – the degree of professionalism of the staff. *BLAU, et al.*

Functional specialization – high or low expert needed. *SAMUEL and MANNHEIM (1970)*

Functional specialization – the proportion of job titles occupied out of a maximum of 39. *HEYDEBRAND (1973)*

Specialization – the proportion of teachers in each school who teach subjects in which they majored or minored. *BECK (1974)*

Person/Task specialization – individuals in specific occupations which require long periods of training (person specialization) – little education skill (task specialization) *HAGE/AIKEN.*

Specialists – individuals who do a variety of tasks, all directed toward a narrow substantive area that requires expertise. *SPAETH*

Specialization – the extent to which tasks are divided among different experts. *MOCH (1976)*

Person specialization – the median G.S. rating of non-supervisory employees/the mean years of education of supervisors. *BEYER and TRICE (1979)*

Span of control on the highest management level. *KLATZKY*

**Task specialization**
Task specialization – is a process of making activities more specific *THOMPSON (1961).*


Functional specialization – the number of unique functional roles that exist in a population. *CLEMENTE (1972)*

Role specialization – duties split within a function. *CHILD*

Overall role specialization – the division of labor. *CHILD*

Table 3: Different approaches to measure specialization.478

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Measurement of organizational complexity

Returning to the previously defined understanding of ambiguity as decentralized information inside the organization and inconsistent information caused by varying interpretations of data, one more indicator can be defined to reflect the value of organizational ambiguity. The organizational alignment that is caused by a strong organizational culture and a clearly communicated strategy is an essential indicator for organizational ambiguity. A strong organizational culture leads to a common understanding as well as an alignment of behaviors inside the organization. For this reason, a strong organizational culture can reduce the variety of interpretations and leads to a more congruous understanding, even in decentralized organizations. A strong organizational culture reduces organizational complexity by providing a framework of values, norms and rules that together limit uncertainty for individuals (agents).

Similarly, a clearly communicated strategy or an underlying dominant logic reduces ambiguity. Accordingly, strength of organizational culture (CULT1) is measured by response consistency among people in survey items, whereas clarity and visibility of the organizational strategy (STRA1) are measured by the number of employees who are familiar with the company's strategy and who can reproduce it. Both measures are chosen to evaluate organizational ambiguity.479

In addition to the already mentioned overlapping indicators, the measurement model of organizational ambiguity is defined by the following indicators:

- intensity of delegation, measured by the number of decisions made on lower levels of the organizational structure (DEL1),
- intensity of delegation, measured by the importance of decisions made on lower levels (DEL2),
- number of subsidiaries (DEL3),
- structural formalization (F1),
- formalization of role-performance (F2),
- formalization of information passing (F3),
- number of given standardized processes (STAND1),
- role variety (SPECI1),
- personal interchangeability (SPECI2),
- strength of organizational culture (CULT1),
- clarity and visibility of the organizational strategy (STRA1).

Figure 17: Measurement of organizational ambiguity.\footnote{Own source.}

Figure 17 presents the new indicators that are described in this section. The overlapping indicators already mentioned, such as number of employees, were once again not included to improve clarity. At the end of the section, Table 4 will summarize all the overlaps. Referring to the discussion above, these new indicators mainly reflect organization-driven complexity as defined in chapter 3. Hence they are particularly important for testing the third hypothesis: “There is a negative relationship between organization-driven complexity and performance”.

5.1.2.3 Organizational complexity – Interdependence

One of the most important and dominant complexity drivers at the individual, company and industry-level is interdependence.\footnote{cf. Steger, U., Amann, W. (2007), pg. 59; Cannon, A., R., St. John, C. H. (2007), pg. 300.} On the individual level, TUNG describes interdependence as a dimension of complexity. He explains that increasing complexity limits “the CEO’s cognitive abilities to grasp and comprehend the relationships that exist among them”.\footnote{Tung, R. (1979), pg. 675.} As discussed before, interdependence as driver of organizational complexity is strongly related to the structural configuration of an organization.\footnote{cf. Lin, X., Germain, R. (2003), pg. 1146.}
Measurement of organizational complexity

In general, the structure of a system or organization is defined as the arrangement of its subsystems and components at a given moment of time. The degree of interdependence is defined by the number of single-sided or reciprocal relationships between these elements.\(^{484}\)

For instance, BOISOT/CHILD measured the degree of interdependence with the structural complexity concept of ASHMOS/DUCHON. In line with the argumentation of YATES, structural complexity, and interdependence in particular, can be defined by the degree of specialization.\(^{485}\)

Once again, the theoretical quantification of IMD’s framework of organizational complexity results in overlapping indicators. As discussed in chapter 4, however, this will not lead to misspecification of the measurement model since an Explorative Factor Analysis will go on to extract distinctive dimensions out of the high number of overlapping indicators in a second step. Furthermore, the reflective measures can be correlated and redundant per definition.

Interdependence as interaction is described by ASHMOS, et al. by the degree of participation as well as by the number of internal stakeholders, e.g. in a strategic decision-making process.\(^{486}\) According to this interpretation, it is possible to argue that the degree of specialization determines the degree of interdependence. If the level of specialization increases, the number of internal groups that are involved in a process is amplified (on the individual or department level). Hence, the coordination efforts and interdependences between departments increase. As a result, the effort of collaboration and coordination will be increased in total and the complexity grows in its entirety.

As discussed above, specialization can be measured at different levels of detail and with the help of qualitative or quantitative scales.\(^{487}\) The indicators to measure ambiguity, as discussed above, can also be used to assess the driver “interdependence”.

It can therefore be stated that the indicators role variety (SPEC1), personal interchangeability (SPEC2) and number of subsidiaries (DEL3) are appropriate indicators for the measurement of interdependencies.

Another possibility to measure the degree of specialization was illustrated by KLATZKY. She defined the degree of specialization as the span of control on the highest management level.\(^{488}\) This is equal to the number of members of the corporate management or executive board

\(^{487}\) cf. Friedrichs, J. (1973), pg. 193 et seq.
Empirical model

This argumentation is in line with BURTON, et al., who also measure complexity by the span of control.\footnote{cf. Burton, R. M., et al. (2002), pg. 1463.}

Regarding the organization as a whole, size in general as well as the typology of functional, divisional or matrix structure are appropriate measures for interdependence.\footnote{cf. Kieser, A., Kubicek, H. (1977), pg. 151; Scott, B. R. (1973), pg. 21} Due to the fact that these different types of organizational structures (STRUC1) represent different levels of complexity, they can be used as a measure of the interdependence between the subsystems of an organization.

While a functional structure consists of departments specialized in different tasks like procurement, production and sales, the divisional structure consists of departments specialized in different products or geographic regions.\footnote{cf. Kieser, A., Kubicek, H. (1977), pg. 65.} The matrix structure is characterized by individual compartments, which are specialized in tasks as well as products or geographic regions.

The categorical measure can be defined as:

- Divisional structure (YES/NO)
- Functional structure (YES/NO)
- Matrix structure (YES/NO)

A functional structure implies strong interdependencies among the departments and is regarded consequently as more complex than a divisional structure. This is in line with the argumentation of CHEN/MILLER, who state that complexity is given when numerous members, other components or subsystems of an organization are involved in a process.\footnote{cf. Miller, D., Chen, M.-J. (1996), pg. 23, Backlund, A. (2002), pg. 34.}

Since functional departments have to cope with more diversified subsystems, they have to manage more relationships.

However, the matrix structure is even more complex than the functional structure with regard to the interdependencies among the departments. Often departments in a matrix structure have to report and manage two or more relationships simultaneously.

The size of the organization is assessed as presented in section 5.1.2.1 and will not be further elaborated.

Interdependence measured by specialization, as discussed before, only comprises the internal dimension. From a holistic point of view, the proportion of value creation reflects the


specialization of the organization in total. The general level of organizational complexity highly depends on that proportion. The intensity of internal interdependencies will be reduced if the company outsources some parts of the value chain, as discussed in chapter 2.2.6. The proportion of value creation also affects other drivers of organizational complexity. It reduces ambiguity while simultaneously increasing diversity inside the organization. To cover the broad dimension of specialization on company level, the organizational specialization is assessed by the financial figure costs of goods sold to sales (SPEC14).494

Keeping in mind the goal to identify and measure as much facets of complexity drivers as possible, it was decided to additionally assess the technological complexity of the organization. Organizations that are based on a great amount of resources or many different kinds of resources, like manufacturing companies, are presumably more complex than organizations with a small basis of resources in terms of production facilities or financial capital, as for example consulting companies. KOTHA/ORNA measure process structure complexity by the level of mechanization, systematization and interconnectedness within and among manufacturing processes and assessed them by the asset and capital intensity.495

Applying this approach to the entire organization makes it possible to measure an additional aspect of organizational complexity, driven by interdependence of resources. The evaluation of technological assets, quantified by the financial figure assets per employee, (INT1) makes this indicator measurable. This indicator is also sometimes used to measure the size of an organization in general, which is related to the dimension of interdependence, as discussed above.496 Summarizing the measurement model for organizational interdependence, the following new indicators can be defined:

- number of subsidiaries (DEL3)
- organizational structure (STRUC1)
- number of members of the corporate management or board (SPEC13)
- costs of goods sold to sales (SPEC14)
- assets per employee (INT1)

The following figure illustrates the new indicators to measure organizational interdependency. A complete discussion of all interdependencies among the indicators will follow at the end of the chapter. Since the defined indicators reflect both market- and organization-driven complexity, they are relevant to all presented hypotheses.

494 COGS is a financial measure, calculated by the costs that are needed to create and sell companies’ products divided by total sales. It provides insight into the degree of value creation provided by the organization.
5.1.2.4 Organizational complexity – Fast flux

The speed of change (fast flux) is the last driver of complexity to be discussed and has been mentioned, amongst others, by BOURGEOIS/EISENHARDT, BROWN/EISENHARDT, D’AVENI, EISENHARDT, EISENHARDT/MARTIN and WILLIAMS. It plays an important role in the academic literature and also in the practice-oriented literature of strategic management. In this context, fast flux is often characterized by rapid changes in product and process technologies and in competitors’ strategic actions. Also the organizational complexity driver fast flux is induced by the market or by the organization. Consequently, both postulated dimensions and points of view have to be considered.

As mentioned above, the complexity driver fast flux influences all other indicators in that it continuously changes the values and influences of the other dimensions that determine organizational complexity. It is not appropriate then to maintain a constant solution to organizational ambiguity, diversity and interdependence. In addition to influencing the other dimensions, fast flux directly influences organizational complexity.

Organizations acting in fast changing markets, with rapid technology and product changes, have to adapt (co-evolve) permanently. FINES introduces a strongly related concept that is useful for the operationalisation of the complexity driver fast flux, which captures the rate of

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497 Own source.
change. The concept of clock speed\textsuperscript{500} is driven by the endogenous factors technology and competition and consists of the three dimensions product, process and organizational clock speed. The product clock speed is operationalized by new product introductions and product obsolescence rates.

Process clock speed is composed of the rates at which process technologies are replaced in an industry, and organizational clock speed reflects the rate of change in strategic actions (in detail: mergers, acquisitions, internal expansion, inter-organizational alliances) and structures (in detail: restructuring and changes of the top management).\textsuperscript{501}

The amount of fast flux can be assessed by five indicators, which represent the changes of technology, products and organizational setting or structure. If the internal fast flux exceeds a manageable level, the organization will struggle with internal confusion and will lose its capacity to adapt.

The dimension of the technological and product change as part of organizational complexity can be measured by the innovativeness of the company.\textsuperscript{502} The internal impulses for change in technologies or products are determined by the innovativeness or innovation intensity of an organization. TOSI, et al. developed a measure for technical change by using the ratio of research and development expenditure and capital spending to total sales.\textsuperscript{503}

This indicator, as also employed by ALDRICH, MINTZBERG and SHARFMAN/DEAN are used. These researchers confirm that complexity is higher in systems that require advanced scientific or technical knowledge.\textsuperscript{504}

This indicator can be measured by the ratio of Research and Development expenditure to sales (FF\textsubscript{1}).\textsuperscript{505} Due to its high correlation to R&D expenditures, another method of assessing technical change is by analyzing the number of patents (FF\textsubscript{2}).\textsuperscript{506} By doing so, the changes in technologies and products will be assessed more accurately.

The structural and strategic changes inside the organization will be measured by financial figures that represent change on company level. Due to the strategic perspective employed

\begin{footnotesize}
\begin{enumerate}
\item cf. Tosi, H., et al. (1973), pg. 32.
\item cf. Evangelista, R., et al. (1998), pg. 316.
\item cf. Sharfman, M. P., Dean, J. W. (1991), pg. 686; Even if there is an empirically tested time lag between expenditures for Research and Development, the correlation between both indicators is high. Prodan, I. (2005), pg. 4.
\end{enumerate}
\end{footnotesize}
and the goal to measure all indicators objectively, the following indicators operationalize the fast flux dimension:

- Discontinued Operations in the last five years (FF3)
- Ratio of Restructuring Expenses to sales (FF4)
- Number and Volume of M&A (FF5), (FF6)

All four indicators represent both market-driven and organization-driven complexity. On the one hand, restructuring activities is often a direct response to changes in the business environment, such as consolidation in the industry or the entry of new competitors or other challenges, such as the financial crises nowadays. On the other hand, internal forces, for example, also drive some restructuring activities to enhance reputation of the management. Hence, the indicators are relevant for testing hypothesis two (H2: There is a positive relationship between market-driven complexity and performance) and three (H3: There is a negative relationship between organization-driven complexity and performance) as defined in chapter 3.

The first indicator represents complexity in terms of changes in the scope of the company, while the second indicator assesses the change of the structure. Additionally, the third indicator constitutes a very important complexity driver for all organizations with regard to structure and scope. M&A activities are a central driver of organizational complexity since they create higher diversity, more interdependencies and ambiguity. The higher level of diversity is induced by different organizational cultures, different IT systems, products and decision processes. The greater number of interdependencies is caused by the additional elements and the integration of a foreign firm into the organization. Ambiguity is reflected by imperfect and incomplete information as well as new mindsets, leading to different interpretations of the common goal. M&A activities can be assessed by its number and by the financial volume. Since the degree of change is very important, the ratio of M&A volume to sales is defined as an additional indicator (FF7). Furthermore, it makes a fundamental difference whether the M&A activity is related to the acquisition of another company or to the selling of parts of the own organization. It is therefore necessary to differentiate between these two possibilities. While buying contributes positively to complexity, selling reduces the organizational complexity. Even if in the short-term the internal change and ambiguity grow, the reduction of number of elements, the elimination of diversity and interdependence will lead to an overall reduction of complexity. To account for this difference, the M&A sales volume (FF8) is also measured.

Another indicator of organizational change is given by employee turnover. The implicit
knowledge of the organization is stored in the minds of the employees; they also form the culture and the character of the organization. A high level of employee turnover leads to more organizational complexity due to constant change of implicit knowledge, individual mindsets and behaviors. This turnover can be measured by counting the number of newly recruited employees of each year (FF9).

To sum up, the organizational complexity driver fast flux will be measured by the indicators:

- Research and development expenditure to sales (FF1),
- Number of patents (FF2),
- Discontinued operations (FF3),
- Restructuring expenses to sales (FF4),
- Number of M&A (FF5),
- Volume of M&A (FF6),
- Ratio of M&A volume to sales (FF7),
- M&A sales volume (FF8),
- Proportion of new employees (FF9).

Figure 19: Measurement of organizational fast flux.507

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507 Own source.
5.1.3 Summary of measuring organizational complexity

The examination of organizational complexity by analyzing its drivers is helpful for the measurement of the complexity of organizations. To measure organizational complexity, the drivers have to be operationalized and specified by different indicators. With this it is possible to assess these influenceable and manageable drivers of organizational complexity reflectively.

Due to the fact that the presented indicators cannot always be assigned to one single driver, the framework for the measurement of organizational complexity is interlinked, as discussed above. The linkage and overlap is twofold: firstly, the indicators are frequently linked to various drivers simultaneously, and secondly, the indicators sometimes represent both market-driven complexity and organization-driven complexity.

The following Table 4 presents linkages and overlaps of the indicators with regard to the different drivers. Due to the fact that the indicators are reflective measures, the overlapping is not problematic. Either way, it will be necessary to extract distinguishable dimensions for an in-depth exploration and discussion of the implications.

With the help of a matrix that illustrates drivers and indicators, the importance of each factor can be displayed and the basis for further discussion can be established.

As shown, several indicators are central for measuring the drivers of organizational complexity, e.g. the number and volume of M&A are important aspects since they are related to many drivers and thus cause a lot of organizational complexity. Furthermore, the proportion of value-creation measured by cost of goods sold to sales, research and development expenditures and assets per employee are important indicators that are related to two or more dimensions. Important aspects for the structure of the organization, which also affects the organizational complexity in several ways, are number of standardized processes, role variety, personal interchangeability and number of subsidiaries.
<table>
<thead>
<tr>
<th>Diversity</th>
<th>Ambiguity</th>
<th>Interdependence</th>
<th>Fast Flux</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales of the dominant business segment in relation to total sales (PD3)</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Number of business segments (PD1) in the portfolio</td>
<td>x</td>
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<tr>
<td>Entropy index of the regional diversification of sales (RD1)</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Entropy index of the portfolio diversification (PD4)</td>
<td>x</td>
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<tr>
<td>Volume of sales in foreign countries in relation to total sales (RD2)</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Volume of international assets in relation to total assets (RD3)</td>
<td>x</td>
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<tr>
<td>Volume of total assets (S3)</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Volume of total foreign sales (S4)</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>Volume of total international assets (S5)</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Total volume of sales (S1)</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Number of employees (S2)</td>
<td>x</td>
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<tr>
<td>Diversification of shareholders (SD)</td>
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<tr>
<td>Size of the dominant segment (PD2)</td>
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<tr>
<td>Number of subsidiaries (DEL3)</td>
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<tr>
<td>Formalization of role of performance (F2)</td>
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<td>Formalization of information passing (F3)</td>
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<td>Intensity of delegation, measured by the importance of decisions made on lower levels (DEL2)</td>
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<tr>
<td>Intensity of delegation, measured by the number of decisions made on lower levels of the organizational structure (DEL1)</td>
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<td>x</td>
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<tr>
<td>Number of given standardized processes (STAND1)</td>
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<td>Personal interchangeability (SPECI2)</td>
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<td>Structural formalization (F1)</td>
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<td>Role variety (SPECI1)</td>
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<td>Strength of organizational culture (CULT1)</td>
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<td>Clarity and visibility of the organizational strategy (STRA1)</td>
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<tr>
<td>Number of subsidiaries (DEL3)</td>
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<td>x</td>
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<tr>
<td>Organizational structure (STRUC1)</td>
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<td>Number of members of the corporate management or board (SPECI3)</td>
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<td>x</td>
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<tr>
<td>Cost of goods sold to sales (SPECI4)</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Assets per employee (INT1)</td>
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<td>x</td>
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<tr>
<td>Discontinued operations (FF3)</td>
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<tr>
<td>Restructuring expenses to sales (FF4)</td>
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<tr>
<td>Number of M&amp;A (FF5)</td>
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<td>x</td>
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<td>Volume of M&amp;A (FF6)</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>M&amp;A Sales volume (FF8)</td>
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<tr>
<td>Ratio of M&amp;A volume to sales (FF7)</td>
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<td>x</td>
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<tr>
<td>Research and development expenditure to sales (FF1)</td>
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<td>x</td>
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<tr>
<td>Number of patents (FF2)</td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>Proportion of new employees (FF9)</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

Table 4: Interdependencies between different drivers of organizational complexity and their indicators.

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508 Own source.
Empirical model

The multiple relations are caused by the fact that the theoretical distinction between the four drivers of complexity is not totally selective when applied to organizations. Various indicators overlap with other dimensions. As shown in Figure 4 at the beginning of chapter 2.1.2, the defined drivers determine each other to a certain degree, e.g. if diversity of elements in a system increases the ambiguity is also affected. For example, higher product diversity leads to the need to collect, structure and process more data about different markets, competitors and substitutes and therefore the total ambiguity of the organization rises. Furthermore, the internal organizational ambiguity increases because the augmentation of diversification results in a growing amount and fragmentation of knowledge.

To establish a valid measurement framework for organizational complexity, it is necessary to extract underlying dimensions from the wide range of indicators. To do so, the premises of the application have to be revoked and the relationships between these indicators have to be studied statistically. This is important because a theoretical discussion and the great number of inconsistent measures for organizational complexity do not lead to a comprehensive understanding of organizational complexity.

In addition to the assignment of the indicators to complexity drivers, it is possible to ascribe the indicators to the before defined dimensions of market-driven and organization-driven complexity. As discussed in the previous sections and explained theoretically in chapter 3, most of the indicators primarily represent one category: market-driven or organization-driven complexity.

The following Table 5 provides an overview of the identified measurable indicators of organizational complexity traced back to basic market- or organization-driven complexity. In general, it can be stated that according to the organization’s openness to its environment, as discussed in chapter 2.2.3, most indicators are classified as market-driven, since they are either a direct response to the market, related to external demands or indirectly needed to fulfill those demands.509 For example, growing product diversification is a direct response to multifaceted customer needs and creates organizational complexity. The resulting organizational complexity is mainly market-driven, even if some organization-driven complexity, caused by wrong configuration, can emerge. The size of the organization is a similar example. Nonetheless, size is a direct response to growing demand and is therefore market-driven and value-creating. The indicator "number of employees" also represents to a small amount of organization-driven complexity when, for example, internal growth of departments is solely induced by increasing bureaucracy. Hence, the indicator reflects both

509 For the detailed differentiation between value-creating and non-value-creating complexity please refer to chapter 3.
market-driven and organization-driven complexity, without facilitating the opportunity of quantifying each dimension separately. Due to the fact that both examples discussed are market-driven, they are assigned to market-driven complexity.

In contrast, there are some indicators that are assigned directly and only to organization-driven complexity, for example, the degree of standardization of processes, which are unrelated to demands or influences of the business environment.

To test the hypotheses defined in chapter 3, the limited differentiation of the two dimensions of organizational complexity on the level of the measurable indicators has some implications. The first hypothesis cannot be tested empirically without limitations by use of the discussed measurement framework, which consists of 38 indicators. If all indicators are applied, the limited discriminability is negligible.

The second hypothesis, which is related to market-driven complexity, can be tested as well. Due to the fact, however, that it is not possible to isolate the exact proportion of market- and organization-driven complexity that is reflected by the indicators, the empirical results of testing H 2 will have some limitations.

Nonetheless, as discussed theoretically above, these limitations led to the fourth hypothesis, which can be tested by the indicators that were selected.

The third and fifth hypothesis can be tested without limitations for the reason that only those indicators that exclusively measure organization-driven complexity are applied.
Sales of the dominant business segment in relation to total sales (PD3) | x |
| Number of business segments (PD1) in the portfolio | x |
| Entropy index of the regional diversification of sales (RD1) | x |
| Entropy index of the portfolio diversification (PD4) | x |
| Volume of sales in foreign countries in relation to total sales (RD2) | x |
| Volume of international assets in relation to total assets (RD3) | x |
| Volume of total assets (S3) | x |
| Volume of total foreign sales (S4) | x |
| Volume of total international assets (S5) | x |
| Total volume of sales (S1) | x |
| Number of employees (S2) | x |
| Diversification of Shareholders (DS) | x |
| Size of the dominant segment (PD2) | x |
| Number of subsidiaries (DEL3) | x |
| Formalization of role of performance (F2) | x |
| Formalization of information passing (F3) | x |
| Intensity of delegation, measured by the importance of decisions made on lower levels (DEL2) | x |
| Intensity of delegation, measured by the number of decisions made on lower levels of the organizational structure (DEL1) | x |
| Number of given standardized processes (STAND1) | x |
| Personal interchangeability (SPECI2) | x |
| Structural formalization (F1) | x |
| Role variety (SPECI1) | x |
| Strength of organizational culture (CULT1) | x |
| Clarity and visibility of the organizational strategy (STRA1) | x |
| Organizational structure (STRUC1) | x |
| Number of members of the corporate management or board (SPECI3) | x |
| Cost of goods sold (SPECI4) | x |
| Assets per employee (INT1) | x |
| Discontinued operations (FF3) | x |
| Restructuring expenses to sales (FF4) | x |
| Number of M&A (FF5) | x |
| Volume of M&A (FF6) | x |
| M&A sales volume (FF8) | x |
| Ratio of M&A volume to sales (FF7) | x |
| Research and development expenditure to sales (FF1) | x |
| Number of patents (FF2) | x |
| Proportion of new employees (FF9) | x |

Table 5: Overview of market-driven and organization-driven complexity indicators.510

510 Own source.
The differentiation between the categories market-driven and organization-driven complexity allows for an indicator-level application of the framework of how to respond to growing complexity as presented in chapter 3.\textsuperscript{511} Hence it is possible to discuss appropriate strategies to cope with the complexity in more detail. As a discussion of each indicator will not be helpful to guide managerial activities, however, in the following section an Explorative Factor Analysis (EFA) is used to narrow the focus and the discussion.

An EFA can be used to extract the different dimensions (drivers) of organizational complexity. In this way it is possible to empirically verify the proposition that organizational complexity is a multi-dimensional construct. Due to the extraction procedure of the EFA, the indicators that represent one dimension are highly correlated – since this is a reflective measure – whereas the dimensions are not correlated among themselves. Drivers of complexity, as discussed in the previous chapter, are a formative measure of organizational complexity. With the help of the EFA multicollinearity is avoided, while the most relevant indicators are extracted at the same time. Multicollinearity simply means that two or more indicators are highly correlated in a multiple regression, but as mentioned before, the dimensions extracted by the EFA are not correlated.\textsuperscript{512} As a result, they do not provide the same information and are therefore not redundant.\textsuperscript{513}

\textsuperscript{511} Please see Figure 13.
\textsuperscript{512} cf. Backhaus, K., et al. (2006), pg. 89.
\textsuperscript{513} cf. Ibid., pg. 91.


5.2 Factor Analysis

The first step of the empirical study is an Explorative Factor Analysis to extract the underlying dimensions of the defined indicators of organizational complexity.

In general, the factor analysis (FA) is a commonly used technique in research, since it leads to unique, reproducible results.\textsuperscript{514} As one of the most popular methods in multivariate analysis, exploratory factor analysis has found extensive applications in many areas in social and behavioral science.\textsuperscript{515}

The factor analysis selects those values for the communalities and coefficient patterns that will best reproduce the data sample variance.\textsuperscript{516} Factor analysis can therefore estimate the underlying dimensions or factors. The extracted factors are only slightly correlated, which is useful since this means that the components are measuring different dimensions of the data.\textsuperscript{517}

For the purpose of this study this means that the Explorative Factor Analysis extracts different drivers of market-driven complexity. To do this in a reliable manner and to guarantee accuracy, the procedure relies on various assumptions about these estimates.\textsuperscript{518} Thereby the quality of an Explorative Factor Analysis largely depends on the reliability of the data sample. Hence, the following section will first present the basic data and its characteristics.\textsuperscript{519} Furthermore, the selection of the studied companies and the selection of the measurable indicators will be presented.

5.2.1 Descriptive statistics

The starting point for an empirical study is the examination of the data.\textsuperscript{520} Therefore the following section provides a short discussion of missing data and the reliability of the data being used. The raw data for this study was collected with the Thomson Research database and annual reports. A pre-study with 100 organizations revealed that the figures from the Thomson research database were reliable in the sense that they match the figures from the primary source – the annual reports of the organizations.\textsuperscript{521} Only some differences appeared in a few instances and these cases were mainly based on missing currency conversion.

\textsuperscript{515} cf. Yuan, K.-H., et al. (2002), pg. 95.
\textsuperscript{516} cf. Bolch, B. W., Huang, C. J. (1974), pg. 239; Harris, R. J. (1975), pg. 207.
\textsuperscript{517} cf. Manly, B. F. J. (1994), pg. 76.
\textsuperscript{519} cf. Backhaus, K., et al. (2006), pg. 269.
\textsuperscript{520} cf. Ibid., pg. 269.
\textsuperscript{521} Steger, U., Schwandt, A. (2009), pg. 32.
5.2.1.1 Selection of companies

The selection of companies has to reflect both the needed size of an appropriate data sample and the required informational quality of the data.

In general, the sample size for an Explorative Factor Analysis is supposed to be 10 to 15 times bigger than the number of variables that are used. TABACHNICK/FIDELL put these prerequisites in concrete terms by stating that it is advantageous to have at least 300 cases for a factor analysis.\textsuperscript{522}

Starting with a sample size of 900 companies, more than half of the organizations were excluded due to missing data. The companies are all listed at stock markets all around the world. In the first step of data specification the number of companies was reduced to 369, because only those companies with (almost) complete data sets were used for further analysis. The companies with a significant amount of missing data were excluded. Due to the fact that only objective data was used, biases were not a problem for the evaluation.

To avoid the third conceptual mistake in measuring complexity – deriving the measure from a low level of complexity – the following empirical study is based on the data of 369 companies from various industries and various levels of complexity.\textsuperscript{523} The data sample contains a wide range of different organizations with characteristics like sales per year ranging from 94 million US$ up to 344 billion US$, from proportion of value creation from 8\% to 94\%, from expenditures for R&D to sales from zero to 23.6\% and from number of employees from 866 up to 1\,900\,000 people. This heterogeneity in the data allows studying differences between different groups later on.

The following graphs illustrate the descriptive statistics of the studied companies. As shown in Figure 20 the studied organizations are active in various industries. Four major industries have a significant prevalence in this sample: health services (80), industrial and commercial machinery and computer equipment (35), electronic and other electrical equipment and components (except computer equipment) (36) and major transportation equipment (37).

\textsuperscript{523} cf. Vesterby, V. (2008), pg. 92; As far as it can be assumed at this point the companies were selected in the way that they represent different levels of organizational complexity.
The number of business segments varies between one and ten. Most of the organizations studied have more than 3 and less than 8 business segments. Again, the data sample represents all facets of possible values. Appendix 1 provides an overview of the value range of all

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524 Own source.
525 Own source.
organizational indicators and highlights data sample’s wide range of organizational settings. While studying the distribution of organizational settings it was found that while some of the characteristics like costs of goods sold to sales, proportion of value-creation and number of business segments are approximately normally distributed, others, like the ratio of research and development expenditures to sales, are not.

The normal distribution of the data is not a stringent necessity for the further empirical study and will be discussed in detail when it is needed for specific assumptions, as for example in chapter 5.2.3.3.

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526 Own source.
527 Own source.
During the second step of the data specification, an additional 67 companies were excluded since they were identified as outliers. Outliers, organizations with unrealistic financial figures or organizational characteristics, were mainly defined as such because of manipulation, miscalculations or other effects. For example, some American airline companies were excluded since they have been covered by “chapter 11” after the terrorist attacks in 2001.\textsuperscript{529} Their financial figures were incomparable to the other organizations.

The remaining 302 companies are the basis for the present empirical study.

The missing-data problem was solved by the exclusion of all incomplete datasets, as mentioned above. The data sample of the 302 remaining companies has an insignificant quota of missing data, as shown in Table 6. The 2.27\% that constitute missing values can be replaced or deleted. The data is still reliable, as the amount of missing data is negligible, even if the missing values were deleted or replaced. It is possible to choose between various methods whereby mean substitution and regression imputation are the most commonly used ones.\textsuperscript{530} For this study, mean substitution was used.

\textsuperscript{528} Own source.

\textsuperscript{529} Chapter 11 was part of a law to protect US companies for bankruptcy.

\textsuperscript{530} cf. Tate, R. (1998); Fox, J. (2002), pg. 9.
Factor analysis

Initially, the data was standardized since this will make the calculation, interpretation and comparability of the data more comprehensive.\textsuperscript{531}

<table>
<thead>
<tr>
<th>N</th>
<th>Missing Total</th>
<th>Missing Data %</th>
</tr>
</thead>
<tbody>
<tr>
<td>17,806</td>
<td>405</td>
<td>2.27</td>
</tr>
</tbody>
</table>

Table 6: Quantitative descriptive statistic of missing data sets.\textsuperscript{532}

In general, the data is considered reliable in its informational quality and quantity.

Due to the empirical study’s step-by-step approach, a second data set is needed later on for the Structural Equation Model. The data were also extracted from the Thomson research database and contained 2.47% of missing data, which were replaced by mean substitution after the standardization. The total number of organizations studied in the second data set was 305.

### 5.2.1.2 Selection of measurable indicators

As mentioned in chapter 3 and 5.1.3, it is possible to distinguish between market-driven and organization-driven complexity. It was decided to only measure the indicators for market-driven complexity within this study. As the goal is to abridge the lack of large empirical studies in complexity science, it was necessary to focus on items that can be methodically collected in large scale.

As a result, despite some good opportunities for objective measurement of organization-driven complexity, indicators like formalization are not assessed. Due to the substantial number of organizations studied (302), it was not possible to measure indicators that are based on an internal perspective and thus require non-public information.

In detail, the following indicators were excluded because organization-driven complexity was not measured in the study.

- Number of subsidiaries (\textbf{DEL3}),
- Formalization of role of performance (\textbf{F2}),
- Formalization of information passing (\textbf{F3}),
- Intensity of delegation, measured by the importance of decisions made on lower levels (\textbf{DEL2}),
- Intensity of delegation, measured by the number of decisions made on lower levels of the organizational structure (\textbf{DEL1}),
- Number of given standardized processes (\textbf{STAND1}),

\textsuperscript{531} Backhaus, K., et al. (2006), pg. 271.
\textsuperscript{532} Own source. calculated by SPSS
Empirical model

- Personal interchangeability (SPECI2),
- Structural formalization (F1),
- Role variety (SPECI1),
- Strength of organizational culture (CULT1),
- Clarity and visibility of the organizational strategy (STRA1),
- Organizational structure (STRUC1),
- Proportion of new employees (FF9).

Nevertheless, organization-driven complexity is an important aspect of organizational complexity, which will be taken into account qualitatively when the concept is discussed in total and when managerial implications are presented. As a result of this restriction, proposition P1 has to be redefined.

**P1: Market-driven organizational complexity is a multi-dimensional construct**

Furthermore, not all hypothesized relationships (see pg. 64.) can be tested. This limitation will be discussed in detail in chapter 6.3.

**5.2.2 Assumptions for an Explorative Factor Analysis**

In the following section the assumptions for the Explorative Factor Analysis are discussed and the adequacy of the data sample is tested with four instruments: the correlation matrix, inverse correlation matrix, Bartlett’s test of sphericity and the Kaiser-Meyer-Olkin-Criteria. By discussing the assumption within these four steps, it is possible to affirm the adequacy of the data sample for an Explorative Factor Analysis.

**5.2.2.1 Correlation matrix**

The first step to evaluate the adequacy of the sample is to look at the structure and values of the indicator’s correlation matrix.

The correlation matrix (R-matrix) contains the Pearson coefficient between all pairs of indicators.\(^{533}\) This correlation already provides a first insight into whether the data sample is appropriate for an Explorative Factor Analysis.\(^{534}\) If significant correlations are given, it can be expected that underlying dimensions exist.

As shown in Appendix 2, there are strong correlations between various indicators. All

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\(^{533}\) cf. Field, A. (2005), pg. 649.
\(^{534}\) cf. Backhaus, K., et al. (2006), pg. 269.
variables were correlated with another variable and therefore none of the variables have to be eliminated.\textsuperscript{535} Furthermore, there is no variable where the majority of significant values are greater than .5 and there are no correlation coefficients greater than .9. Apparently multicollinearity is not a problem for this data sample.\textsuperscript{536} To sum up, it can be assumed that the correlation matrix affirms this samples’ appropriateness for an Explorative Factor Analysis. However, due to the fact that not all correlations in the correlation matrix are sufficiently strong and that some significance values are close to .5, it is advisable to check the reliability with additional criteria.

\textbf{5.2.2.2 Inverse correlation matrix}

The adequacy of the data sample can further be examined by the structure of the inverse correlation matrix, as presented in Appendix 3.\textsuperscript{537} Adequacy is given if the inverse correlation matrix is a diagonal matrix.\textsuperscript{538} Accordingly, the values of the non-diagonal elements should be close to zero. Even if no reliable criteria defining the frequency and the value of the acceptable divergence from these criteria exist, it is still possible to claim that the matrix confirms the adequacy of the data.\textsuperscript{539} Most of the values are close to zero – below .5 – and nearly all are smaller than 1.

\textbf{5.2.2.3 Bartlett’s test of sphericity}

Another test to confirm the requirements is Bartlett’s test of sphericity. The results of the Bartlett’s test are shown in Figure 25.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
Measure of sampling adequacy by Kaiser-Meyer-Olkin. & .681 \\
Bartlett’s test of sphericity & \\
Chi-square test & 6587.994 \\
df & 210 \\
Significance by Bartlett & .000 \\
\hline
\end{tabular}
\caption{KMO and Bartlett test.\textsuperscript{540}}
\end{table}

\textsuperscript{535} cf. Field, A. (2005), pg. 649.
\textsuperscript{536} cf. Ibid., pg. 649; Backhaus, K., et al. (2006), pg. 273.
\textsuperscript{537} cf. Backhaus, K., et al. (2006), pg. 274.
\textsuperscript{538} cf. Ibid., pg. 274.
\textsuperscript{539} cf. Ibid., pg. 274.
\textsuperscript{540} cf. Own source, calculated by SPSS.
Empirical model

Based on the hypothesis that “the original correlation matrix is an identity matrix”, the test calculates the significance to which the hypothesis is not true.\footnote{cf. Field, A. (2005), pg. 652, Backhaus, K., et al. (2006), pg. 275.}

As shown in Figure 25, the Bartlett test confirms with a significance of .000 that the original correlation matrix is not an identity matrix. Consequently, there are some relationships between the variables that can be studied.

One preliminary assumption of the Bartlett test is that the data is normally distributed. Hence, normal distribution has to be approved before considering the results of this test. As already discussed in section 5.2, some of the characteristics of the studied organizations are not normally distributed and it is therefore appropriate to expect that normal distribution is not given. Since outliers were excluded in a second step of data specification, the normal distribution will additionally be empirically tested by the Kolmogorov-Smirnov test and the Shapiro-Wilk test. Both tests calculate the degree to which the hypothesis "the data are not normally distributed" is true. The results are presented in Appendix 4 and 5 and indicate that the test is significant for nearly all indicators. This means that it is not possible to confirm a normal distribution.\footnote{cf. Backhaus, K., et al. (2006), pg. 275.} Deviation from normal distribution confirms that it is not possible to use this parametric test.\footnote{cf. Field, A. (2005), pg. 96.} Hence one should be careful in interpreting the results of the Bartlett test. It is not possible to conclude that this test underlines the adequacy of the data sample. Consequently, additional criteria have to be tested and taken into account.

Due to the fact that normality is not an assumption of the Exploratory Factor Analysis in general, this result does not violate the method in total.\footnote{cf. Ibid., pg. 641. Even if the assumption is worthwhile for the generalization of the results of the analysis beyond the sample collected, it is not imperative.} \textit{BROWN} and \textit{BARTHOLOMEW} confirm that factor analysis somewhat depends on the normality of common factors and no assumptions about the distribution are needed.\footnote{cf. Bartholomew, D. J. (1984), pg. 231 et seq.; Brown, M. W. (1987), pg. 376.}

\subsection*{5.2.2.4 Kaiser-Meyer-Olkin criteria}

The fourth test uses the Kaiser-Meyer-Olkin criteria to shows to which degree the data refer to each other. It is one of the best criteria for evaluating the adequacy for Exploratory Factor Analysis.\footnote{cf. Backhaus, K., et al. (2006), pg. 276.}

As shown in Figure 25, the value of the “Measure of sampling adequacy (MSA)” is .681. Comparing this result with the suggested interpretation given by \textit{KAISER/RICE}, it can be...
stated that the data is between “mediocre” and “pretty well” appropriate for an Explorative Factor Analysis.\footnote{cf. Kaiser, H. F., Rice, J. (1974), pg. 111 et seq.}

<table>
<thead>
<tr>
<th>MSA</th>
<th>Adequacy Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>( MSA \geq 0.9 )</td>
<td>Marvelous</td>
</tr>
<tr>
<td>( MSA \geq 0.8 )</td>
<td>Meritorious</td>
</tr>
<tr>
<td>( MSA \geq 0.7 )</td>
<td>Pretty well</td>
</tr>
<tr>
<td>( MSA \geq 0.6 )</td>
<td>Mediocre</td>
</tr>
<tr>
<td>( MSA \geq 0.5 )</td>
<td>Miserable</td>
</tr>
<tr>
<td>( MSA &lt; 0.5 )</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

\textit{Table 7: Adequacy categorization given by KAISER/RICE.}\footnote{cf. Ibid., pg. 111 et seq.}

The Kaiser-Meyer-Olkin criterion can be used for both, the evaluation of the whole data sample or for every single item.

The item values of the Kaiser-Meyer-Olkin criteria are presented in the anti-image-matrix (Appendix 6). In the second part of the table the values of each item can be analyzed on the diagonal of the matrix. All indicators have high values between .6 and .9. Only three indicators “Foreign Sales to Total Sales”, “International Assets to Total Assets” and “Dominant Business Segment” are below .5. It was decided not to exclude them from the sample since an improvement of the adequacy of the sample will lead to a reduction of the information value of the sample. Due to the fact that the study should be based on a wide range of theoretically induced indicators for complexity drivers, they were not rejected.

Summarizing the results of testing the assumptions for an exploratory factor analysis, the sample is expected to be adequate and appropriate.

\subsection*{5.2.3 Factor extraction}

Second, the factors were extracted with the help of SPSS. The factor extraction procedure determines the linear components within the data set by calculating the eigenvalues of the R-matrix in the first step.\footnote{cf. Field, A. (2005), pg. 652.}

The eigenvalues, which are associated with each factor, represent the variance explained by that particular linear component. The extraction largely depends on the important decision of
what kind of extraction technique is used.\textsuperscript{550} Generally, a factor analysis is used for finding common underlying dimensions within the data. The goal is therefore to identify common variance of the components.\textsuperscript{551} This objective, however, leads to a logical dilemma. For the execution of a factor analysis one needs to know how much common variance is presented in the data, but the only way to determine the extent of common variance is to accomplish the factor analysis.\textsuperscript{552}

In general, there are two major extraction techniques: the principal component analysis (PCA) and the principal axes analysis (PAA).\textsuperscript{553}

Even if there is no difference in the calculation between these two analysis techniques, their theoretical basis is fundamentally different. This is essential for the following interpretation of the extracted factors.\textsuperscript{554}

Both techniques calculate the linear combinations in that the first set describes as much of the total variance of the original data as possible, the next set describes as much of the remaining variance as possible and so on, until no more factors can be extracted.\textsuperscript{555}

The PCA technique seeks to describe a set of associated variables in terms of a set of mutually uncorrelated linear combinations of the same variable. Therefore the PCA does not make causal interpretations of the factors, whereas the principal axes analysis aims at explaining the variance of the components with hypothetic factors.

This difference between the techniques leads to different ways of estimating the communalities of the indicators.\textsuperscript{556} The principal component analysis assumes that all of the variance in the data is common variance and therefore defines the communalities of each variable to be one at the beginning. The principal axes analysis starts with an estimation of the amount of common variance by estimating the common variance for each variable.\textsuperscript{557}

These different starting points lead to different interpretations of the extracted factors.

\textsuperscript{551} cf. Field, A. (2005), pg. 631.
\textsuperscript{552} cf. Ibid., pg. 631.
\textsuperscript{553} cf. Backhaus, K., et al. (2006), pg. 293; Field, A. (2005), pg. 631 describes also other methods like alpha factoring and squared multiple correlation to estimate communalities but this study will concentrate on the both methods mentioned before.
\textsuperscript{554} cf. Backhaus, K., et al. (2006), pg. 293.
\textsuperscript{556} cf. Field, A. (2005), pg. 631.
\textsuperscript{557} cf. Ibid., pg. 631.
The question behind the principle component analysis is:

“With what collective term could we best summarize the components that heavily load on a factor?”

The main question for the interpretation of the results from the principle axes analysis is:

“What is the cause of the heavy loading of the components on a factor?”

For the purpose of this study, the principle component analysis was chosen. The main question is which kind of market-related organizational complexity drivers (collective term) summarize the factor in the best way, and on which factor do the components or indicators load heavily. Or in other words: Which market-related driver of organizational complexity is represented by the grouped indicators? Similar to the theoretical discussion in chapter 2.1.2, dimensions (drivers) of market-driven organizational complexity were extracted empirically.

Table 8 presents the results of the factor extraction. As illustrated, the first few factors explain relatively large amounts of variance. whereas subsequent factors explain only small amounts. SPSS extracts all factors with an eigenvalue greater than 1, which leads to six factors.

The factors represent 78% of the variance of the data sample, whereby the first indicator accounts for nearly 22% of the total variance. Looking at the final part of the table in column three the eigenvalues of the factors after rotation are displayed. Generally the rotation optimizes the factor structure. In this study, this leads to an equalization of the importance of the factors. The importance of the factors has to be carefully interpreted. It is not possible to conclude that factor one is the most important market-related driver of organizational complexity. It just displays the most variance, which could be caused by the number of the variables considered. If more variables load on this factor it can explain the higher value of the variance, as their loadings have the same origin.

Nevertheless, the extraction is very useful for defining the measurement model of the following Structural Equation Model.

Empirical model

<table>
<thead>
<tr>
<th>Components</th>
<th>Initial eigenvalue</th>
<th>Sum of squared factor loadings for the Extraction</th>
<th>Rotated sum of squared factor loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>% of Variance</td>
<td>Cumulated %</td>
<td>Total % of Variance</td>
</tr>
<tr>
<td>1</td>
<td>5.529</td>
<td>26.327</td>
<td>5.529</td>
</tr>
<tr>
<td>3</td>
<td>2.585</td>
<td>12.310</td>
<td>2.585</td>
</tr>
<tr>
<td>5</td>
<td>1.723</td>
<td>8.206</td>
<td>1.723</td>
</tr>
<tr>
<td>6</td>
<td>1.566</td>
<td>7.456</td>
<td>1.566</td>
</tr>
<tr>
<td>7</td>
<td>.985</td>
<td>4.689</td>
<td>.985</td>
</tr>
<tr>
<td>8</td>
<td>.813</td>
<td>3.870</td>
<td>.813</td>
</tr>
<tr>
<td>9</td>
<td>.532</td>
<td>2.533</td>
<td>.532</td>
</tr>
<tr>
<td>10</td>
<td>.425</td>
<td>2.026</td>
<td>.425</td>
</tr>
<tr>
<td>11</td>
<td>.386</td>
<td>1.837</td>
<td>.386</td>
</tr>
<tr>
<td>12</td>
<td>.328</td>
<td>1.560</td>
<td>.328</td>
</tr>
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<td>13</td>
<td>.296</td>
<td>1.410</td>
<td>.296</td>
</tr>
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<td>15</td>
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<td>16</td>
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<td>.088</td>
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<td>18</td>
<td>.039</td>
<td>.186</td>
<td>.039</td>
</tr>
<tr>
<td>19</td>
<td>.029</td>
<td>.140</td>
<td>.029</td>
</tr>
<tr>
<td>20</td>
<td>.028</td>
<td>.133</td>
<td>.028</td>
</tr>
<tr>
<td>21</td>
<td>.016</td>
<td>.077</td>
<td>.016</td>
</tr>
</tbody>
</table>

Extraction procedure: Principle component analysis

Table 8: Eigenvalues of the factors and total explained variance.\textsuperscript{560}

Additionally, Table 9 presents the communalities of each component before and after extraction. As mentioned before, the communality is the proportion of common variance within a variable.\textsuperscript{561} Since the principle component analysis was used, the first values were set to 1 before the factor analysis was performed. Nearly all variables have high values of communalities; only the variable “Restructuring Expenses” has a low value of common variance. This is not surprising since this item also accounts for low values in the inverse correlation matrix (Appendix 3). The indicator was not excluded due to its high value in the anti-image correlation of .815. As discussed above, this sample adequacy value from Kaiser-Meyer-Olkin means that this variable is “meritorious” for an Explorative Factor Analysis.

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\textsuperscript{560} Own source.
\textsuperscript{561} cf. Field, A. (2005), pg. 653.
During the last step of factor extraction, one needs to decide how many factors will be used for further discussion. Generally, there is no common rule on how many factors should be extracted. However, there are some statistical criteria that can be used to affirm a subjective decision. The Kaiser criteria suggest that the number of extracted factors should be proportional to the number of factors with eigenvalue larger than 1. As a result, only the factors that explain more variance than a single variable are extracted. Another method is a graphic interpretation of the eigenvalues. The following graph therefore

### Table 9: Communalities before and after extraction

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial</th>
<th>Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.TotalAssetsy06</td>
<td>1.000</td>
<td>.884</td>
</tr>
<tr>
<td>tf.Salesy06</td>
<td>1.000</td>
<td>.932</td>
</tr>
<tr>
<td>tf.Employeesy06</td>
<td>1.000</td>
<td>.741</td>
</tr>
<tr>
<td>ForeignSales_to_TotalSales</td>
<td>1.000</td>
<td>.767</td>
</tr>
<tr>
<td>InternationalAssets_to_TotalAssets</td>
<td>1.000</td>
<td>.826</td>
</tr>
<tr>
<td>tf.CostOfGoodsSoldToSalesy06</td>
<td>1.000</td>
<td>.756</td>
</tr>
<tr>
<td>tf.CostOfGoodsSoldToSales5YrAvgy06</td>
<td>1.000</td>
<td>.775</td>
</tr>
<tr>
<td>Number.BusinessSegments</td>
<td>1.000</td>
<td>.799</td>
</tr>
<tr>
<td>ws.BusinessSegment1Salesy06</td>
<td>1.000</td>
<td>.871</td>
</tr>
<tr>
<td>DominantBS</td>
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<td>.844</td>
</tr>
<tr>
<td>tf.ResearchAndDevelopmentToSalesy06</td>
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</tr>
<tr>
<td>tf.AssetsPerEmployeey06</td>
<td>1.000</td>
<td>.950</td>
</tr>
<tr>
<td>tf.AssetsPerEmployee5YrAvgy06</td>
<td>1.000</td>
<td>.948</td>
</tr>
<tr>
<td>ws.InternationalAssetsy06</td>
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<td>.763</td>
</tr>
<tr>
<td>wsRestructuringExpensey06</td>
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<td>.271</td>
</tr>
<tr>
<td>tf.ForeignSalesy06</td>
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<td>.839</td>
</tr>
<tr>
<td>MAVolumen2006Total</td>
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<td>.866</td>
</tr>
<tr>
<td>MAVolumen2006Sold</td>
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<td>.706</td>
</tr>
<tr>
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<td>.593</td>
</tr>
<tr>
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<td>.847</td>
</tr>
<tr>
<td>tf.ResearchDevelopmentToSales5YrAvgy06</td>
<td>1.000</td>
<td>.791</td>
</tr>
</tbody>
</table>

Extraction Procedure: Principle component analysis

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562 Own source.
564 cf. Ibid., pg. 295.
565 cf. Ibid., pg. 295.
Empirical model

presents the screeplot. The first point left of the elbow defines the number of factors.\textsuperscript{566}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{screeplot.png}
\caption{Screeplot.\textsuperscript{567}}
\end{figure}

As shown in Figure 26, the elbow is located at the seventh factor. The screeplot therefore confirms the extraction of the six factors.

\textsuperscript{566} cf. Ibid., pg. 296.
\textsuperscript{567} Own source.
5.2.4 Factor interpretation

Table 10 presents the rotated factor matrix. The non-rotated factor matrix is presented in Appendix 7. The Explorative Factor Analysis of variables for market-related drivers of organizational complexity extracted six different factors, which will be presented and discussed in the following section.

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<td></td>
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</tr>
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<td>M&amp;AVolumeToSalesy06</td>
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<td></td>
</tr>
<tr>
<td>M&amp;AVolumen2006Total</td>
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<td>.900</td>
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<td>M&amp;AVolumen2006Sales</td>
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<td>.826</td>
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</tr>
<tr>
<td>tf.AssetsPerEmployeey06</td>
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<td></td>
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</tr>
<tr>
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<td></td>
<td>.967</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>InternationalAssets_to_TotalAssets</td>
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<td></td>
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<td>ForeignSales_to_TotalSales</td>
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<td>DominantBS</td>
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<td>Number.BusinessSegments</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>.866</td>
</tr>
</tbody>
</table>


Table 10: Rotated factor matrix.568

Table 10 provides insight into the variable loadings on each factor and facilitates interpreting the results. It shows that variables with similar contents are grouped. Especially the variables “cost of goods sold to sales” and “assets per employee” seems to be similar. One can argue that they are clustered since they measure the same concept and do not have one underlying

568 Own source.
cause for high loadings. Testing this by excluding one of the redundant variables has proved that the same factors were extracted. Hence the redundancy does not encumber the calculation; rather, it avoids that short-term variation of values become too influential.\textsuperscript{569} Two indicators are correlated with two components. Both “international assets” and “number of M&A” are assigned to the first components, since, as explained in the following section, their contents fit better into the first indicator and secondly the correlation is slightly higher. The indicator "restructuring expenses" did not correlate with any dimension and is excluded from further discussion and examination. Based on the low value of communality, as presented in Table 9, this decision is reasonable.

**The first factor** includes the variables: sales, total assets, business segment sales, foreign sales, employees, international assets and number of M&A. Searching for a comprehensive term of the market-related driver of organizational complexity these indicators represent, it is possible to conclude that the underlying commonality is the reflection of the organizations’ size its interdependencies.\textsuperscript{570} Size and interdependency are closely related. A high number of employees and a high value of sales and total assets always reflect both, size of a company and the various relationships between its elements. According to the general system theory discussion in chapter 2.2.1.1, a growing number of elements result in a growing number of relationships. The other indicators also reflect size in different aspects and are highly correlated. The first factor is easy to interpret and accounts for a large proportion of common variance. As mentioned before, however, this should by no means lead to the conclusion that the size or the interdependency is the most important market-related driver of organizational complexity. The high number of indicators loading on it causes the high value of common variance. The direct influence of this factor on market-driven organizational complexity will become more obvious in the Structural Equation Model – the second part of the empirical study.

**The second factor** includes the variables: “research and development” and “costs of goods sold”. To interpret this factor it is possible to refer to the findings of complexity researchers about the system depth and breadth.\textsuperscript{571} While the breadth describes the complexity of a system at a given point in time, the depth describes the change of the system within a period of time.\textsuperscript{572} Correspondingly, the indicator “costs of goods sold” can be used to measure the breadth of


\textsuperscript{570} cf. Ibid., pg. 302.


\textsuperscript{572} cf. Ibid., pg. 23.
the organization, and the expenditures for research and development represent the change over the course of time – the depth. Besides this general interpretation, the underlying drivers that these factors represent can be assumed to be ambiguity and fast flux. Both variables directly influence the level of market-driven organizational complexity in several ways. The following discussion will emphasize that organizations cannot be studied independent of their environment, as discussed in chapter 2.2.2.5 where organizations were defined as complex adaptive systems. It is necessary to consider the relationships between external and internal complexity dimensions.573 Treating organizations as complex adaptive systems helps to clarify that organizational ambiguity is mainly caused by the information exchange with the environment. The proportion of value creation within an organization leads to an increase of organizational ambiguity in total. Even if the information quality rises, the total organizational ambiguity increases, since a larger amount of information needs to be processed, as discussed in section 5.1.2.2.

The sign of the indicator “cost of goods sold to sales” in Table 10 is negative because the variables were not inverted prior to running the factor analysis. A growing value of costs of goods sold to sales means that the organization’s proportion of value creation declines. Consequently, the market-driven organizational complexity is reduced as discussed in chapter 5.1.2, which results in a negative correlation.

Additionally, higher expenditures of R&D cause more frequent changes in products and processes and lead to instability. As noted, the R&D expenditures and costs of goods sold to sales are directly correlated with the ambiguity and fast flux inside the organization. If environmental ambiguity grows, organizations will invest in R&D to discover or follow new trends and technologies. They will integrate more parts of the production into their value chain to gain control over input factors or distribution channels. By doing so, they become more adapted and increase internal complexity to match the growing external complexity.

The third factor includes variables related to M&A activities: M&A volume to Sales, M&A volume total and M&A volume sales. It is important to look at the details to interpret the factor. Normally one would expect that the total volume is also related to the first factor size and that large organizations have a higher volume of M&A. The factor analysis, however, leads to the conclusion that these indicators together represent a different factor. Additionally, it is very interesting to see that it does not matter if parts of companies are bought or sold. The cause for this cannot be the growing diversity or interdependence since in this case there is a significant difference between buying a part of a company and selling a part of it.

It can be assumed that these indicators mainly represent organizational change (fast flux) and to some extent ambiguity. M&A are often used as strategic instruments for fast and full-scale market entrances or to improve or to secure the market position. M&A always cause a lot of internal change by incorporating different processes, cultures, management systems and products into the organization. If M&A are not well managed, they cause a fair amount of ambiguity inside the organization.

The fourth factor consists of variables related to assets per employees. As discussed before, assets per employee is a good measure for technological complexity inside an organization. Compared to the other indicators, it mainly represents technological interdependence on two levels: the first is the level of machines and second the level of interdependencies between machines and employees.574

The fifth factor’s variable loadings symbolize the factor diversity, particularly geographic diversity. The indicators reflect the degree of internationalization or globalization of the organization. The proportion of foreign sales to total sales and international assets to total assets stands for the geographic diversification of both products and production.

The sixth factor consists of the indicator dominant business segment and number of business segment. Thus it reflects the focus of the organization, or in other words, the product diversification.

<table>
<thead>
<tr>
<th>Factor description</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Size</td>
<td>Interdependence</td>
</tr>
<tr>
<td>2 Depth and breadth</td>
<td>Ambiguity, Fast Flux</td>
</tr>
<tr>
<td>3 Organizational change</td>
<td>Fast Flux, Ambiguity</td>
</tr>
<tr>
<td>4 Technological intensity</td>
<td>Interdependence</td>
</tr>
<tr>
<td>5 Globalization</td>
<td>Geographic diversity</td>
</tr>
<tr>
<td>6 Product diversification</td>
<td>Product diversity</td>
</tr>
</tbody>
</table>

Table 11: Summary of extracted factors and interpretations.

Summarizing the six major market-related drivers of organizational complexity that are extracted out of the range of different variables that measure various aspects of market-driven organizational complexity (Table 11), it can be stated that they confirm the theoretical reflections of chapter 2.1.2 in that complexity is driven by diversity, ambiguity,

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interdependency and fast flux. Even if the dimensions are found not to be as selective as required to capture all different facets of market-driven organizational complexity, proposition one: "Market-driven organizational complexity is a multi-dimensional construct" can be confirmed. To specify, it must be stated that market-driven complexity is found to be a multi-dimensional construct. Since market-driven complexity is only a part of organizational complexity, however, the general proposition is also found to be true.

Due to this finding, it is possible to specify the first proposition with more detailed propositions. 575

**Proposition 1a:**
Market-driven organizational complexity is positively related to (driven by) size of the organization.

**Proposition 1b:**
Market-driven organizational complexity is positively related to (driven by) product diversity inside the organization.

**Proposition 1c:**
Market-driven organizational complexity is positively related to (driven by) globalization of the organization.

**Proposition 1d:**
Market-driven organizational complexity is positively related to (driven by) depth and breadth of the organization.

**Proposition 1e:**
Market-driven organizational complexity is positively related to (driven by) organizational change.

**Proposition 1f:**
Market-driven organizational complexity is positively related to (driven by) technological intensity inside the organization.

Based on the discussion in chapter 3 it can be expected that the market-related drivers of organizational complexity vary in relation to the level of market-driven organizational complexity. Hence, the following hypotheses can be specified as well.

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575 Due to the fact that the relationships between the drivers and value-creating complexity are part of the measurement model, these ideas or theses cannot be named hypotheses.
Proposition 2a:
The positive relationship between size and market-driven complexity vary between different levels of market-driven organizational complexity.

Proposition 2b:
The positive relationship between product diversity and market-driven complexity vary between different levels of market-driven organizational complexity.

Proposition 2c:
The positive relationship between globalization and market-driven complexity vary between different levels of market-driven organizational complexity.

Proposition 2d:
The positive relationship between depth and breadth and market-driven complexity vary between different levels of market-driven organizational complexity.

Proposition 2e:
The positive relationship between organizational change and organizational complexity vary between different levels of market-driven organizational complexity.

Proposition 2f:
The positive relationship between technological intensity and organizational complexity vary between different levels of market-driven organizational complexity.
5.3 Measuring organizational performance

In general, performance improvement is the top priority of strategic management.\textsuperscript{576} Hence the influence of organizational complexity on organizational performance is studied in this thesis.

As mentioned at the beginning of Part II, the Structural Equation Model consists of two measurement models. Therefore the measures of market-driven organizational complexity are linked to the construct of organizational success to analyze the relationship between these constructs. By doing so it is necessary to distinguish between the different aspects of organizational success. The term “success” or “performance” is often used interchangeably with financial success, even if performance is a more differentiated construct than financial success, since it incorporates non-financial indicators like customer satisfaction, employee satisfaction and level of goal realization.\textsuperscript{577} The following section discusses the multi-dimensional nature of organizational performance and presents the development of a framework for measuring these different dimensions. According to this the second measurement model required for the following empirical study and the Structural Equation Model is established.

5.3.1 Organizational performance as a multi-dimensional construct

As often discussed in the relevant literature, organizational performance is a multi-dimensional construct.\textsuperscript{578} Four approaches to differentiate between the dimensions of organizational performance are discussed.

5.3.1.1 Strategy perspective

The first approach to highlighting the differences between dimensions of organizational performance is the strategic perspective. Due to contrasting sets of resources and capabilities, organizations follow different strategies at different times.\textsuperscript{579} Performing a consistent measure of performance can be difficult as organizations have different goals. For example, organizations aiming at increasing their market share are hard to compare to organizations with the strategic goal of higher internal efficiency. Additionally, organizations do not pursue

\textsuperscript{578} cf. Venkatraman, N., Ramanujam, V. (1986), pg. 801.
\textsuperscript{579} cf. Devinney, T. M., et al. (2005), pg. 3; Rubenstein, R., Schwartz, A. E. (2003), pg. 608; The impact of this heterogeneity on how firms compete is the central concern of the resource based view of organizations, but should not be discussed in detail here. For introduction see Barney, J. (1991) und Knyphausen – Aufseß, D. z. (1993) pg. 775.
one strategic goal; they aim at multiple goals simultaneously.\textsuperscript{580} Mainly the different goals are interconnected and constitute a company-specific goal system, as discussed in section 5.1.2.1.\textsuperscript{581} Especially when treating organizations as complex adaptive systems in a complex environment, the co-evolution in several organizational parts, as discussed in chapter 2.2.2.5, leads to a growing number of simultaneous goals and highly interdependent goal systems.\textsuperscript{582}

The strategic perspective of measuring organizational performance underlines the need to measure different aspects of the multi-dimensional constructs.\textsuperscript{583} Within the strategic perspective, possible categorizations are effectiveness and efficiency. While effectiveness assesses the dimension of goal achievement, efficiency assesses the resource consumption necessary to reach a goal.

In general, the measurement of organizational performance needs to incorporate non-financial indicators, like customer satisfaction, employee satisfaction and the level of goal realization.\textsuperscript{584}

The narrowest concept of business performance is the use of simple outcome-based financial indicators, which are assumed to reflect the fulfillment of economic goals of the organization.\textsuperscript{585} \textit{VENKATRAMAN/RAMANUJAM} state that measures like degree of goal achievement, product quality, new product introduction or market share cover a broader understanding and different dimensions of organizational performance but are difficult to assess for a expanded range of organizations.\textsuperscript{586} Besides financial success, they measure the organizational effectiveness.\textsuperscript{587}

The strategic perspective underlines the need to measure performance while considering multiple goals.

\subsection*{5.3.1.2 Systems perspective}

From a systems point of view it is possible to differentiate between the internal and the external perspective of performance.\textsuperscript{588} While the internal perspective can include employee satisfaction, plant efficiency, employee productivity or costs of goods sold, typical external

\begin{itemize}
\item \textsuperscript{581} cf. Heinen, E. (1976), pg. 24.
\item \textsuperscript{582} cf. chapter 2.1.4.5.
\item \textsuperscript{583} cf. Coenenberg, A. G. (1997), pg. 10; Devinney, T. M., et al. (2005), pg. 6; Venkatraman, N., Ramanujam, V. (1986), pg. 801.
\item \textsuperscript{584} cf. Carton, R. B., Hofer, C. W. (2006), pg. 42.
\item \textsuperscript{585} cf. Venkatraman, N., Ramanujam, V. (1986), pg. 803.
\item \textsuperscript{586} cf. Ibid., pg. 804.
\item \textsuperscript{587} cf. Ibid., pg. 804; Cameron, K., Whetten, D. (1983), pg. 5 et seq.
\item \textsuperscript{588} cf. Devinney, T. M., et al. (2005), pg. 11.
\end{itemize}
Measuring organizational performance

Measures are return to shareholders, reputation measures or customer satisfaction. Both perspectives are essential for the overall performance of an organization, as discussed by many researchers. The systems perspective is consistent with the stakeholder perspective and distinguishes between internal and external stakeholders.

5.3.1.3 Stakeholder perspective

Based on the stakeholder approach that was introduced by Freeman, the organizational performance can be assessed with regard to different stakeholder groups with different expectations and levels of power. Due to the fact that stakeholders are “any group or individual who can affect or is affected by the achievement of the firm’s objects”, performance can be assessed in many different dimensions.

In general, it is possible to differentiate between the internal and the external perspective of performance. On the one hand organizations, which rely heavily on bank financing or other main shareholders, are assessed by their performance according to the demands of these external stakeholders, such as total shareholder return or earnings per share.

On the other hand, organizations that depend on scarce and highly skilled labor, such as consulting firms or law firms, assess their success also in other internal dimensions like labor satisfaction or labor turnover. By adding additional stakeholder groups, such as NGOs, consumer groups and society at large, the number of dimensions of performance increases further. In this case, organizational performance should include items like environmental concerns, sustainability and social responsibility.

The incorporation of different stakeholder groups corresponds to the concept of organizational effectiveness, due to the fact that a broader range of goals and needs are considered. Both the internal and external perspective is essential for the assessment of the overall performance of an organization, as discussed by many researchers.

593 cf. Devinney, T. M., et al. (2005), pg. 11.
594 Total shareholder return (TSR) captures the gain (loss) made by shareholders during the period (generally each year). TSR is the sum of the change in stock price during the year plus and dividends paid out, expressed as a percentage of the opening value of the stock. See Ibid., pg. 41.
595 cf. Ibid., pg. 3; Steger, U. (2006), pg. 4.
5.3.1.4 Timeframe

Another dimension of organizational performance is the time period within which the performance shall be measured. In general, organizational performance can be approached from either a historical or a prospective point of view.598 While most accounting measures only represent historical performance, market-based measures incorporate future developments and risks. Both measures are presented in detail in the next section. At this point it is important to note that both perspectives need to be incorporated in the assessment of organizational performance to establish a reliable framework.

Furthermore, as several measures are time-dependent, the concept of time is very important with regard to different measurement approaches.599 On the one hand, subjective measures are biased regarding recent events, and on the other hand, objective measures, such as accounting rates or return, have temporal properties that imply that the internal antecedents of performance in any year may not relate directly to performance in the same year even if they appear to be highly correlated.600 To adequately measure organizational performance it is necessary to use indicators that reflect both a longer period and/or indicators that are not as time-dependent as others. Since both subjective and objective measures of organizational performance are time-dependent, it is important to incorporate this in the discussion about the empirical findings.

By summarizing the approaches of all four perspectives it becomes obvious that organizational performance has to be treated as a multi-dimensional construct.601 As HOFER states, different fields of study will and should use different measures of organizational performance due to discrepancies in their research questions.602 The following empirical study assesses organizational effectiveness and efficiency from internal and external points of view. The measurement model will not incorporate diverse stakeholder perspectives. It will rather concentrate on shareholders, since this is one of the most important dimensions of organizational performance in a globalized world with nearly no boundaries for the most liquid factor: capital. Additionally, as mentioned before, the incorporation of stakeholder perspectives like employee satisfactory is hard to apply on a

large sample of organizations. Due to the focus of the empirical study, data that is publicly available and illustrates comparable content is utilized. The organizational performance is assessed in the short and the long-term perspective to avoid a disproportionate influence of any single event. Furthermore, both, the assessment of the historical performance and future expectations are incorporated. The following section explains which specific measures will be used and what their advantages and disadvantages are.

5.3.2 Methods to Measure Organizational Performance

The multi-dimensionality of organizational performance includes a broad range of potential measures within its ambit.  

In the following section, five methods to measure organizational performance and their advantages and disadvantages within the purpose of this study will be discussed. In particular, subjective and objective measures based on accounting- or market- or mixed market/accounting-based data will be presented. It is argued that only objective measures are appropriate for this empirical study, and that both accounting- and market-based measures have to be employed.

5.3.2.1 Subjective measures of performance

As indicated above in section 5.3.1.3, subjective measures are widely discussed in current literature, not least due to the validity problems they pose. Particularly cognitive biases can influence subjective measures substantially, e.g. participants tend to view themselves in too positive a light and will construe external criteria to match their own strength.

In 1980 CHAKRAVARTHY already discusses the use of subjective measures for measuring strategic performance. In the following years, several studies with a broad range of conceptualization use subjective measures. They range from single items to assess overall performance by DESS/ROBINSON to four or more combined items to assess different aspects of organizational performance by DELANEY/HUSELID, use subjective measures.

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GUIMAREAS, et al. use subjective measures to study the relationship between manufacturing system complexity and performance.\textsuperscript{608}

One advantage of subjective measures is that they are not constrained by structured accounting or financial market rules and that they can be collected on any organizational level.\textsuperscript{609}

Amongst others, WALL, et al. study the relationship between subjective and objective measures in detail. They found a correlation between subjective and objective measures to be between 0.4 and 0.6.\textsuperscript{610}

Additionally, GUTHRIE, DESS/ROBINSON and BOMMER, et al. have found the correlations between subjective and objective measures regarding different dimensions of performance to be between 0.39 and 0.81.\textsuperscript{611}

The empirical findings suggest that subjective measures can be used with confidence if they are appropriate for the research design. Especially if the study mainly focuses on a part of the organization rather than the organization as a whole, subjective measures are efficient.\textsuperscript{612}

For the present study subjective measures for organizational performance were excluded, because the focus lies on the organization as a whole, and is interested in an objective assessment of performance, not in perceived performance. Consequently, misleading underlying effects are avoided.\textsuperscript{613}

5.3.2.2 Objective measures

Objective measures are commonly used to assess organizational performance.\textsuperscript{614} In general, it is possible to differentiate between two groups of objective measures: accounting measures and financial market measures.\textsuperscript{615} Despite the fact that there are several disadvantages, these measures prove to be the most appropriate for the study at hand. The following section will therefore provide a discussion about accounting-based, financial market-based and mixed objective measures for organizational performance.

\textsuperscript{608} cf. Guimareas, T., et al. (1999), pg. 1254.
\textsuperscript{609} cf. Devinney, T. M., et al. (2005), pg. 30; Wall, T., et al. (2004), pg. 96.
\textsuperscript{611} cf. Devinney, T. M., et al. (2005), pg. 15; Wall, T., et al. (2004), pg. 96.
\textsuperscript{613} As discussed chapter 5.1.1 Guimareas, T., et al. (1999), pg. used subjective measures to measure both complexity and success. It could be argued that the perception of complexity is determined by the education and intelligence of the respondent and that an underlying relationship will be given to the perception of success, too.
\textsuperscript{615} cf. Devinney, T. M., et al. (2005), pg. 15.
5.3.2.2.1 Accounting-based measures

The conceptualization of performance still appears to be dominated by the accounting approach, with 74% of all empirical studies using this measures to assess performance.\textsuperscript{616} The reasons for this are, firstly, the validity of accounting measures of performance that is given by the fact that they are widely used by firms to monitor and control their own activities.\textsuperscript{617} Secondly, the data is available due to government issued claims, as well as shareholders’ information requirements, which calls for the continual publication of a firms’ financial data.\textsuperscript{618}

The validity is also supported by empirical evidence showing that accounting and economic returns are related, albeit not perfectly, with correlation coefficients between 0.75 and 0.9.\textsuperscript{619} Nevertheless, basic accounting measures have two major limitations. The first major limitation is that they can be manipulated.\textsuperscript{620}

Accounting measures’ main causes of distortion are: accounting procedures and policies, government policies towards specific activities, human error and purposeful deception.\textsuperscript{621} Different items can be booked in various ways, which for example, allows to smooth the income or to allocate funds that distort returns.\textsuperscript{622} It is nearly impossible to compare measures, which are based on different accounting rules. As a result, the empirical study presented here needs to employ commonly used objective measures, like total sales or return on investment, when examining the nearly 300 companies sampled. Almost all companies that were analyzed in this thesis are listed at international stock markets such as London, New York, Frankfurt, Paris, and Tokyo. Accordingly, these companies are mainly located in the OECD and generally follow identical international accounting rules. Consequently, there is only limited distortion expected.

The second limitation is that accounting measures only reflect the current state of affairs and are quite limited in revealing anything about performance even only one period in advance.\textsuperscript{623} Furthermore, one can argue that even current accounting measures do not reflect current operational activities, as discussed before.\textsuperscript{624}

\textsuperscript{617} cf. Devinney, T. M., et al. (2005), pg. 16.
\textsuperscript{618} cf. Ibid., pg. 16.
\textsuperscript{620} cf. Devinney, T. M., et al. (2005), pg. 16, 18; Chakravarty, B. (1986), pg. 444.
\textsuperscript{622} cf. Devinney, T. M., et al. (2005), pg. 19.
\textsuperscript{623} cf. Ibid., pg. 16, 18; Chakravarty, B. (1986), pg. 444.
\textsuperscript{624} cf. Devinney, T. M., et al. (2005), pg. 18.
Empirical model

Well-established indicators to measure financial performance are sales growth, profitability (reflected by indicators as return on investment, return on sales or return on equity) and earnings per share. Table 44 in Appendix 9 presents an overview of possible measures as well as the corresponding explanation and calculation.

Corresponding to the argumentation of section 5.3.1.1, both strategic perspectives of organizational performances – effectiveness and efficiency – are assessed. For measuring the organizational effectiveness, the accounting-based indicators net income, earnings before interest and taxes are used, since they are commonly established and reliable.

Furthermore, organizational efficiency will be measured by the indicators, return on invested capital, weighted cost of equity and return on assets. As mentioned above these measures are also broadly used in several studies of international companies and can be seen as established measures. To limit the influence of single events, return on invested capital is measured as a five-year average.

Additionally, the companies’ performance is assessed by examining their cash-flow. With the five-year average cash flow, the financial health of the observed company is assessed. In order to eliminate effects of size and to establish a more comparable measure, the cash-flow is divided by the Sales volume.

![Figure 27: Accounting-based measures of organizational performance.](image-url)

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625 cf. Ibid., pg. 16; Chakravarthy, B. (1986), pg. 440.
629 Own source.
5.3.2.2.2 **Financial market measures**

The empirical success of market measures confirms that human opinions informing market values are able to overcome many of the distortions that accounting measures face.\(^{630}\) Contrary to the accounting based-measures, financial market measures are forward-looking.\(^{631}\) Thus they represent a very important aspect of the multi-dimensional construct of organizational performance. Moreover, financial market measures are appropriate for measuring organizational performance since they allow for more effective accounting of intangible assets than accounting data.\(^{632}\) The second major advantage, in contrast to accounting-based measures, is that they are not easily manipulated and that they are not susceptible to the influence of accounting policy changes or mere timing effects.\(^{633}\) One major limitation related to financial market measures is that they are only available on a company level.\(^{634}\) Hence, they are not suitable for a large number of managerial and strategic research endeavors. This is not the case for present study. Due to the fact that this study focuses on overall company performance, financial market measures are applicable.

However, it is important to remember that due to the broad range of the stock market, financial market measures often reflect environmental influences that may not be relevant for certain organizational performance, e.g. empirical research in finance has shown that share price movements are largely attributable to market volatility, momentum and herding behavior.\(^{635}\)

Financial market measures are appropriate to assess the shareholder-related dimension of organizational performance. Hence, the indicator “earnings per share” is used, as it is a suitable measure to assess the firm value in relation to the number of stocks issued.\(^{636}\) The indicator is calculated as a five-year average to again eliminate short-term effects. Additionally, the indicator market value is applied to assess organizational effectiveness also from the market perspective.

\(^{632}\) cf. Devinney, T. M., et al. (2005), pg. 23.
\(^{633}\) cf. Ibid., pg. 20; Chakravarthy, B. (1986), pg. 443.
5.3.2.2.3 Mixed market and accounting measures

The limitation of both accounting measures and financial market-based measures has led to the development of mixed market and accounting measures. As a result, these measures can be used for future estimations of performance. They are less historical, can be adjusted for risk, are available and applicable to business units and functional levels and are more readily available.

Very popular hybrid measures are Tobin’s q and economic value added (EVA). Tobin’s q is the ratio of the market value of firm assets to their replacement cost and is nearly equivalent to market to the book value of the firm’s assets, as VARAIYA, et al. show in their research.

General measures for organizational effectiveness, like economic value added, are appropriate since they measure performance more generally and are available for a large number of companies. Economic value added is calculated as Net Operating Profit after Taxes minus (Weighted average cost of capital multiplied with the invested capital). It is rooted in the economic viewpoint that a firm must earn more than its cost of debt and equity capital to create wealth. During the last two decades after its introduction in 1991, EVA has become increasingly popular as a tool to measure corporate financial performance.

Due to the nature of complexity and the disagreement about the most appropriate response to

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637 Own source.
639 cf. Ibid., pg. 20.
environmental complexity, it is of interest to study if growing complexity is in general related to organizational performance. The indicator Market Value Added (MVA) is incorporated to assess organizational effectiveness more accurately.

![Figure 29: Financial performance measures for assessing the effectiveness dimension of performance.](image)

5.3.3 Summary of measuring organizational performance

Summarizing the different methods of measuring organizational performance, it can be stated that instead of using a single measure, a multi-factor model of performance assessment should be employed.\(^{646}\)

A truly excellent firm must balance the competing claims of its shareholders and stakeholders in order to ensure continuing cooperation – subsequently different dimensions of organizational performance do exist.\(^{647}\)

The measuring of organizational success focuses on four dimensions of organizational performance: effectiveness, efficiency, financial health, and shareholder value. Overall organizational effectiveness with the incorporation of many different stakeholder groups was not assessed due to the difficulty of measuring labor satisfaction or labor turnover for such a great number of companies. Moreover, specific aspects of organizational effectiveness are only appropriate to compare different companies if they aim at the same goal, as discussed in section 5.3.1.1.\(^{648}\)

As a result, this study focuses on the assessment of the organization’s financial success with the help of financial indicators that are officially published by the companies and recommended by approved literature, as discussed before. In this framework, the advantages of both the accounting and financial market indicators approaches were combined to create a reliable success measurement framework. The figures were evaluated for a short (one year), as well as for a long (five year) period to reduce the effect of single events or manipulation.

Figure 30 shows the complete measurement framework with four dimensions and 9 indicators.

\(^{645}\) Own source.


\(^{647}\) cf. Altman, E. I. (1968), pg. 447.

Figure 30: Measurement framework for measuring organizational performance.\textsuperscript{649}

\textsuperscript{649} Own source.
5.4 Structural Equation Model

The following chapter presents the test of the relationship between market-driven complexity and organizational performance. Hence, a Structural Equation Model needs to be defined. To do so, the extracted factors of market-driven complexity are used as formative measures in the Structural Equation Model. Based on the discussion about organizational performance, the defined dimensions are used as reflective measures of the overall organizational performance construct.

In general, a Structural Equation Model is a method that can be utilized if variables of a model are measured reflectively and formatively. At the beginning of the following chapter the theoretical basis and the constraints for using this method and the selection of an appropriate parameter estimation procedure are presented.

5.4.1 Selection of the estimation procedure

To figure out what kind of estimation procedure is appropriate for the specification of a variable, a set of criteria developed by Jarvis, et al. can be used.

In general, the common covariance-based methods that are calculated with programs like LISREL (Linear Structural RELationships) and AMOS (Analysis of MOment Structures) are appropriate to handle reflective measurement models but need particular assumptions to incorporate formative indicators. The relatively new and less commonly used PLS-Procedure is able to handle both reflective and formative measurement models and has less requirements with regard to its application.

The main aspects that determine the selection of an appropriate estimation procedure are the (i) size of the data sample, (ii) the assumption for data distribution, (iii) the parametric assumptions, (iv) the model complexity, (v) the identification of factors and the factor indeterminacy. In the following section all five determinants will be discussed.

(i) The first parameter that can be discussed is the sample size. The covariance structural analysis requires, even for small models, a large number of observations, in the range of \( n > 150 \) or \( n > 5q \) (whereby \( q \) is the number of estimated factors) while PLS needs a minor

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Empirical model

number of cases.\textsuperscript{655} The use of a covariance structural analysis with small data samples can lead to deficient parameter estimations and flawed model test statistics, as shown by CHOU/BENTLER.\textsuperscript{656}

For using PLS, the number of cases should be ten times bigger than the number of indictors used for the most complex formative measured variable, or ten times bigger than the number of endogenous variables which load on exogenous variables.\textsuperscript{657}

(ii) In order to use the covariance-based structural equation modeling it is assumed that the observed variables follow a specific multivariate distribution and that the observations are independent from one another.\textsuperscript{658} Should the typically used maximum-likelihood function be applied, the data has to be normally distributed.\textsuperscript{659}

As shown in the exploratory factor analysis, the data of this study is not normally distributed. Both the Kolmogorov-Smirnov-test and the Shapiro-Wilk test for normality found non-normality.\textsuperscript{660}

Furthermore, a disadvantage can be seen in the fact that the latent variables are dependent and that fit indices tend to reject models with sample sizes of 250 or less.\textsuperscript{661}

(iv) Besides this, MULAIK, et al. show that covariance-based SEMs are not adequate to study complex models. If the degrees of freedom increase with a rising number of indicators and latent variables, various model fit indices tend to be positively biased in comparison to simpler models.\textsuperscript{662}

(v) Another disadvantage of covariance-based SEMs is their inherent indeterminacy. For the reason that case values for the latent variables cannot be obtained in the process, it is not possible to estimate scores for the underlying latent variables in order to predict the observed indicator.\textsuperscript{663}

As mentioned before, an alternative to covariance-based SEM analysis (the Partial Least Square approach) is available. The basic PLS design was established by WOLD to elude the limitation of the covariance-based SEM to help researchers obtain determinate values of latent

\textsuperscript{658} cf. Chin, W. W., Newsted, P. R. (1999), pg. 313.
\textsuperscript{659} cf. Ibid., pg. 309; Backhaus, K., et al. (2006), pg. 371; Scholderer, J., Balderjahn, I. (2006), pg. 62.
\textsuperscript{660} Refer to Appendix 4 and 5.
\textsuperscript{661} cf. Hu, L.-T., Bentler, P. M. (1995), pg. 82.
\textsuperscript{662} cf. Chin, W. W., Newsted, P. R. (1999), pg. 310.
\textsuperscript{663} cf. Ibid., pg. 311.
variables for prediction.\footnote{cf. Ibid., pg. 315.}

For this purpose, the formal model explicitly defines latent variables as linear aggregates of their observed indicators.\footnote{cf. Ibid., pg. 315.} The weight estimates to create the latent variable component scores are received on the basis of the specification of inner (structural) and outer (measurement) models. As a result, the residual variances of dependent variables are minimized.\footnote{cf. Ibid., pg. 315.}

In general, the PLS has fewer preconditions than the covariance-based approaches. Due to the fact that it is a non-parametrical procedure, it has no distribution assumptions for the observed indicator.\footnote{cf. Babakus, E., et al. (1987), pg. 224 et seq.; Chin, W. W., Newsted, P. R. (1999), pg. 315.} PLS can cope with more complex models and is more conservative in estimating the inner model path coefficients than the covariance-based approach.\footnote{cf. Herrmann, A., et al. (2006), pg. 41; Scholderer, J., Balderjahn, I. (2006), pg. 61; Geiger, I. (2007), pg. 19; Chin, W. W., Newsted, P. R. (1999), pg. 315.}

For the purpose of this empirical study the Partial Least Square approach is chosen. Due to the advanced determinateness of the Structural Equation Model, the research design within which formative and reflective measures in the outer model are combined with a complex model makes the PLS superior to the covariance-based procedure. Furthermore, \textit{SCHOLDERER/BALDERJAHN} agree with this decision by stating that PLS is more appropriate than LISREL if aggregated data or objective company data are used for the measurement.\footnote{cf. Scholderer, J., Balderjahn, I. (2005), pg. 97.} PLS has been used for research in strategic management and other business disciplines various times, e.g. by \textit{GEIGER, HSU, et al., BONTIS/SERENKO, JOHANSSON/YIP} and others.

\subsection*{5.4.2 Formal specification of the PLS model}

As mentioned before, the Structural Equation Model, consists of three sets of relations: the inner model, the outer model, and the weight relations on the base of which case values for latent variables can be estimated.\footnote{cf. Backhaus, K., et al. (2006), pg. 338; Chin, W. W., Newsted, P. R. (1999), pg. 307; Homburg, C., Baumgartner, H. (1995), pg. 1092.} Based on the findings of the Exploratory Factor Analysis and the theoretical discussion about the measurement of organizational performance in chapter 5.3, both outer models of the Structural Equation Model have already been defined.
The specification of the measurement model was based on the immanent logic of the measures. As shown in Figure 31, the measurement model for market-driven organizational complexity is defined as a second order model. The first level is defined by the market-related factors (drivers) of organizational complexity. Due to the fact that they constitute the level of market-driven organizational complexity, they are defined to be formative. The extracted drivers of market-driven organizational complexity themselves are measured reflectively by the indicators that were previously grouped by the factor analysis. The right specification of the model is crucial for establishing a reliable measurement model. Jarvis, et al. find that more than twenty-five percent of the latent constructs of multiple indicators that were published in the top marketing journals were incorrectly specified. The misspecification did not only involve the first order but frequently the second order as well. He stated that first
order reflective and second order formative measures are not appropriate. Aside from that, it is possible to eliminate one level if both levels of measurement are reflective.

The outer measurement model of organizational performance, as shown in Figure 30, is also a second order model. The overall performance construct was split into four different reflectively measured dimensions to study the influence of market-driven organizational complexity on different aspects of organizational performance.

To specify both second order constructs in SmartPLS, the hierarchical component approach was used. The partial least square algorithm makes it necessary to repeat the indicators on the first level.674

The inner model of the Structural Equation Model is less complex. It only consists of the relationship between market-driven organizational complexity and organizational performance.

![Figure 32: Complete Structural Equation Model.](image)

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675 Own source.
### 5.4.3 Model evaluation

The evaluation of the Structural Equation Model follows a two-step approach. Initially, the reliability and the validity of the measurement models (outer model) are tested. Afterwards the inner model can be assessed.\(^{676}\)

While reliability verifies whether the measurement model is free of occasional errors and whether the results are stable, the validity tests whether the measurement variables measure the latent construct in an exact way.\(^{677}\)

Due to the fact that reflective and formative measurement models have different characteristics in their error terms, different tests for reliability and validity are necessary.\(^{678}\)

Both test approaches are discussed since reflective and formative measures are incorporated in the Structural Equation Model.

#### 5.4.3.1 Assessment of the reflective measurement model

For testing the quality of reflective measurement models, HULLAND, CHIN/NEWSTED, GÖTZ/LIEHR-GOBBERS and HOMBURG/GIERING recommend the following criteria.\(^{679}\)

<table>
<thead>
<tr>
<th>Quality dimension</th>
<th>Meaning</th>
<th>Measurement parameter</th>
<th>Limit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content validity</td>
<td>Indicators are semantically related to the construct</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Indicator reliability</td>
<td>Percentage of the explained variance given by a specific indicator</td>
<td>Item-to-Total correlation</td>
<td>&gt; 0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Factor loading</td>
<td>&gt; 0.4 – 0.7</td>
</tr>
<tr>
<td>Construct validity</td>
<td>Measurement quality of the construct given by the related indicators</td>
<td>Internal consistency</td>
<td>&gt; 0.6 – 0.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average of variance explained (AVE)</td>
<td>&gt; 0.5</td>
</tr>
<tr>
<td>Discriminant validity</td>
<td>Degree of differentiation between the constructs in the same model</td>
<td>AVE</td>
<td>&gt; highest squared value of correlation with all other constructs in the model</td>
</tr>
</tbody>
</table>

Table 12: Conspectus of quality criteria for reflective measures.\(^{680}\)

In the empirical study a total of 10 reflective constructs were used in total. The content

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\(^{677}\) cf. Homburg, C., Giering, A. (1996), pg. 6 et seq.

\(^{678}\) cf. Hulland, J. (1999), pg. 198.


validity of the second order reflective complexity measurement model is given since the selection of these variables was based on a theoretical discussion and an exploratory factor analysis. Usually content validity is tested by an Explorative Factor Analysis.\textsuperscript{681} Due to the fact that this was already done for the single complexity measures, an additional analysis for the performance measure will be performed to confirm the theoretically developed measurement model. Subsequently the chapter starts with the evaluation of the organization's first and second order reflective performance measures, followed by the evaluation of the second order reflective measures of the complexity drivers.

\textbf{5.4.3.1.1 Organizational performance measuring model}

As shown in the rotated factor matrix (Table 13), the theoretical extraction that was presented in chapter 5.3.2 can be confirmed. The principal components analysis accomplished by SPSS extracted four factors, which were previously theoretically defined as efficiency, effectiveness, shareholder value and financial health. It is possible to conclude that the content validity of the different constructs is given, since the principal component analysis identifies semantically related indicators.

The second and third step in evaluating the measurement model is testing the indicator reliability and construct validity. The following tables present the results of these quality dimensions for the different performance constructs and indicators. Here the internal consistency, Cronbach's Alpha, AVE and factor loadings were calculated with Smart PLS and the item correlation in comparison to the total correlation was calculated with SPSS.

<table>
<thead>
<tr>
<th>Components</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.EarningsBeforeInterestAndTaxesy07</td>
<td>.946</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tf.NetIncomey07</td>
<td>.941</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tf.MarketValuey07</td>
<td>.888</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws.MarketValueAddedy07</td>
<td>.851</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tf.WtdCostOfEquityy07</td>
<td></td>
<td>.898</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tf.ReturnOnAssetsy07</td>
<td></td>
<td>.895</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tf.ReturnOnInvestedCapital5YrAvgy07</td>
<td></td>
<td>.747</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tf.CashFlowToSales5YrAvgy07</td>
<td></td>
<td></td>
<td>.925</td>
<td></td>
</tr>
<tr>
<td>ws.EPS5YrAvgy07</td>
<td></td>
<td></td>
<td></td>
<td>.986</td>
</tr>
</tbody>
</table>

Extraction method: Principle component analysis.
Rotation method: Varimax with Kaiser-Normalization.
(a The Rotation converged in the 5 Iteration)

Table 13: Rotated Component matrix (a).  

682 Own source.
Structural equation model

### Financial effectiveness

<table>
<thead>
<tr>
<th>Indicator:</th>
<th>Item-to-total correlation</th>
<th>Factor loading</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.EarningsBeforeInterestAndTaxesy07</td>
<td>.890</td>
<td>.916</td>
<td>Internal consistency: 0.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AVE: 0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cronbach’s Alpha: 0.96</td>
</tr>
<tr>
<td>ws.MarketValueAddedy07</td>
<td>.860</td>
<td>.941</td>
<td></td>
</tr>
<tr>
<td>tf.NetIncomey07</td>
<td>.922</td>
<td>.961</td>
<td></td>
</tr>
<tr>
<td>tf.MarketValueConsolidatedy07</td>
<td>.896</td>
<td>.915</td>
<td></td>
</tr>
</tbody>
</table>

**Table 14: Quality criteria for the reflective measurement model for financial effectiveness.**

The construct “financial effectiveness” is reliable according to the fact that all quality criteria are fulfilled. All indicators met the reliability criteria of the item-to-total correlation with values being greater than 0.7, along with a very high factor loading. The internal consistency exceeds 0.7, the average variance explained (AVE) is greater than the postulated value of 0.5 and Cronbach’s Alpha demonstrates an excellent value of 0.96.

The construct “financial efficiency” also complied with the construct validity criteria, as defined in Table 12 and shown in Table 15.

### Financial efficiency

<table>
<thead>
<tr>
<th>Indicator:</th>
<th>Item-to-total correlation</th>
<th>Factor loading</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.ReturnOnAssetsy07</td>
<td>.808</td>
<td>.926</td>
<td>Internal consistency: 0.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AVE: 0.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cronbach’s Alpha: 0.87</td>
</tr>
<tr>
<td>tf.ReturnOnInvestedCapital5YrAvgy07</td>
<td>.734</td>
<td>.889</td>
<td></td>
</tr>
<tr>
<td>tf.WtdCostOfEquityyy07</td>
<td>.717</td>
<td>.850</td>
<td></td>
</tr>
</tbody>
</table>

**Table 15: Quality criteria for the reflective measurement model for financial efficiency.**

To summarize, both tested reflectively measured constructs met the quality criteria construct validity and indicator reliability. Even if the other constructs “shareholder value” and “financial health” in the measurement model are also measured reflectively, it is not necessary to assess their quality since they are only measured with one indicator.

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683 Own source.
684 Own source.
The fourth and last step of evaluating the quality of the performance measurement model is verifying the discriminate validity. For this the AVE has to exceed the largest squared correlation between the latent variable (construct) and all others. These so-called Fornell/Larcker-criteria suggest that more variance is explained within the latent variable and its block of indicators than between the latent variable and some other, allegedly different, block of indicators.685 The squared values of the latent variable correlations were calculated within the program SmartPLS and are presented in the Table 16.

<table>
<thead>
<tr>
<th></th>
<th>AVE</th>
<th>(Latent Variable Correlation)²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial health</td>
<td>1.000</td>
<td>0.387</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.8849</td>
<td>0.535</td>
</tr>
<tr>
<td>Shareholder value</td>
<td>1.000</td>
<td>0.639</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.7247</td>
<td>0.560</td>
</tr>
</tbody>
</table>

Table 16: Discriminant validity of the reflective performance measures.686

To sum up, it can be stated that the second order reflective outer model of organizational performance is valid.

In the next step, it is also necessary to evaluate the first-order reflective measure of organizational performance. For this purpose it is possible to use the model-specific characteristic of second-order reflective models, as mentioned in chapter 5.4.2. As JARVIS, et al. state if both first and second order models are measured reflectively it is also possible to eliminate the second order so that all indicators are directly related to the primary latent construct. By doing so, it is possible to assess the overall quality of the first order model in line with already applied methods. Another possibility would be to use factor values for each dimension of organizational success, calculated by SPSS via a confirmatory factor analysis. As it is not possible to assess the indicator reliability for each indicator with regard to the first order construct, the first approach will be used.

The following table presents the values for the different quality dimensions and indicators for the first-order reflective measurement model of organizational performance. The AVE,

686 Own source.
Structural equation model

Internal consistency and Cronbach’s Alpha all exceed the limit value. The factor loadings are relatively high. Only the indicator “earnings per share” calculated for in a five-year average has a low value. In particular, the value for the Item-to-total correlation is below the limit value.

<table>
<thead>
<tr>
<th>Organizational performance</th>
<th>Indicator reliability</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
<td>Item-to-total correlation</td>
<td>Factor loading</td>
</tr>
<tr>
<td>EPS5YrAvgy07</td>
<td>.184</td>
<td>.289</td>
</tr>
<tr>
<td>Market Valuey07</td>
<td>.803</td>
<td>.855</td>
</tr>
<tr>
<td>WtdCostofEquityy07</td>
<td>.513</td>
<td>.749</td>
</tr>
<tr>
<td>Market Value Addeddy07</td>
<td>.812</td>
<td>.861</td>
</tr>
<tr>
<td>ROI5YrAvgy07</td>
<td>.652</td>
<td>.741</td>
</tr>
<tr>
<td>Return on Assets y07</td>
<td>.557</td>
<td>.665</td>
</tr>
<tr>
<td>Net Income y07</td>
<td>.813</td>
<td>.868</td>
</tr>
<tr>
<td>Cash Flow to sales 5 Yr</td>
<td>.502</td>
<td>.618</td>
</tr>
<tr>
<td>Avg y07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EBITA</td>
<td>.751</td>
<td>.825</td>
</tr>
</tbody>
</table>

Table 17: Quality criteria for the reflective measurement model for organizational performance.\(^{687}\)

As CHURCHILL states, the indicators with the lowest item-to-total value should be excluded from the model until the AVE is above the limit value.\(^{688}\) As long as several indicators represent the same latent variable or construct, this is unproblematic. Since the EPS indicator is the only available indicator in this case, it is not excluded. Furthermore, the value of Average Variance Explained is above the limit value. With this it is possible to retain an additional dimension of organizational performance for further studies and group comparisons later on.\(^{689}\)

All other indicators are well beyond the limit values and the total construct validity is given.

Lastly, it is necessary to test the discriminant validity of this construct. Since the discriminant

\(^{687}\) Own source.


\(^{689}\) In detail Bearden, W. O., et al. (1989) defined that the values oft he indicators exceed .5 but despite that advice no clear limit value exist. Bearden, W. O., et al. (1989), pg. 475.
validity is defined as the highest squared value of correlation, all other constructs in the model should be smaller than the AVE of the construct.

In the case of the first order construct of organizational performance, the only related constructs are market-driven organizational complexity and the different drivers. The highest squared correlation is given by the correlation between market-driven organizational complexity and organizational performance with 0.43, which is below the value of AVE of 0.52. Discriminant validity is therefore given.

In conclusion, the first and second order reflective measurement models of organizational performance are valid and can be used for further analysis.

5.4.3.1.2 Organizational complexity measuring model

As mentioned before, it is not necessary to test the content validity of the complexity measurement model due to the fact that the latent variables were extracted by an exploratory factor analysis. According to this, solely the indicator reliability, the construct validity and the discriminate validity of the second order model were tested in accordance with the process mentioned above.

The following tables present in detail the quality criteria for each latent variable

<table>
<thead>
<tr>
<th>Size</th>
<th>Indicator reliability</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indicator</td>
<td>Item-to-total</td>
</tr>
<tr>
<td></td>
<td></td>
<td>correlation</td>
</tr>
<tr>
<td>tf.TotalAssets07</td>
<td>.849</td>
<td>.936</td>
</tr>
<tr>
<td>tf.Salesy07</td>
<td>.931</td>
<td>.901</td>
</tr>
<tr>
<td>ws.InternationalAssets07</td>
<td>.587</td>
<td>.741</td>
</tr>
<tr>
<td>tf.ForeignSalesy07</td>
<td>.838</td>
<td>.916</td>
</tr>
<tr>
<td>M&amp;A Number</td>
<td>.449</td>
<td>.650</td>
</tr>
<tr>
<td>ws.BusinessSegment1Sale sy07</td>
<td>.831</td>
<td>.840</td>
</tr>
<tr>
<td>tf.Employeesy07</td>
<td>.480</td>
<td>.489</td>
</tr>
</tbody>
</table>

Table 18: Quality criteria for the reflective measurement model for size.690

690 Own source.
The construct of size, which explains the largest proportion of variance of market-driven organizational complexity, has high values for Cronbach’s Alpha and of internal consistency. Due to the low value for the Item-to-total correlation of the indicators M&A number and Employees, they were excluded. By doing so, the internal consistency rises to 0.95, the AVE to 0.79 and Cronbach’s Alpha to 0.93. Nevertheless, it is important to keep in mind the challenges for managing complexity, which are caused by these indicators.

<table>
<thead>
<tr>
<th>Product diversification</th>
<th>Indicator reliability</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
<td>Item-to-total correlation</td>
<td>Factor loading</td>
</tr>
<tr>
<td>DominateBSinverted</td>
<td>.717</td>
<td>.897</td>
</tr>
<tr>
<td>NumberofBSy07</td>
<td>.717</td>
<td>.951</td>
</tr>
</tbody>
</table>

Table 19: Quality criteria for the reflective measurement model for product diversity.\textsuperscript{691}

The construct “product diversification” is highly internally consistent with 0.92. The factor loadings are high and all other criteria exceed the limit values as well. The construct “Depth and Breadth” has nearly similar values for the internal consistency and a slightly lower value for the Average Variance Explained whereas the factor loadings are very high. Overall, both constructs fulfill the quality criteria.

<table>
<thead>
<tr>
<th>Depth and breadth</th>
<th>Indicator reliability</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
<td>Item-to-total correlation</td>
<td>Factor loading</td>
</tr>
<tr>
<td>tf.ResearchAndDevelopmentToSalesy06</td>
<td>.775</td>
<td>.740</td>
</tr>
<tr>
<td>tf.ResearchDevelopmentToSales5YrAvgy07</td>
<td>.768</td>
<td>.736</td>
</tr>
<tr>
<td>CostofGoodsSoldToSalesinverted5YAvrg</td>
<td>.785</td>
<td>.966</td>
</tr>
<tr>
<td>CostofGoodsSoldToSalesinverted</td>
<td>.756</td>
<td>.956</td>
</tr>
</tbody>
</table>

Table 20: Quality criteria for the reflective measurement model for business depth and breadth.\textsuperscript{692}

\textsuperscript{691} Own source.
\textsuperscript{692} Own source.
As shown in Table 21, the construct (driver) “technological intensity” has high construct validity and excellent values for the item-to-total correlations and factor loadings. Also the construct “organizational change” as important driver for market-driven organizational complexity in terms of fast flux and ambiguity is valid. All limit values for the different quality dimensions are exceeded as presented in Table 22.

<table>
<thead>
<tr>
<th>Technological intensity</th>
<th>Indicator reliability</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator:</td>
<td>Item-to-total correlation</td>
<td>Factor loading</td>
</tr>
<tr>
<td>tf.AssetsPer Employeey07</td>
<td>.968</td>
<td>.991</td>
</tr>
<tr>
<td>tf.AssetsPer Employee 5YrAvgy07</td>
<td>.968</td>
<td>.993</td>
</tr>
</tbody>
</table>

Table 21: Quality criteria for the reflective measurement model for product diversity.

<table>
<thead>
<tr>
<th>Organizational change</th>
<th>Indicator reliability</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
<td>Item-to-total correlation</td>
<td>Factor loading</td>
</tr>
<tr>
<td>M&amp;AVolume to Salesy07</td>
<td>.782</td>
<td>.895</td>
</tr>
<tr>
<td>M&amp;AVolume2007 Total</td>
<td>.854</td>
<td>.947</td>
</tr>
<tr>
<td>M&amp;AVolume2007 Sales</td>
<td>.840</td>
<td>.926</td>
</tr>
</tbody>
</table>

Table 22: Quality criteria for the reflective measurement model for fast flux.

To conclude the evaluation of the reflective measurement model of market-related drivers of organizational complexity, the discriminant validity has to be tested. The following Table 23 shows the highest squared latent variable correlations, which are always below the explained average variance.

---

693 Own source.
694 Own source.
Table 23: Discriminant validity for the complexity driver constructs.\(^{695}\)

<table>
<thead>
<tr>
<th>Complexity Driver Construct</th>
<th>AVE</th>
<th>(Latent Variable Correlation)(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change</td>
<td>0.8514</td>
<td>0.238</td>
</tr>
<tr>
<td>Geographic diversity</td>
<td>0.7783</td>
<td>0.233</td>
</tr>
<tr>
<td>Product diversity</td>
<td>0.8552</td>
<td>0.010</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.6348</td>
<td>0.179</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.9841</td>
<td>0.216</td>
</tr>
<tr>
<td>Interdependence</td>
<td>0.7346</td>
<td>0.401</td>
</tr>
</tbody>
</table>

Since discriminate validity is also given, all quality criteria are fulfilled. The reflective second order measuring model of the drivers of organizational performance is valid.

**5.4.3.2 Assessment of the formative measurement model**

The Structural Equation Model contains a second order measurement model for market-driven organizational complexity. While the second order is measured reflectively, the first order is measured formatively. As discussed above, the reason for this is that the market-related drivers of organizational complexity constitute the value of the construct. There will be a significant difference, if one of the drivers is excluded.\(^ {696}\) Due to this fact, the formative level of the measurement model has to be tested regarding its quality as well.

For the evaluation of a formative measurement model statistical criteria, like those that were used for the reflective models, are not appropriate.\(^ {697}\) In general, only few reliability aspects can be tested.\(^ {698}\) Therefore DIAMANTOPOULOS/WINKLHOFER propose the following three steps for the evaluation.\(^ {699}\)

(i) Content and indicator specification
(ii) Examination of multicollinearity
(iii) Examination of external validity

---

\(^{695}\) Own source.  
\(^{696}\) cf. Bollen, K., Lennox, R. (1991), pg. 308  
5.4.3.2.2 Content and indicator specification

The content and indicator specification are based on a literature review, preliminary studies and tests of correlation, as discussed in previous chapters. The market-related drivers of organizational complexity determine the overall value of market-driven organizational complexity. The drivers consist of highly correlated indicators while being uncorrelated with one another. Hence, they define different aspects of organizational complexity.

Furthermore, it is possible to evaluate the reliability of the formative measurement model by studying the indicator weights and significance values. Table 24 presents the indicator weights and t-statistics.

<table>
<thead>
<tr>
<th>Indicator Weight</th>
<th>T-Statistics</th>
<th>Significance (two side)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size -&gt;Organizational complexity</td>
<td>0.610</td>
<td>15.876</td>
</tr>
<tr>
<td>Depth and breadth -&gt;Organizational complexity</td>
<td>0.380</td>
<td>9.066</td>
</tr>
<tr>
<td>Organizational change -&gt;Organizational complexity</td>
<td>0.310</td>
<td>7.042</td>
</tr>
<tr>
<td>Technological intensity -&gt;Organizational complexity</td>
<td>0.236</td>
<td>10.938</td>
</tr>
<tr>
<td>Globalization -&gt;Organizational complexity</td>
<td>0.198</td>
<td>10.847</td>
</tr>
<tr>
<td>Product diversification -&gt;Organizational complexity</td>
<td>0.131</td>
<td>6.537</td>
</tr>
</tbody>
</table>

Table 24: Indicator weights for the formative measurement model of organizational complexity.\(^{700}\)

As shown, all indicators have a significant indicator weight. Even if some weights are relatively weak, it is not appropriate to exclude these indicators. Due to the formative character of the measure, the construct value would change significantly.

To conclude, it can be stated that the significance values for all drivers of complexity are excellent, which approves the quality of the model.

5.4.3.2.3 Examination of multicollinearity

The test for multicollinearity is also executed with SPSS. For this, the factor values of the complexity drivers have to be calculated in SPSS. Subsequently, the factors can be tested by performing a linear regression. The test of multicollinearity studies the relationship between

\(^{700}\) Own source.
the different indicators (in this case the construct of drivers of market-driven organizational complexity). Multicollinearity is given when two indicators represent the same information to the latent variable (market-driven organizational complexity). Multicollinearity is a normal phenomenon in empirical studies, but a high level of multicollinearity can be a problem due to the fact that it comes along with a higher standard error of the regression coefficients.

Because the model was developed by using an Exploratory Factor Analysis, multicollinearity is not expected to be a problem. Nevertheless, a regression of each driver with all other factor values of drivers was calculated to test the multicollinearity.

<table>
<thead>
<tr>
<th>Collinearity statistic</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Depth and Breadth</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Organizational change</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Globalization</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Product diversification</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Table 25: Test for multicollinearity of the formative first order measurement model of market-driven organizational complexity.

The value of tolerance and the Variance Inflation Factor (VIF) can be calculated by the use of the corrected $R^2$. Correspondingly, tolerance is defined by $1-R^2$ and the VIF is defined by $1/(1-R^2)$.

As shown, all values are equal and valid; hence multicollinearity is not a problem. Particularly due to the high tolerance values, multicollinearity can be ruled out for all drivers.

In sum, it is possible to conclude that the indicator reliability for the formative first order construct of market-driven organizational complexity is given.

---

702 cf. Ibid., pg. 90.
703 Own source.
5.4.3.2.4 Examination of external validity

The examination of external validity is the third step of evaluating the quality of the formative measure and can be done in three different ways.\textsuperscript{704}

Firstly, it is possible to use a single indicator that represents the construct of market-driven organizational complexity at its best and to study the significance of correlation of all formative indicators with such a single indicator. Due to the fact that such an indicator does not exist – and will not exist as argued before – this possibility is not appropriate for the evaluation of the measurement model.\textsuperscript{705}

Secondly, a MIMIC model can be defined. In this case the formatively measured construct is simultaneously measured reflectively. Hence, all formative indicators with non-significant factor weights can be eliminated. This option is also not feasible in that case, since measuring market-driven organizational complexity reflectively would imply that several or even only one indicator exist that reflect the value of complexity adequately.

The third option is to study the relationship between the formatively measured construct and the other constructs. If empirically tested relationships between both constructs exist and if the formatively measured construct reproduces this correlation (with the same algebraic sign) and is significant, then it can be supposed that the operationalization is valid.

To this date, no other empirical study assesses market-driven organizational complexity and therefore no other empirical study can be used as reference for the correlation. Only theoretical discussions about the correlation exist, as presented in previous chapters, which is identified as one major limitation of the complexity theory.

Nevertheless, it is possible to state that external validity is given, since the derivation of the model was based on a detailed review of literature and several pre-studies.\textsuperscript{706}

Altogether, the formative first order measuring model is valid.

In conclusion, the assessment of the formative and reflective measurement model makes it possible to state that all used models are valid.

\textsuperscript{705} See section 5.1.1.
\textsuperscript{706} First pre-study was done in 2007 within a research seminar with 90 students at the Technical University of Berlin. The second pre-study was done in 2008 as longitudinal study with 47 students at the Technical University of Berlin.
5.4.3.3 Assessment of the inner structural model

To assess the overall quality of the structural model, re-sampling methods like Jackknifing or Bootstrapping can be used. The following Figure 33 presents the path coefficients and the significance value of the structural model.

Due to the fact that the PLS algorithm aims at maximizing the explained variance $R^2$ of the endogenous variables, the quality of the SEM can be assessed by the sign, value and significance of the path weights and the explained variance of the endogenous variables (performance).\(^{708}\)

In general, it can be stated that all path coefficients are significant and that the value of the path weights is reasonably high. The explained variance of most of the constructs is good. Only the explained variance of the shareholder value is relatively low. Bearing in mind the low value of the indicator “EPS 5YAvrg y07” in the reliability test, presented in chapter 5.4.3.1.1, this result is explainable.

\(^{707}\) Own source.
\(^{708}\) cf. Krafft, M., et al. (2005), pg. 83.
Empirical model

The central path between market-driven organizational complexity and performance has an appropriately high weight, and due to the fact that all paths are significant, the quality of the model can be confirmed.

An additional quality test examines $Q^2$, the prediction relevance of the model.\footnote{cf. Chin, W. W. (1998), pg. 316.}

An additional quality test examines $Q^2$, the prediction relevance of the model.\footnote{cf. Chin, W. W. (1998), pg. 316.}

<table>
<thead>
<tr>
<th>Construct</th>
<th>Communality $Q^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market-driven organizational complexity</td>
<td>0.2432</td>
</tr>
<tr>
<td>Product Diversity</td>
<td>0.8472</td>
</tr>
<tr>
<td>Geographic Diversity</td>
<td>0.7797</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.7871</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.9841</td>
</tr>
<tr>
<td>Depth and Breadth</td>
<td>0.7535</td>
</tr>
<tr>
<td>Organizational change</td>
<td>0.8518</td>
</tr>
<tr>
<td>Organizational Performance</td>
<td>0.5211</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.885</td>
</tr>
<tr>
<td>Financial health</td>
<td>1</td>
</tr>
<tr>
<td>Shareholder value</td>
<td>1</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.7901</td>
</tr>
</tbody>
</table>

Table 26: Prediction relevance of the Structural Equation Model.\footnote{Own source.}

If $Q^2$ is greater than zero, the construct has prediction validity. Since all values of $Q^2$ are unequal to zero, prediction quality of the model can be assumed.\footnote{cf. Ringle, M. C., Spreen, F. (2007), pg. 214.}

Additionally the following equation can be used to calculate the effect size of each latent variable in the model. COHEN argues that $f^2$-values of 0.02, 0.15 and 0.35 represent a small, good and strong influence respectively on the endogenous variable.\footnote{cf. Cohen, J. (1988), pg. 412 et seq.}

\[
f^2 = \frac{R^2_{incl} - R^2_{excl}}{1 - R^2_{incl}}
\]

Formula 3: Effect size calculation of each latent variable.\footnote{cf. Ringle, M. C., Spreen, F. (2007), pg. 214.}
Structural equation model

With $f^2 = \text{effect size}, R^2_{\text{incl}} = \text{explained Variance with the latent variable}, R^2_{\text{excl}} = \text{explained Variance without the latent variable}.$

Since the presented model consists only of one major relationship, testing the effect size is not practicable.

Summarizing the findings of the model evaluation, it can be stated that the SEM meets nearly all criteria. The reflective and formative measurement models are reliable and valid, and accordingly the quality of the outer models is given.

The inner model has a high content validity and shows good results with high explanatory power.
6 Advanced statistics – Testing hypotheses

After approving the quality of the model, it is now possible to test the hypotheses.

6.1 The relationship between market-driven organizational complexity and performance

As shown in Figure 34, there is a strong positive (0.653) relationship between market-driven complexity and organizational performance. The main correlation and all other paths in the model are significant. The explanatory power of organizational performance provided by the construct of market-driven organizational complexity is good. 43% of the overall variance of organizational performance in the data sample is explained.

![Inner Structural Equation Model with path coefficients and significance values.](image)

Regarding the path coefficient, it can be stated that size is the most important market-related complexity driver of organizational complexity. The depth and breadth of the business model is the second major factor, but the other drivers also play a significant role in causing market-driven organizational complexity. The model has high explanatory power since it explains 82% of the organizational effectiveness, 56% of the organizational efficiency and 38% of the average variance of the dimension financial health. The path coefficient between

---

**Figure 34: Inner Structural Equation Model with path coefficients and significance values.**

---

Own source.
organizational performance and the dimension of shareholder value is good with a value of 0.289 and significant, the explained variance of this dimension is relatively low with $R^2 = 0.084$.

According to the developed model and given limitations, it is not possible to approve the first hypothesis defined in chapter 3. Due to the focus on market-driven complexity, the positive correlation presented in the model has only explanatory power for the second hypothesis. As discussed above, it was not feasible to measure both dimensions of organizational complexity in one data sample and with one methodology; it was therefore decided to exclude the organization-driven complexity dimension from the empirical study. As a result, the third hypothesis can similarly not be approved.

<table>
<thead>
<tr>
<th>H 1</th>
<th>There is an inversely u-shaped relationship between organizational complexity and organizational performance.</th>
<th>–</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 2</td>
<td>There is a positive relationship between market-driven complexity and performance: approved.</td>
<td>✔</td>
</tr>
<tr>
<td>H 3</td>
<td>There is a negative relationship between organization-driven complexity and performance.</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 27: Results of testing the hypotheses 1, 2 and 3.\textsuperscript{715}

In chapter 5.2.5 six additional propositions were defined, which were approved by the use of the established structural equation model. Whereas the Exploratory Factor Analysis confirms the proposition that market-driven organizational complexity is a multi-dimensional construct, the SEM confirms that the relationships between the drivers and market-driven complexity are significant.

The following Table 28 presents a summary of these propositions.

\textsuperscript{715} Own source.
Relationship between organizational complexity and organizational performance

<table>
<thead>
<tr>
<th>P 1a</th>
<th>Market-driven organizational complexity is positively related to (driven by) the size of the organization.</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 1b</td>
<td>Market-driven organizational complexity is positively related to (driven by) product diversity inside the organization.</td>
<td>✓</td>
</tr>
<tr>
<td>P 1c</td>
<td>Market-driven organizational complexity is positively related to (driven by) globalization of the organization.</td>
<td>✓</td>
</tr>
<tr>
<td>P 1d</td>
<td>Market-driven organizational complexity is positively related to (driven by) depth and breadth of the organization.</td>
<td>✓</td>
</tr>
<tr>
<td>P 1e</td>
<td>Market-driven organizational complexity is positively related to (driven by) organizational change inside the organization.</td>
<td>✓</td>
</tr>
<tr>
<td>P 1f</td>
<td>Market-driven organizational complexity is positively related to (driven by) technological intensity inside the organization.</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 28: Results of testing the proposition 1a-f.\textsuperscript{716}

Furthermore it is possible to study the total effects of each market-related driver of organizational complexity on organizational performance. Table 29 presents the specific values for each market-related driver of organizational complexity.

<table>
<thead>
<tr>
<th>LV</th>
<th>Total Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>0.271648</td>
</tr>
<tr>
<td>Product Diversity</td>
<td>0.193288</td>
</tr>
<tr>
<td>Globalization</td>
<td>0.173045</td>
</tr>
<tr>
<td>Organizational Change</td>
<td>0.203083</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.204389</td>
</tr>
<tr>
<td>Depth and Breadth</td>
<td>0.251405</td>
</tr>
</tbody>
</table>

Table 29: Total effect of the formative indicators in the SEM.\textsuperscript{717}

As illustrated by the path weights of the Structural Equation Model (Figure 34) and the total effects, the majority of the complexity drivers have a comparable influence on organizational performance, wherein the drivers "size" and "depth and breadth" have a slightly higher influence.

\textsuperscript{716} Own source.
\textsuperscript{717} Own source.
6.2 Multi-group comparison

One of the assumptions of the Partial Least Square Method is that the correlation between the latent construct is linear. Due to the fact that in theory there is a varying correlation between different levels of market-driven organizational complexity, further hypotheses and propositions can be tested by a multi group comparison. The following Table 30 presents the hypotheses and propositions that will be tested in the next sections.

<table>
<thead>
<tr>
<th></th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 4</td>
<td>The positive relationship between market-driven complexity and performance varied between different levels of market-driven organizational complexity.</td>
</tr>
<tr>
<td>H 5</td>
<td>The negative relationship between organization-driven complexity and performance varied between different levels of market-driven organizational complexity.</td>
</tr>
<tr>
<td>P 2a</td>
<td>The positive relationship between interdependency and market-driven complexity varied between different levels of market-driven organizational complexity.</td>
</tr>
<tr>
<td>P 2b</td>
<td>The positive relationship between product diversity and market-driven complexity varied between different levels of market-driven organizational complexity.</td>
</tr>
<tr>
<td>P 2c</td>
<td>The positive relationship between geographical diversity and market-driven complexity varied between different levels of market-driven organizational complexity.</td>
</tr>
<tr>
<td>P 2d</td>
<td>The positive relationship between ambiguity and market-driven complexity varied between different levels of market-driven organizational complexity.</td>
</tr>
<tr>
<td>P 2e</td>
<td>The positive relationship between fast flux and market-driven complexity varied between different levels of market-driven organizational complexity.</td>
</tr>
<tr>
<td>P 2f</td>
<td>The positive relationship between technological intensity and market-driven complexity varied between different levels of market-driven organizational complexity.</td>
</tr>
</tbody>
</table>

Table 30: Hypothesis for testing group differences with PLS.\textsuperscript{718}

Testing H5 is not possible, since the empirical study did not consider the indicators to measure organization-driven complexity.

To prove all other hypotheses and propositions, a group splitting of the data is needed. At this point, the real advantage and strength of the PLS algorithm emerges. The algorithm allows splitting up the total sample of 305 companies into smaller groups without violating the fundamental assumption for each group that the validity of the data sample depends particularly on the group sizes. Due to the fact that the number of cases should be ten times bigger as the highest number of indicators used to measure the most complex construct, the limit for the smallest sub sample in the study is defined to be 60.

\textsuperscript{718} Own source.
Multi-group comparison

It is possible to examine differences across different groups with the help of PLS, but it is not automated in the SmartPLS program. Thus it is necessary to take the standard errors for the structural paths provided by SmartPLS in the re-sampling output and calculate the significance manually.

In general, there are two major approaches to this calculation. The first approach is to calculate the significance non-parametrically. This requires a random selection of cases from combined multi-group sets for each group. SmartPLS can then run a bootstrapping test and the results of the re-sampling can be sorted by each parameter for each population. For the simple reason that such a permutation approach does not exist in SmartPLS, an alternative approach is required.

The second approach is to treat the estimates of the re-sampling in a parametric sense via t-tests. Based on a parametric assumption it is possible to take the standard errors for the structural paths provided by SmartPLS in the re-sampling output and calculate the t-test manually for the differences in paths between groups.

To do so, the following equation can be applied:

\[
t = \frac{Path_{\text{sample,1}} - Path_{\text{sample,2}}}{\sqrt{\frac{(n-1)^2}{(m+n-2)} \cdot SE_{\text{sample,1}}^2 + \frac{(m-1)^2}{(m+n-2)} \cdot SE_{\text{sample,2}}^2}} \cdot \sqrt{\frac{1}{m} + \frac{1}{n}}
\]

**Formula 4: Significance of path differences for multi-group comparison.**

In general, this approach entails running a bootstrap re-sampling for various groups and treating the standard error estimates from each re-sampling in a parametric sense via t-test. For the following a parametric assumption has to be fulfilled. As discussed in chapter 5.2, the main data of the study is not normally distributed; hence, the parametric assumption is violated. As FIEDLER states, many researchers used the partial least square method because their data is not normally distributed, but simultaneously made multi-group comparisons with these data.

---

721 cf. Ibid., pg. 238; With regard to the discussion about general mistakes of measuring organizational complexity, this limitation does not lead to a domination of research tools, as argued in section 5.1.1. It rather enables an objective discussion about the results later on.
This can be seen as an inappropriate measurement since the equation presented above only delivers reliable results if the sample is not too non-normally distributed as argued by CHIN.\(^\text{722}\)

The normal distribution of the sample is always determined by the studied indicators. The subject of this group comparison and the criteria for the group selection are the market-related drivers of organizational complexity. Subsequently, the normal distributions of these factors have to be checked.\(^\text{723}\) Figure 35 presents an example of the histograms for all six-factor values of the drivers of market-driven organizational complexity in the sample. The other figures are presented in the Appendix 13.

![Figure 35: Sample distribution for the driver „Globalization“.\(^\text{724}\)](image)

As shown, the factor values for the data sample are nearly normally distributed or at least not too non-normally distributed, as mentioned before. Thus it is possible to use the presented equation to calculate the significances of the group comparisons.\(^\text{725}\)

The following discussion presents two different approaches of group splitting. Within the first case, the groups are separated by the average value of “virtual value of market-driven organizational complexity”. Based on the factor loading presented in Figure 34 and the factor values of each driver of market-driven organizational complexity, the “virtual value of market-driven organizational complexity” was calculated. As discussed in section 5.1.1, normally it is not possible to use such a reductionist approach for studying complexity. Due to


\(^{723}\) The factor values were calculated with SPSS.

\(^{724}\) Own source.

the fact that complexity is a holistic concept, it is not possible to divide it into different parts to then reassemble the results. Complexity and market-driven organizational complexity in particular, is more than the sum of its parts. Bearing that in mind, the “virtual value of market-driven organizational complexity” is calculated and used only to split up the companies into different groups.

In the second case, the companies are divided in groups by the quartiles of the “virtual value of market-driven organizational complexity”.

### 6.2.1 Multi-group comparison – mean value separation

The first group evaluation includes a group splitting into two groups that are separated by the mean. The total number of studied companies is again 305. The maximum value for the “virtual market-driven organizational complexity value” is 4.08 and the minimum is -1.36. The mean value is -0.19 and leads to a group size of 194 companies in the low complexity group and 111 companies in the high complexity group.

For each group, the path coefficients, the significance and the R² values are calculated. Figure 36 presents the path coefficients and significances for the low complexity group in detail.

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**Figure 36: Empirical results of Structural Equation Model – low complexity sub-group.**

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726 Own source.
Furthermore, each model was tested analogously to the proceeding of the model evaluation of chapter 5.4.3 in order to rule out the possibility that the sub-sample violates the overall quality assumptions.\textsuperscript{727} It can be stated that for the mean value separation both groups fulfill the construct quality criteria of e.g. AVE, Cronbach’s Alpha and of internal consistency.\textsuperscript{728}

![Structural Equation Model Diagram](image)

**Figure 37: Empirical results of Structural Equation Model – high complexity sub-group.**\textsuperscript{728}

As shown in the figures above, the correlation between market-driven complexity and organizational performance is stronger in the high complexity group than in the low complexity group. Moreover, market-driven complexity explains more average variance of organizational performance. This can indicate that the need for managing complexity increases in importance if the level of market-driven organizational complexity grows.

Another major difference is the correlation of the formative indicator (driver) of market-driven complexity, product diversity. While this indicator is positively correlated with a value of 0.323 in the low complexity group, the correlation is negative with a value of -0.205 in the high complexity group.

\textsuperscript{727} Detailed values are presented in Appendix 10.

\textsuperscript{728} Own source.
Multi-group comparison

The differences in the loadings of the other indicators for market-driven complexity are nearly equal in both samples. One difference can be detected by the loading of the reflective indicator shareholder value. While in the low complexity sample the market-driven organizational complexity explained 20% of the variance of the indicator, the explanatory power in the high complexity group is limited to 2% of the variance. Additionally, the path coefficient is with 0.144 only $\frac{1}{4}$ of the value of the low complexity group.

To test the significance of these difference, Formula 4 presented above can be used. The following table presents the t-values for the differences between the path coefficients of each group.

<table>
<thead>
<tr>
<th>Paths</th>
<th>Path coefficient</th>
<th>low complex</th>
<th>high complex</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change -&gt; Organizational complexity</td>
<td>0.4048</td>
<td>0.348</td>
<td></td>
<td>0.98180636</td>
</tr>
<tr>
<td>Geographic diversity -&gt; Organizational complexity</td>
<td>0.3134</td>
<td>0.2993</td>
<td></td>
<td>0.28317153</td>
</tr>
<tr>
<td>Organizational complexity -&gt; Organizational performance</td>
<td>0.4048</td>
<td>0.5487</td>
<td></td>
<td>1.11143561</td>
</tr>
<tr>
<td>Product diversity -&gt; Organizational complexity</td>
<td>0.3226</td>
<td>-0.2049</td>
<td></td>
<td>6.79475114</td>
</tr>
<tr>
<td>Size / Interdependence -&gt; Organizational complexity</td>
<td>0.516</td>
<td>0.497</td>
<td></td>
<td>0.25835921</td>
</tr>
<tr>
<td>Technological intensity -&gt; Organizational complexity</td>
<td>0.365</td>
<td>0.3714</td>
<td></td>
<td>0.1077965</td>
</tr>
<tr>
<td>Depth and breadth -&gt; Organizational complexity</td>
<td>0.4298</td>
<td>0.4981</td>
<td></td>
<td>0.47729645</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial effectiveness</td>
<td>0.9067</td>
<td>0.8896</td>
<td></td>
<td>0.61200456</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial health</td>
<td>0.5935</td>
<td>0.4845</td>
<td></td>
<td>1.0152616</td>
</tr>
<tr>
<td>Organizational performance -&gt; Shareholder value</td>
<td>0.4478</td>
<td>0.1443</td>
<td></td>
<td>3.37522354</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial efficiency</td>
<td>0.75</td>
<td>0.8318</td>
<td></td>
<td>1.43789289</td>
</tr>
</tbody>
</table>

Table 31: T-values for group comparison of path-coefficients between low and high complexity groups.\(^{729}\)

Only two of the discussed path differences are significant. The difference of the main path between market-driven complexity and organizational performance is not significant. Hence the hypothesis 4 cannot be approved at this point.

The differences of the other two-path coefficient that were studied are significant and will be discussed in detail in chapter 6.3. For now, only proposition P 2b can be confirmed.

Another approach to study the differences between the two groups is to compare the total effect sizes. For this approach, no significance value can be calculated, but nevertheless it provides meaningful indications for further discussion.

The following Table 32 presents the values of the total effect size of the different drivers of market-driven complexity on organizational performance for the comparison of the low and high complex group.

\(^{729}\) Own source.
As shown, the total effect of the driver “size” on organizational performance is stronger in high complex organizations. In general, nearly all drivers have a stronger total effect due to the higher correlation between market-driven organizational complexity and organizational performance. The drivers “size” and “depth and breadth,” however, have increased disproportionately. The factor “product diversity” demonstrates the largest difference. In the group with low complex organizations the total effect on performance is positive, whereas the total effect on performance in the high complexity group is negative.

To sum up, the multi-group comparison by mean separation shows that the overall correlation between market-driven complexity and organizational performance does not differ significantly. Two other paths with significant differences and the difference in total effect of product diversity on organizational performance will be discussed further. At this point it can be stated that proposition P 2b is approved.

**6.2.2 Multi-group comparison – quartile separation**

Due to the fact that the mean value separation was not able to confirm the fourth hypothesis, a second multi-group comparison is presented in the following section. The groups are again split by the “virtual value of market-driven organizational complexity”. Quartiles define the separation lines.

<table>
<thead>
<tr>
<th>Value</th>
<th>Group size (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Quartile -0.54565075</td>
<td>77</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Quartile -0.19220164</td>
<td>76</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Quartile 0.37071952</td>
<td>75</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; Quartile 4.08049243</td>
<td>77</td>
</tr>
</tbody>
</table>

Table 33: Group size of the quartile sub-samples for the multi-group comparison.  

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730 Own source.  
731 Own source.
As shown in Table 33, the groups sizes are nearly equal and do not violate the assumption of the minimal group sample size of 60. The following figures present the path coefficients, the explained variance $R^2$ and the significances of each quartile group.

Figure 38: Structural equation model with path coefficients and $R^2$ for first quartile sub-group.

Figure 39: Structural equation model with path coefficients and $R^2$ for second quartile sub-group.

---

732 Own source.
The quality criteria for the Structural Equation Model that were discussed in detail in chapter 5.4.3 are fulfilled for each sub-sample. The following discussion is therefore based on reliable and valid models. The detailed figures of each sub-sample are presented in Appendix 15.

<table>
<thead>
<tr>
<th>Path Coefficient</th>
<th>1st Quartile</th>
<th>2nd Quartile</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change -&gt; Organizational complexity</td>
<td>0.3792</td>
<td>0.3217</td>
<td>0.83012667</td>
</tr>
<tr>
<td>Geographic diversity -&gt; Organizational complexity</td>
<td>0.3192</td>
<td>0.231</td>
<td>1.44141775</td>
</tr>
<tr>
<td>Organizational complexity -&gt; Organizational performance</td>
<td>0.1811</td>
<td>0.4875</td>
<td>1.19657045</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial effectiveness</td>
<td>0.9125</td>
<td>0.8945</td>
<td>0.58198043</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial health</td>
<td>0.5857</td>
<td>0.6868</td>
<td>1.10979306</td>
</tr>
<tr>
<td>Organizational performance -&gt; Shareholder value</td>
<td>0.4121</td>
<td>0.5171</td>
<td>0.83743982</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial efficiency</td>
<td>0.7947</td>
<td>0.7614</td>
<td>0.44270673</td>
</tr>
<tr>
<td>Product diversity -&gt; Organizational complexity</td>
<td>0.3784</td>
<td>-0.2494</td>
<td>6.59286636</td>
</tr>
<tr>
<td>Size -&gt; Organizational complexity</td>
<td>0.5067</td>
<td>0.4133</td>
<td>0.74292303</td>
</tr>
<tr>
<td>Technological intensity -&gt; Organizational complexity</td>
<td>0.3086</td>
<td>-0.1953</td>
<td>6.68688743</td>
</tr>
<tr>
<td>Depth and breadth -&gt; Organizational complexity</td>
<td>0.1847</td>
<td>0.4147</td>
<td>1.65339901</td>
</tr>
</tbody>
</table>

Table 34: T-values for group comparison of path-coefficients between first and second quartile complexity groups.\textsuperscript{734}

The differences between the path coefficients of product diversity to market-driven organizational complexity, as well as the path between technological intensity and market-driven organizational complexity are significant on the 0.0001 level. Additionally, there is a significant difference regarding these sub-samples in the path between depth and breadth and market-driven organizational complexity on the 0.10 level. The overall correlation between market-driven organizational complexity and organizational performance shows no significant differences.

\textsuperscript{733} Own source.

\textsuperscript{734} Own source.
Comparing the second and the third group, it can be stated that the correlation between the market-driven organizational complexity and organizational performance is decreased. Hence, the importance of managing market-driven complexity (with the aim of being successful) declines. In detail, however, the paths between the drivers and market-driven organizational complexity show no significant differences, as presented in Table 35. Only two significant differences are given: the relationship between organizational performance and shareholder value and financial efficiency. While the first relationship is significant on the 0.1 level, the second is significant on the 0.05 level with respect to a two side t-test.
### Table 35: T-values for group comparison of path-coefficients between second and third quartile complexity groups.\(^{736}\)

<table>
<thead>
<tr>
<th>Path Coefficient</th>
<th>2(^{nd}) Quartile</th>
<th>3(^{rd}) Quartile</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change -&gt; Organizational complexity</td>
<td>0.3217</td>
<td>0.2835</td>
<td>0.6330636</td>
</tr>
<tr>
<td>Geographic diversity -&gt; Organizational complexity</td>
<td>0.231</td>
<td>0.249</td>
<td>0.29963714</td>
</tr>
<tr>
<td>Organizational Complexity -&gt; Organizational Performance</td>
<td>0.4875</td>
<td>0.3485</td>
<td>0.82252795</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial effectiveness</td>
<td>0.8945</td>
<td>0.9398</td>
<td>1.61937568</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial health</td>
<td>0.6868</td>
<td>0.5297</td>
<td>1.35747237</td>
</tr>
<tr>
<td>Organizational performance -&gt; Shareholder value</td>
<td>0.5171</td>
<td>0.2957</td>
<td>1.91088891</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial efficiency</td>
<td>0.7614</td>
<td>0.9089</td>
<td>2.13429554</td>
</tr>
<tr>
<td>Product diversity -&gt; Organizational complexity</td>
<td>-0.2494</td>
<td>-0.2763</td>
<td>0.32420422</td>
</tr>
<tr>
<td>Size -&gt; Organizational complexity</td>
<td>0.4133</td>
<td>0.3947</td>
<td>0.16756367</td>
</tr>
<tr>
<td>Technological intensity -&gt; Organizational complexity</td>
<td>-0.1953</td>
<td>-0.2683</td>
<td>0.95733247</td>
</tr>
<tr>
<td>Depth and breadth -&gt; Organizational complexity</td>
<td>0.4147</td>
<td>0.3604</td>
<td>0.57075529</td>
</tr>
</tbody>
</table>

\(^{736}\) Own source.

### Figure 41: Structural equation model with path coefficients and R\(^2\) for fourth quartile sub-group.\(^{737}\)

Evaluating the differences between the third and the fourth sub-sample of organizations, no significant differences in the correlation between complexity and performance can be

\(^{737}\) Own source.
confirmed. Due to this, the second multi-group comparison cannot confirm the fourth hypothesis.

**H4**

“The positive relationship between market-driven complexity and performance varies between different levels of market-driven organizational complexity.”

<table>
<thead>
<tr>
<th>Path Coefficient</th>
<th>3rd Quartile</th>
<th>4th Quartile</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change -&gt; Organizational complexity</td>
<td>0.2835</td>
<td>0.3462</td>
<td>1.16683573</td>
</tr>
<tr>
<td>Geographic diversity -&gt; Organizational complexity</td>
<td>0.249</td>
<td>0.2978</td>
<td>0.74085818</td>
</tr>
<tr>
<td>Organizational Complexity -&gt; Organizational Performance</td>
<td>0.3485</td>
<td>0.4217</td>
<td>0.4572563</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial effectiveness</td>
<td>0.9398</td>
<td>0.8833</td>
<td>2.54831268</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial health</td>
<td>0.5297</td>
<td>0.4219</td>
<td>0.68817187</td>
</tr>
<tr>
<td>Organizational performance -&gt; Shareholder value</td>
<td>0.2957</td>
<td>0.4524</td>
<td>1.08654633</td>
</tr>
<tr>
<td>Organizational performance -&gt; Financial efficiency</td>
<td>0.9089</td>
<td>0.8474</td>
<td>1.41890613</td>
</tr>
<tr>
<td>Product diversity -&gt; Organizational complexity</td>
<td>-0.2763</td>
<td>-0.178</td>
<td>0.95528063</td>
</tr>
<tr>
<td>Size -&gt; Organizational complexity</td>
<td>0.3947</td>
<td>0.5046</td>
<td>1.32516398</td>
</tr>
<tr>
<td>Technological intensity -&gt; Organizational complexity</td>
<td>-0.2683</td>
<td>0.4036</td>
<td>9.77266829</td>
</tr>
<tr>
<td>Depth and breadth -&gt; Organizational complexity</td>
<td>0.3604</td>
<td>-0.1316</td>
<td>4.85986234</td>
</tr>
</tbody>
</table>

Table 36: T-values for group comparison of path-coefficients between third and fourth quartile complexity groups.738

Regardless, three other paths show significant differences, as presented in Table 36. The constructs technological intensity and the depth and breadth of the business model have significantly different influences on market-driven complexity in total, which will be discussed in the next chapter. Furthermore, the differences in total effects between the subgroups, as shown in Table 37, will be discussed. It can be stated that the differences of product diversity and technological intensity on organizational performance are large and strongly related to significant differences of the path coefficients as shown above. Hence, the propositions P 2d and P 2f are confirmed.

738 Own source.
The following table summarizes the findings of the discussed hypotheses.

<table>
<thead>
<tr>
<th>Table 37: Differences in total effects of each driver of organizational complexity on organizational performance. 739</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LV</strong></td>
</tr>
<tr>
<td>Size</td>
</tr>
<tr>
<td>Product Diversity</td>
</tr>
<tr>
<td>Geographic Diversity</td>
</tr>
<tr>
<td>Fast Flux</td>
</tr>
<tr>
<td>Technological intensity</td>
</tr>
<tr>
<td>Depth and Breadth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 38: Results of testing hypotheses 4, 5 and Propositions P2a-f by multi-group comparisons. 740</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H 4</strong></td>
</tr>
<tr>
<td><strong>H 5</strong></td>
</tr>
<tr>
<td><strong>P 2a</strong></td>
</tr>
<tr>
<td><strong>P 2b</strong></td>
</tr>
<tr>
<td><strong>P 2c</strong></td>
</tr>
<tr>
<td><strong>P 2d</strong></td>
</tr>
<tr>
<td><strong>P 2e</strong></td>
</tr>
<tr>
<td><strong>P 2f</strong></td>
</tr>
</tbody>
</table>

739 Own source.
740 Own source.


6.3 Discussion

This section discusses the findings of the empirical study and in particular the results of the advanced statistics. As shown above, some very interesting significant correlations and group differences were detected, which will be examined in the following section. To do so, initially the propositions and hypotheses are discussed.

The first proposition that market-driven organizational complexity is a multi-dimensional construct was confirmed in chapter 5.2 by performing a factor analysis. As shown with the help of this statistical method, market-driven complexity is driven by six major drivers: interdependence, product diversity, geographic diversity, organizational change, technological intensity and business depth and breadth. Based on these findings, six propositions, which specified the relation between the drivers and the market-driven complexity, were defined. All six propositions are confirmed in a SEM and this confirms that market-driven complexity is a multi-dimensional construct. Since the study only incorporates indicators for the measurement of market-driven complexity it, is presumed that further dimensions of organizational complexity, which this study does not examine, exist. Hence, multi-dimensionality will be more multifaceted should organization-driven complexity be integrated into further studies. For the first time, the multi-dimensionality of organizational complexity was tested and confirmed empirically.

The overall research questions, How should organizations respond to growing environmental complexity?, was answered partially.

It was noted in chapter 2 that organizations face growing business environmental complexity, which is, amongst other things, caused by the characteristics of globalization. Chapter 3 offered a theoretical discussion about the fact that organizations have to differentiate between market-driven and organization-driven complexity when responding to this increase of business environmental complexity. It was therefore argued that organizations should respond to growing environmental complexity in different ways, depending on the character of organizational complexity.

The general hypothesis 1, that there is an inversely u-shaped relationship between organizational complexity and organizational performance, was not confirmed due to the limitation that only market-driven complexity was assessed in the measurement model. Accordingly, it was not possible to model the overall relationship. For example, the degree of standardization, the degree of formalization and the strength of organizational culture were not studied, although these were defined to be theoretically relevant drivers of organizational complexity. Since these complexity drivers are expected to have a negative total effect on
organizational performance – if the degree of standardization decreases, the organization-driven complexity rises and organizational performance will decrease – they are important for determining the inversely u-shaped correlation.

Additionally, it was not possible to confirm the hypothesized negative relationship between non-value-adding organizational complexity and organizational performance (H3).

Regarding hypothesis two (H2: There is a positive relationship between market-driven complexity and performance.), the presented results underline ASHBY’s postulate of the “complexity equivalence” as response to growing environmental complexity in the case of market-driven complexity. A positive relationship between market-driven complexity and performance was found and confirmed to be significant in the SEM.

Furthermore, it was hypothesized that the relationship between market-driven complexity and organizational performance varies with regard to the level of market-driven organizational complexity. By performing two multi-group comparisons, no significant differences with reference to the relationships were discovered. Hence, hypothesis 4 cannot be confirmed and Ashby’s “Law of Requisite Variety” turned out to apply to different levels of market-driven organizational complexity. If new market opportunities emerge out of growing business environmental complexity, organizations can be advised to incorporate additional complexity to enhance market-driven complexity.

In other words, the overall level of market-driven complexity does not determine the organizational performance in different ways regarding different levels of market-driven organizational complexity. This is an important finding since it confirms the overall positive effect of enhanced market-driven complexity on performance.

General advisory statements can be refined, by examining the influence of different drivers of market-driven complexity on performance.

Due to the fact that the influence of some drivers of market-driven complexity differ significantly among different levels of complexity, organizations have to be careful not to overly enhance market-driven complexity of specific dimensions. As discussed in chapter 3, the main reason for the changing total effect of the drivers of market-driven complexity on performance is the inseparable linkage of market-driven and organization-driven complexity. According to KEUPER’s categorization, which defines organization-driven complexity as either indirectly linked to the market or independent from the market, the following discussion will focus on the indirectly linked organizational complexity, as pure organizational complexity was not measured. The results of the empirical study confirm this inseparability, since they demonstrate that related organization-driven complexity can have a
significant impact on performance. As organization-driven complexity is defined to be less value creating, it can influence or even dominate the positive effect on performance of market-driven complexity. The postulated differences, pointed out in chapter 3, when studying the overall level of organizational complexity, already manifest on the level of the complexity drivers of market-driven complexity.

As shown in Figure 42, the increase of some specific drivers, such as product diversification, depth and breadth, or technological intensity, have a negative impact on the firm’s performance.

Especially the driver “product diversification” was detected to have a positive total effect on performance only in the lowest complexity group. As it already is on a relatively low level of total market-driven complexity, the overall effect on performance turned out to be negative. Hence, increasing product diversification further will not improve organizational performance.

It is likely that product diversification as driver of market-driven complexity causes a large proportion of organization-driven complexity as well. As was shown by the negative correlation between the driver "product diversification" and market-driven complexity in the second, third, and fourth sub-group, the driver did not enhance market-driven complexity but rather reduced it. Due to the fact that the enhancement of the driver actually causes organizational complexity, it is the internal or organization-driven complexity that increases.

When the product diversity grows, the organization becomes more difficult to manage and the immanent organization-driven complexity (multi-brand/channel conflicts, cannibalization of products and services) results in a negative effect on performance. Even if the negative total effect between sub-groups two, three and four varies slightly the differences are supposedly not significant. Thus, the negative influence of growing product diversity on performance remains constant if total organizational complexity grows further.

This empirical result emphasizes the importance of the dilemma discussed in section 2.3. Increasing market-driven organizational complexity, while responding to market demands, can cause serious internal challenges that have to be balanced if the organization aims at long-term success.
Two more drivers differ significantly with regard to their path on market-driven complexity and thus with relation to their total effect on performance – "depth and breadth" and "technological intensity". The driver “depth and breadth” has a negative total effect on performance only in the group of organizations with the highest “virtual complexity”. In all other groups of low and moderate complexity the influence is positive. The driver of depth and breadth is measured by expenditures for research and development and costs of goods sold to sales. In highly complex organizations, where the proportion of market-driven complexity is already high and the products require high expenditures for research and development, the further increase of these indicators does not lead to growing organizational performance. A possible explanation is that an increase of the depth of the business simultaneously leads to an increase of organization-driven complexity. Reasons for this are a heightened need for coordination, as well as potential conflicts of interests, which override the positive effects on performance. Hence, increasing the driver does not increase “positive” market-driven complexity but rather enhances organization-driven complexity.

The negative effect of the driver as a whole is also caused by the indicator expenditures for research and development. Taking a closer look at organizations with the highest proportions of expenditures for R&D to sales helps to understand this negative impact on performance. Organizations with high proportions of R&D to sales are often not able to accomplish all the

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741 Own source.
research themselves. As a result, increasing expenditures for R&D are often related to additional challenges like managing research alliances and other forms of cooperation. Hence, the proportion of organization-driven complexity grows and the total effect on performance decreases. Innovativeness becomes more and more expensive and ineffective.

The combination of both indicators and thus the driver itself has a negative impact on organizational performance because an increase is closely related to high proportions of organization-driven complexity.

As shown in Figure 42, technological intensity also has partially negative total effects on performance in the second and third quartile.

One possible reason for these differences is the market relatedness of the increase of technological intensity. If the market drives the investments or if the customer can benefit from the technological intensification, there will be a positive influence on overall performance. If the technological intensification does not add value for the customer, the relationship will be negative.

In low complex businesses and organizations, the increase of technological intensity measured by assets per employee is often related to economization and economies of scale, as discussed in section 2.2.1 and by REBELO/MENDES. Simple product lines with only few products become more and more effective by investing in more technological assets or new production plants. In line with the argumentation of chapter 3, the additional complexity is directly related to the customer needs – it leads to decreasing costs for the company and thus enables price reductions for customers without jeopardizing the company's margins. Even if increased technological intensity causes internal complexity as a consequence of increased training, as well as changes of processes and production structures, the positive outweighs the negative effect.

Considering the fourth quartile, it can also be states that the customer appreciates the technological intensification. The increasing technological intensity facilitates modern and asset-intensive production processes that result in high-technology goods with high quality standards. In a complex business environment with intense competition and elevated average asset intensity, a further increase enables the organization to add value for the customer that differentiates the company from its competitors. If the products fulfill the claims of the market and customers are willing to pay, the increased level of complexity results in performance increases of the organization because the negative effects are overridden.

In moderately complex organizations (quartile II and III) growing technological intensity

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appears to have a negative impact on the organizational performance, as shown in Figure 42. A possible explanation for this result is that an increase of technological intensity equally leads to growing organization-driven complexity as discussed above, but in this case the negative effects caused by the related organization-driven complexity outweigh the positive performance effects. Moderately complex organizations are stuck between low cost mass production and high-end products; hence they cannot differentiate themselves to establish a competitive advantage by increasing technological intensity. Nonetheless, the internal complexity increase does not lead to an improved organizational performance because it does not add sufficient value for the customer.

The multi-group comparison also exposes several significantly different path weights in the performance measurement model, which are worth mentioning. A very interesting finding is that the relationship between organizational overall performance and shareholder value differs between low and highly complex organizations. The difference is significant on a 0.0001 level with an absolute value of path weights from 0.4478 for the low and only 0.1443 for the high complex group. Hence, in complex organizations the overall performance is reflected in the development of the shareholder value only to a lower degree. Such being the case, it would be more effective for shareholders to invest in low complex organizations, like start-ups. If they are successful, the shareholder participates more in the development. Growing market-driven organizational complexity in low complex organizations leads on average to higher growth in shareholder value than the same increase of complexity in high complex organizations.

Also in the multi-group comparison of quartile separation, three significant path weight differences exist. Between the second and the third quartile, the relationship between organizational performance and shareholder value is different again. While the path weight in the second quartile is high, with 0.517, the value drops down to 0.29 in the third quartile. On the other hand, the correlation between organizational performance and financial efficiency increases from 0.761 to 0.909. This effect can be caused by economies of scale.

As shown in Table 36, the path between organizational performance and financial effectiveness differs significantly between the third and the fourth group. While the relationship in the third quartile is very high with 0.939, the fourth group accounts for only 0.883. This can be a hint that highly complex organizations face internal challenges that need additional efforts and resources, which do not adequately allow for the improvement of net income or market value added.

By summarizing the findings and the discussion, it can be pointed out that the theoretical model presented at the beginning of this thesis has to be refined.
The empirical study that is presented here is focused on the upper side of the framework presented in Figure 43.

As discussed before, the complexity equivalence postulated by Ashby is only meaningful with reference to market-driven complexity. More precisely, it was argued that a consistent positive effect on organizational performance could only be assumed with regard to the driver "size, globalization and organizational change". As long as the increase of size, geographic diversification and organizational change is related to market needs, complexity equivalence is an appropriate strategy.

In detail: if the demand of the business environment increases, a linear scaling of the size of the organization to fulfill these needs is an appropriate strategy. The same is true for the globalization. If new markets can be served with existing products on account of the increasing boundary erosion, rising levels of market-driven organizational complexity that are caused by an expansion strategy can be accepted. The positive effects of market-driven complexity on performance will overshadow the indirectly induced organization-driven complexity.

If business environment complexity enhances due to increasing change, a direct response of the organization is also appropriate – the organization must respond to changes of the environment to be successful.

With regard to the other drivers, the empirical study points out that they can also have a negative influence on performance, since the related increase of organization-driven

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743 Own source
complexity can override the positive impact of the market-driven complexity. Hence, organizations should carefully optimize the level of incorporated business environmental complexity. In particular, product diversification on a 4-digit SIC code level was found to provoke a significant increase of internal complexity that has negative an impact on the overall performance. Moreover, the advantages of insourcing parts of the value chain (increasing the proportion of value-creation within the own organization) instead of benefiting from work division in a specialized supply chain are limited. It was found that in organizations that are already complex, a further increase of the proportion of value-creation has a negative impact on the organizational performance. Additionally, the increase of technological intensity has to be optimized, as it always has a positive effect on performance if the enhancement creates additional value for customers or provides a competitive advantage for the organization.
7 Synopsis

The following section summarizes the findings and points out the implications for theory and for management. At the end of this chapter, recommendations for further research are discussed.

7.1 Summary

The thesis analyzed the phenomenon “complexity” from various perspectives. In the beginning, a general definition of complexity was given, and the relationship between complexity and globalization was examined. It was found that globalization and complexity are two highly interlinked phenomena. Globalization causes rising business environmental complexity for organizations, which have to respond to this development. Hence, complexity and globalization create the following major dilemmas for organizations:

- Fragmentation of markets vs. economies of scale,
- Multi-brand/channel conflict vs. internal cooperation,
- Local leadership vs. standardized processes,
- Short term profitability vs. long-term sustainability,
- Strategic flexibility vs. dominant logic,
- Core competencies vs. knowledge accumulation.

These dilemmas express the fundamental challenges in coping with growing complexity in practice. The presented discussion demonstrated that there is not even a clear theoretical recommendation on how organizations can cope with growing complexity. The postulates given by Ashby and Luhmann lead to an inconsistency that current research has not been able to solve. Consequently, the hypothesis that organizations should enhance (Ashby) or reduce (Luhmann) organizational complexity to cope with growing complexity in the business environment were discussed theoretically and tested empirically in this thesis.

The theoretical discussion required a differentiation between market-driven and organization-driven complexity, which enables a partial reconciliation of the inconsistency. If increasing business environment complexity challenges organizations, they have to carefully enhance the market-driven complexity of the organization and be aware of the value-creating and non-value creating character of this category of organizational complexity. Furthermore, to ensure success, they should reduce organization-driven complexity.

To empirically test this new theoretical framework, a comprehensive model for measuring
organizational complexity was developed. It contains 38 measurable indicators for measuring the four fundamental drivers of organizational complexity: diversity, interdependence, ambiguity and fast flux.

The empirical study focused on market-driven complexity and was based on a data sample of 305 organizations. Firstly, an Exploratory Factor Analysis was performed to identify the underlying dimensions (drivers) of market-driven complexity and to examine the theoretical assumptions of the four major drivers. It was found that market-driven complexity is driven by six factors: size, depth and breadth, organizational change, technological intensity, globalization, product diversification. Table 39 summarizes the relationship between the generic four-factor model of complexity and six-factor model of market-driven complexity.

<table>
<thead>
<tr>
<th>General dimensions</th>
<th>Diversity</th>
<th>Ambiguity</th>
<th>Fast Flux</th>
<th>Interdependence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drivers of market-driven organizational complexity</td>
<td>Size</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth and breadth</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organizational change</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technological intensity</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Globalization</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product diversification</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Table 39: Relationship between market-related drivers of organizational complexity and general drivers.

Secondly, a Structural Equation Model was designed to test the relationship between market-driven complexity and organizational performance. It showed that Ashby is right in his assumptions about market-driven complexity. A positive relationship was confirmed. In contrast to the theoretical assumption that this relationship would vary between different levels of market-driven organizational complexity, no significant differences were found. Furthermore, the Structural Equation Model confirmed that the relationships between the drivers and the construct of market-driven complexity are significant and therewith confirm the multi-dimensionality of the construct.

On the level of the drivers, significant differences were examined and it was noted that, for example, the driver product diversification has a negative impact on organizational
performance if the level of market-driven complexity increases. Only in the lowest complexity group the influence on performance was positive. Hence, managers need to be careful in enhancing the market-driven complexity.

Besides that, the multi-group comparison shows that the several dimensions of organizational performance are affected in different ways and on distinct levels of market-driven complexity. In particular, it was shown that growing market-driven complexity leads to significantly lower increases of shareholder value in highly complex organizations than in low complex ones.

### 7.2 Implications for theory

This thesis has far reaching implications for the theory of complexity science in two different aspects. Theoretically, the presented distinction between market-driven and organization-driven complexity allows for a partial reconciliation of the inconsistent approaches to how to respond to growing complexity in the system (business) environment. Research needs to carefully distinguish between the different kinds of organizational complexity since the approaches to either type differ. Furthermore, it was pointed out that a reductionistic approach for studying complexity is not appropriate and that measuring complexity is one of the core challenges for research in complexity science. Typical mistakes in measuring complexity were detected, categorized and discussed. As a result, future studies of complexity can be grounded on a more solid basis to avoid that faulty and inconsistent measures of complexity and particularly organizational complexity lead to incomparable and partially incorrect results in empirical studies.

As discussed in chapter 2.3.2, in complexity science, only few, limited empirical studies exist. Therefore, the comprehensive measurement model and empirical study performed in this thesis is a major contribution to existent research. The overall theoretical discussion on measuring organizational complexity leads to the conclusion that measuring the drivers of organizational complexity is appropriate for the indirect measurement of organizational complexity. It was found that a reductionistic approach of splitting complexity into parts is inappropriate and that one single indicator is inadequate in assessing complexity – only an indirect measurement of complexity's intrinsic characteristics (drivers) can overcome these difficulties. In consequence, the theoretically established measurement framework is a first step toward improving the quality of complexity theory.

By testing the theoretical assumptions, several important implications for theory were found. First, it was shown that organizational complexity is a multi-dimensional construct. In particular, it was confirmed that market-driven complexity is driven by six different factors.
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Thus, researchers should not limit their models to one overarching complexity indicator, but should rather incorporate multivariate drivers.

Second, it was shown that the distinction between these two main qualities of organizational complexity is meaningful, since the results (correlation between market-driven complexity and organizational performance) had the expected sign and were stable when tested for several sub-groups.

In sum, the thesis contributes to the advancement of complexity theory by establishing a solid basis for future empirical studies.

7.3 Implications for management

The theoretical discussion emphasized that organizations are embedded in a highly interdependent and fast changing business world – thus they face a high level of business environmental complexity that is continuously increasing. Complexity is ubiquitous in every organization and needs to be classified into two different qualities\textsuperscript{744} As shown by the empirical study, complexity is not a problem that has to be avoided; it is rather a challenge that has to be managed.\textsuperscript{745} As HEYWOOD, et al. emphasize, the development of an understanding of value creation within companies is the fundamental basis of complexity management.\textsuperscript{746} The findings of this thesis confirm that identifying and enhancing the organizational complexity that is related to market needs and value drivers will also enhance organizational performance. As a result, organizations must be open and adaptive.\textsuperscript{747}

Managing complexity is one of the main challenges for today’s managers.\textsuperscript{748} The distinction between market-driven and organization-driven complexity, however, makes the phenomenon more concrete and manageable. Depending on the current level of organizational complexity and performance, there are four generic strategies to actively manage organizational complexity in business environments with growing complexity (Figure 44). First, as shown by the empirical study, it is appropriate to carefully enhance market-driven complexity. Second, organizations should strengthen their complexity absorption capabilities when they are already confronted with a high level of organizational complexity. This implies balancing the organization-driven complexity that is related to market-driven complexity, since the positive

\textsuperscript{744} cf. Mahini, A. (1990), pg. 27; Heywood, S., et al. (2007), pg. 95.
\textsuperscript{745} cf. Maznevski, M., et al. (2007), pg. 4.
\textsuperscript{746} cf. Heywood, S., et al. (2007), pg. 85 et seq.
\textsuperscript{748} cf. Maznevski, M., et al. (2007), pg. 4.
effects on organizational performance should be dominant. Third, it can be concluded that simplifying is an imperative to managing purely organization-driven complexity – even if this was not directly measured in the empirical study, it was indicated by the impact of the related organization-driven complexity. Should this be disregarded, organization-driven complexity will overwhelm the organization. Simplification will enhance the ability to cope with high levels of market-driven complexity. Fourth, it is possible to reduce both kinds of organizational complexity and to strengthen complexity-reducing capabilities simultaneously.

![Figure 44: Matrix of generic strategies to manage organizational complexity.](image)

### 7.3.1 Enhancing market-driven complexity

If the company is located within the first sector with low organizational complexity and low success, managing complexity means carefully enhancing market-driven complexity. As shown in the empirical study, all six drivers of market-driven complexity have a positive total effect on the performance for low complex organizations. In general the margins and prospects for financial success in this section are low. Managers should carefully increase market-driven complexity, for example, through the introduction of additional services to the commoditized products or by technological intensification as discussed in section 6.3. Commoditization can be interpreted as the reduction of market-driven complexity to the

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minimum – in this case, this should be avoided.

Additionally, managers can embrace complexity by extending the scope of the business in terms of new products or geographical regions. When doing so, an examination of the value creation of the added complexity is highly important. In general, adding value will be more likely if it is possible to leverage the core competencies and capabilities without a major increase of organization-driven complexity.

7.3.2 Reducing organization-driven complexity or market driven complexity

As shown in the empirical study, the often cited Law of Requisite Variety (that an organization has to be as complex as its environment to cope efficiently with the external complexity) is only partially true. As discussed in the introduction, some global companies have attempted to be as complex as their business environment to a certain degree, and as a result have found themselves to be overwhelmed by the internal coordination requirements and the associated high transaction costs. Growing organization-driven complexity is the cause for rising transactions costs and ineffectiveness. These companies, being positioned in the second sector of the matrix in Figure 44, are not adequately internally aligned. Due to this fact, the second generic strategy is to reduce organization-driven complexity and realign the internal setup in terms of strategy, structure, processes, rewards and people. Even if pure organization-driven complexity was not measured in the empirically tested framework, the presented results show that the related organization-driven complexity has a negative impact on performance. This underlines the fact that increasing pure organization-driven complexity should be restricted or reduced to the fixed minimum.

Concrete measures are: The management in highly complex organizations needs to be reliable and consistent in its logic. Even if strategies tend to shift in some business segments, the management must provide a meaningful framework to the whole organization and to the decision makers in particular. This framework can be seen as dominant logic and refers to the knowledge structures that top managers use to make strategic decisions. It is a filter for strategic decision makers to interpret information and to transform decisions into organizational actions. A strong dominant logic will reduce ambiguity and diversity in decision-making and thus significantly reduces organization-driven complexity.

753 cf. Huff, A. S. (1982), pg. 120.
Another effective lever for the reduction of organization-driven complexity is to focus on identifying and reducing the degree of individual complexity by clarifying roles, refining key processes and developing appropriate coping skills and capabilities among employees and managers to understand complexity.\footnote{Heywood, S., et al. (2007), pg. 86.}

Refining key processes should include the standardization of the firm’s core processes, which should be based on comprehensive and accessible information platforms. Even if such processes change in the course of time, they will generate transparency, which is a key factor for accountability on the lower levels of an organization.\footnote{Maznevski, M., et al. (2007), pg. 8.}

Despite this option, the reduction of market-driven complexity can also constitute an appropriate strategy. Refocusing the strategy and limiting the scope or scale of business activities, can reduce related organization-driven complexity as well. As a consequence, the reduction of market-driven complexity can be a crucial step toward restructuring an organization to facilitate long-term success.

**7.3.3 Strengthening complexity absorption capabilities**

The companies of the third sector already cope with high levels of both market-driven complexity and organization-driven complexity. According to the empirical study, it is still worthwhile to further enhance the market-driven complexity. These companies, however, have to strengthen their complexity absorption capabilities. This implies balancing the organization-driven complexity that is induced by the enhancement of market-driven complexity in the organization. As shown by the multi-group comparison, the organizations must be aware of this interplay of market-driven and organization-driven complexity, since it can have a significant impact on the performance (Table 37).

The complexity absorption capabilities will increase if the organization incorporates additional complexity related to the market and customer needs in one area, while simultaneously reducing complexity in other areas to hold the system in balance at the edge of chaos. For example, if organizations incorporate additional complexity by the enlargement of product diversification, breaking into new markets with different cultures, or transforming the organization with a significant merger, they must simultaneously cope with induced complexity which can be counteracted by standardizing the reporting structures, formalizing the rules of each member and providing clear and simple strategies. The strength in managing complexity is based on global guidance and simple principles of giving a common sense and
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vision to dissimilar organizational parts.
If every manager within the company understands the business’ driving force and if there is a common knowledge about the fundamentals of the business’ profitability and competitive position, managers are guided in day-to-day decisions.756
A clearly defined strategy with a well-accepted set of core values and a directive set of behavioral values enables decentralization.757 Within a clear framework that provides stability and connectivity, the company can cope with peripheral diversity in a more effective way. Local adaptation, learning and experimentation will then provide a good basis for sustainable success while still being able to absorb complexity.

7.3.4 Strengthening complexity reduction capabilities

The fourth generic strategy is a complexity reduction response. These companies are often focused on niche markets and specific customer segments. The internal organizational arrangements are based on a more mechanistic understanding of the world and include high levels of control, centralization and formalization.758
Organizations that attempt to reduce complexity will emphasize codification and abstractions.759 Furthermore, they try to minimize the number of goals and strategic activities, they formalize and centralize structures and decision-making patterns and minimize the number of interdependencies necessary for their decisions.
Companies with a complexity reduction strategy simplify both market-driven and organization-driven complexity when focusing on specific customer segments. They decide to fulfill only well-chosen market demands and focus on this limited scope. Therewith, they achieve low levels of organizational complexity. Through focusing on the core business processes, success factors and customers, they excel at managing the remaining complexity. After developing these competencies, they are able to leverage these capabilities into different business models or enhance complexity again carefully. As shown by the empirical study (Figure 38), all drivers of market-driven complexity have a positive impact on organizational performance in low complex organizations. Consequently, the increase of complexity can easier be managed, if the organization starts from a low level of complexity.
The empirical study has confirmed that increasing market-driven complexity is in general an appropriate strategy to cope with growing business environmental complexity. Nonetheless,

756 cf. Ibid., pg. 8.
757 cf. Ibid., pg. 8.
759 Codification is defined as Specifying categories to which data are assigned, and abstraction is defined as limiting the number of categories that need to be considered in the first place.)
the multi-group comparisons have shown that managers have to be aware of the related consequences of their decisions while responding to the needs of the market. Depending on the level of immanent organizational complexity, the presented generic strategies are meant to be feasible approaches to coping with growing business environmental complexity. It becomes obvious that there is not one single right way or one unique strategy to successfully manage complexity. The approach to managing complexity depends on the current situation at hand, and the success of the organization depends on the capabilities of the company to manage the six fundamental drivers of market-driven complexity: product diversification, globalization, organizational change, depth and breadth, technological intensity, and size.

7.3.5 Balancing the central dilemmas

Based on the theoretical discussion, the results of the empirical study and the implications for management presented above, the following section will offer some recommendations for managing the central dilemmas caused by globalization and complexity discussed in chapter 2.3. Within this, the argumentation will go beyond the results of the empirical study. The empirical study focused on market-driven complexity however at this point the excluded indicators like formalization, culture and standardization have to be incorporated. Therein it is possible to demonstrate the implications that can be derived from answering the central research question (of how organizations should respond to growing environmental complexity from a practical point of view) in a more general sense, while incorporating the presented discussion and findings and highlighting the emerging challenges. Accordingly, this section will present selected examples from the business world to reflect the results.

7.3.5.1 Fragmentation of markets vs. economies of scale

As noted above, organizations are confronted with growing diversity of customer needs and a fragmentation of markets. The empirical findings showed that the total impact of enhancing product diversification in terms of number of different business segments (4-digit SIC code) and sales volume in the dominant business segment is only positive for organizations with low complexity. Hence, trying to fulfill all needs in these fragmented markets might not be the most appropriate strategy. Organizations as complex adaptive systems permanently co-evolve with their business environment and tend to incorporate the fragmentation of the market in their own organization. This so-called "co-evolution in pockets", as discussed in

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section 2.2.2.5.3, has a negative impact on the efficiency and limits the positive potential of economies of scale.

The balance between responding to the fragmentation of markets and economies of scales can be secured if the customization of products is performed as late as possible in the value chain. On the operational level, the enhancement of diversification has to be flanked or combined with consequent standardization of all non-visible parts of the product and the production processes. On the strategic level, an increase of diversification should be driven by a dominant logic or be based on long lasting core competencies that can be leveraged into that new business segment. In order to secure the focus and competitiveness of the organization, the management has to be cautious as increasing product diversification induces large amounts of organization-driven complexity which as a negative impact on the overall performance.

### 7.3.5.2 Multi-brand/channel conflict versus internal cooperation

Multi-brand/channel conflicts are a typical phenomenon of complex organizations. As shown in the empirical study (Figure 42), the enhancement of product diversity and the subsequent increase of brand and channel diversity in already highly complex organizations will result in a greater number of conflicts than in organizations with a low level of complexity. Positive feedback-loops will amplify internal competition and conflicts if the organization fails to implement rules and procedures to align the organization.

To cope with the additional internal conflicts organizations have to improve their complexity absorption capabilities by strengthening the corporate culture and managing the interdependencies actively. The definition of interfaces between the different entities with standardized communication- and problem-solving procedures will help to reduce conflicts. In line with the previous argumentation, the impact of brand differentiation should be situated at the latest possible position of the value chain to strive for potential synergies. To avoid internal conflicts, a strong common culture, values and norms and equitable rewarding structures should be ensured to enforce strong employee behavior alignment. To reduce the impact of organization-driven complexity, which is related to the increase of product diversification, and for the enhancement of internal cooperation, transparency and trust are important influence factors. Both transparency and trust significantly reduce ambiguity in the organization.\(^{761}\)

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\(^{761}\) Rawlins, B. (2008), pg. 4; Luhmann, N. (1979), pg. 15.
### 7.3.5.3 Local leadership versus standardized processes

The presented study did not capture the related dimension of the dilemma of local leadership versus standardized processes, since decentralization and standardization were not part of the measurement model. Nevertheless, it is possible to state that enhancing local leadership can only be successful if it is done with a clear strategic and operative framework. As the empirical results suggest, the related organization-driven complexity can have a negative impact on the performance. Hence, this internal complexity has to be balanced. If the organization grows, i.e. expands to new regions or enters with new products into different markets, the internal coordination requirements and the complexity increase. The reduction of this complexity can be achieved by decreasing internal interdependencies as well as diversity. Both should be addressed simultaneously to keep the organization balanced.

Organizations as complex adaptive systems need to transfer the power of decision-making from the high and central level to the border of the system to make fast and appropriate decisions. To avoid that co-evolution with the environment leads to a diversification of processes, goals, and behaviors, which would come along with an impairment of organizational coherence, the organization has to provide a balanced framework.

A conglomeration of only locally acting and adaptive subsidiaries in different markets is not characteristic of an effective global company. In order to be effective, the entire organization needs to leverage core competencies within its own network. Standardized core processes are the backbone of such a framework and with processes like accounting and reporting, it is possible to secure transparency, as well as to avoid the increase of ambiguity inside the organization. In addition, a strong corporate culture and a dominant logic will help to align a more decentralized and successful structure.

### 7.3.5.4 Short-term profitability versus long-term sustainability

According to the empirical studies’ results, enhancing market-driven complexity has a positive influence on both short- and long-term organizational performance. Nevertheless, it is crucial to find a balance between enhancing market-driven complexity and reducing organization-driven complexity, as the it has also been found that incorporating too much business environmental complexity in specific dimensions, such as product diversification, can have a detrimental effect on performance. To secure long-term sustainability, organizations should evolve and adapt steadily and avoid adding overwhelming degrees of complexity, e.g. through an unneeded prestigious merger. An expansion of the product

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762 Since organizational performance was partially measured for a one year and five year period.
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portfolio and an increase of the size of the organization should be introduced carefully to ensure sustainable co-evolution and adaptation to growing market complexity. Thereby, managing organizational complexity successfully always implies the management of processes and people. Especially employees as agents in the system are vital for the continuous evolution of the organization. The management has to utilize and secure these important resources of the company and avoid high fluctuation.

Furthermore, the empirical study has confirmed that increasing R&D investments and the proportion of value creation inside the company have a positive effect on organizational performance. Hence, organizations should not underestimate the importance of making appropriate investments in R&D that secure the future competitiveness instead of having a nearsighted focus on short-term profitability. Apart from that, the empirical study underlines the fact (Figure 42) that it becomes increasingly difficult to manage complexity and to secure long-term sustainability in already complex organizations, as increased innovativeness and proportion of value creation within one company cause significant related organizational challenges.

7.3.5.5 Strategic flexibility versus dominant logic

As mentioned before, strategic flexibility is needed while both long-term planning and linear approximation of trends are no longer appropriate. Furthermore it is important to secure a dominant logic behind different strategic actions. Only a strong focus combined with a clearly communicated dominant logic will reduce ambiguity for the employees and within the subsidiaries. General Electric and Emerson Electric are two companies that are prominent examples for such a successful balance. As mentioned in the introduction of this thesis, General Electric is one of the most complex organizations in the world. With more than 100 mergers and acquisitions (M&A) per year they change continuously. They are able to cope with this high level of complexity because of highly standardized core processes and a strong dominant logic. No matter what the business model of the acquired company looks like, the goal is to become the best player in its market within the next three years. Based on a transparent reporting structure, GE is able to assess and compare the development of each entity nearly in real time. As a result they can adequately manage the subsidiaries. In line with the theoretical discussion about organizations as complex adaptive systems in section 2.2.2.5, such a dominant logic – based on simple consistent rules – is an important enabler for decentralized co-evolution and emergent behavior that is aligned with the core principles of

763 Weick, K. E. (1979), pg. 50.
the organization. As shown in the empirical study, adapting to the changes in the environment through M&A activities can improve performance significantly (Figure 42). The impact on organizational performance is similar within all compared groups and thus the ability to manage such activities is important for all levels of complex organizations.

7.3.5.6 Core competencies versus knowledge accumulation

The empirical study has emphasized the significance of the dilemma of organizations to focus on their core competencies vs. accumulating knowledge in various fields to secure vital perspectives within changing business environments.

On the one hand, it was shown that incorporating additional market-driven complexity, like by increasing product diversification, R&D investments and proportion of value creation, which will lead to accumulation of competencies, has positive influence on performance. On the other hand it was shown that organizations could suffer from the related organization-driven complexity induced by the increase of market-driven complexity, which underlines the appropriateness of also concentrating on core competencies. Especially the impact of product diversification on performance has been found to be negative for organizations with an average level of complexity. A possible approach is to concentrate on related diversification. In this case the organization can leverage its core competencies into new areas to reduce the negative impact of the related organization-driven complexity.\(^\text{764}\)

Due to the positive influence of the other drivers of market-driven complexity, the empirical results also confirm that concentrating on core competencies is not a dominant strategy in business environments with growing complexity. For example, outsourcing reduces knowledge accumulation, but from the complexity perspective it implies significant changes. Even if the internal complexity is reduced in terms of divisions, products or employees, the number and intensity of relationships to suppliers increase. Only in highly complex organizations the overall effect of focusing on core competencies will improve performance. That is why these organizations should carefully reduce the scope of the company through outsourcing.

In conclusion, it can be stated that the performed empirical study enables a meaningful discussion about the core dilemmas brought about by complexity and globalization. Organizations that face growing business environmental complexity will be confronted with such dilemmas and have to actively manage and balance the related categories of organizational complexity.

Further research

7.4 Limitations and further research

The thesis and the presented theoretical discussion about the measurement of organizational complexity, as well as the empirical study establish a framework for further empirical research in the field of complexity studies.

The developed measurement model of organizational complexity was designed to avoid most of the misleading measurement approaches of measuring complexity. The empirical study is therefore based on a measurement model that neither measured imaginary complexity nor factors that are related but not intrinsic to organizational complexity. The measurement did not derive from a low level of complexity and is not based on a limited field of research. Furthermore, the measurement model did not use subjective measures, or minor number of quantities and qualities to assess organizational complexity. One remaining limitation of the presented measurement approach in this thesis is the use of quantitative analysis (Explorative Factor Analysis) and research tools (Structural Equation Model) to study the phenomenon of organizational complexity. These tools however did not strongly influence the approach, as discussed in section 5.1.1, which reduces the impact of this limitation to a minimum.

By using objective data from 307 organizations, it was possible to avoid the bias of self-report, as well as a small sample bias. Nevertheless, since the empirical study is based on the data of only one source (Thomson Database) a common method bias exists. It can be argued, however, that the common method bias did not alter the empirical results of this study. First, the objective data in the database is collected from three different primary sources of company data and second, the quality of the data is continuously verified by analysts and other institutions. Indeed, the value of such a database should be pointed out as for the first time, company data becomes available on large scales for a long period of time.

Based on the categorization and the defined measurement model for organizational complexity it is possible to test both the organization-driven complexity with an assumed negative correlation to organizational performance and the market-driven complexity with an expected positive correlation to organizational performance. Since the presented study was limited to market-driven complexity, further research is needed. Maybe other research methods such as case studies make it possible to consider the two qualities of complexity simultaneously to examine the presumed inversely u-shaped correlation.

Additionally, it can be studied if different drivers of organizational complexity challenge organizations in specific industries or if the overall correlation between organizational complexity and performance varies. Combined with the findings from CANNON/ST. JOHN, who developed a framework to measure business environmental complexity, it will be
possible to study the influence of the fit between organizational complexity and business environmental complexity on the performance.

In sum, it can be concluded that this thesis constitutes an important step toward improving complexity theory by taking it to a new stage with verifiable empirical studies.
VII Appendix

Appendix 1: Descriptive statistics

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Table 40: Descriptive statistic – value range of organizational characteristics.\(^{765}\)

\(^{765}\) Own source.
## Appendix 2: Correlation matrix

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<td>0.474</td>
<td>0.288</td>
<td>0.548</td>
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Note: Correlation values are rounded to two decimal places.
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<th>Table 41: Correlation matrix.766</th>
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<td>tf.ResearchDevelopmentT oSales5Yr/Av gy06</td>
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<td>.395</td>
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<td>.159</td>
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</table>

766 Own source.
### Appendix 3: Inverse correlations matrix

| tf.TotalAssetesy06 | tf.Salesy06 | tf.EmplOyeesy06 | ForeignSalesy06 | Interna|tnalAsssetsTo|TotalAssets | tf.Re|seArch|andDevelopment|ToSalesy06 | tf.A|ssetPer|Employee5YearAvgy06 | tf.AssetPer|Employee5YearAvgy06 | tf.InternationalAssetesy06 | tf.ForeignSalesy06 | MAVolumenmen2006Total | MAVolumenmen2006Sold | MANumber2006 | MAVolumeSsegments06 | ws.RestructuringExpensey06 | NumberofBusinessSegments |
|-------------------|------------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------------|----------------|---------------------------|---------------------|----------------|-----------------------|------------------------|----------------|----------------------|
| 7.026             | -3.115     | -2.71           | -2.022          | 1.218          | -3.311         | 0.955           | -0.405         | -0.311         | -0.262         | -0.698         | -2.995                     | 0.685           | 0.287                     | 0.006               | 0.301          | -0.947                | 0.194                   | -0.751               | -1.163               |
| -3.115            | 20.648     | -3.383          | 2.986           | -1.299         | -0.535         | -0.400          | -11.746        | 3.308           | -0.421         | -1.716         | 1.315                     | 2.295           | 0.144                     | -6.413              | -2.636         | 0.535                 | 0.918                     | 1.959               | -0.084               |
| -2.71             | -3.383     | 3.335           | 0.62            | 0.033          | 0.124          | 0.586           | 0.869           | 0.018           | 0.760          | 0.580          | 0.532                     | 0.093           | -0.338                    | 0.249               | 0.649          | 0.005                 | -0.262                    | -0.381             | 0.044                |
| -2.022            | 2.986      | 3.881           | -2.074          | 0.244          | -1.089         | 0.688           | 0.347           | -0.688         | 0.798          | -2.488         | 0.900                     | 1.739           | -1.333                    | 0.126               | 0.073          | -0.147                | -0.485                    | 0.086               | 0.255                |
| 1.218             | -1.299     | 0.033           | 2.074           | 2.978          | 0.003          | 0.105           | 0.692           | 0.369           | -0.511         | 0.587          | 0.607                     | -2.488         | 0.900                     | -1.333             | 0.034          | -0.294                | 0.323                     | -0.182             | 0.016                |
| -0.331            | 0.535      | 0.124           | 0.244           | 0.003          | 17.646         | -16.949         | 0.060           | 0.495           | 2.102          | 1.487          | 1.028                     | -0.244         | 0.189                     | 0.432               | 0.465          | 0.599                 | 0.505                     | 0.565               | 0.387                |
| -0.332            | 0.003      | 17.646          | -16.949         | 18.285         | -0.233         | 0.342           | -0.508          | -1.077         | 1.019          | -0.123         | 1.701                     | -0.398         | 1.188                     | 0.309               | -0.283         | -0.566                | 0.657                     | -0.574             |                      |
| 0.405             | -11.746    | 0.069           | -1.089          | 0.692          | 0.060          | 0.233           | 10.628          | -3.438          | -0.445         | 0.303          | -0.303                    | -1.382         | 0.353                     | 2.409               | 0.914          | 0.048                 | 0.791                     | -0.849             | 0.180                |
| -0.311            | 3.308      | 0.018           | 0.688           | 0.009          | 0.342          | -3.438          | 3.130           | 0.237           | 0.092          | 0.137          | 0.688                     | -0.220         | 0.080                     | 0.122               | 0.061          | 0.003                 | -0.006                    | 1.200               |                      |
| -0.819            | -0.421     | 0.760           | 0.347           | 0.511          | 2.102          | -0.508          | -0.445          | 0.237           | 31.284         | 0.936          | 0.622                     | 2.817          | -29.846                    | -1.360              | -0.326         | 0.516                 | 0.341                     | -293               | 0.385                |
| -2.626            | 2.176      | 0.560           | -0.688          | 0.007          | 1.487          | -1.077          | 0.303           | -0.082         | 0.936          | 13.935         | 13.047                    | 0.435           | 0.377                     | 1.199               | 0.389          | 0.145                 | 0.496                     | -0.498             | 0.288                |
| -0.698            | 1.315      | 0.532           | 0.798           | 0.007          | 10.268         | -1.028          | 0.019           | 0.303           | 10.044         | 0.007          | 0.109                     | 0.109           | 0.007                     | 0.576               | -0.262         | -0.564                | 0.536                     | 0.084               |                      |
| -2.995            | 2.295      | 0.093           | 1.553           | 1.248          | 4.15           | 0.123           | 1.382           | 0.688           | 2.817          | 0.435          | 0.579                     | 5.156           | 0.267                     | 2.873               | 0.109          | 0.007                 | 0.576                     | -0.364             | 0.536                |
Table 42: Inverse correlation matrix.\textsuperscript{767}

\begin{table}[h]
\centering
\begin{tabular}{cccccccccccc}
\hline
\text{tf.ResearchD} & \text{evelopmentToSalesYrAvg} & \text{06} & \text{tf.ForeignSales} & \text{06} & \text{MAVolume2} & \text{006Total} & \text{MAVolume2} & \text{006Sold} & \text{MANumber20} & \text{06} & \text{MAVolume} & \text{t} & \text{oS}alesY} & \text{06} & \text{ws.ReststructuringExpense} & \text{06} & \text{Number.Busi} & \text{nessSegmen} & \text{ts} \\
\hline
0.685 & 0.144 & -0.338 & -0.910 & 0.900 & -2.244 & 1.701 & 0.353 & -2.20 & -29.846 & -3.77 & 0.375 & -2.672 & 30.216 & 1.282 & 0.261 & -0.388 & -1.122 & 0.241 & -0.395 & -0.286 \\
-0.287 & -6.413 & 0.249 & -3.897 & 1.739 & 0.189 & -0.398 & 2.409 & -0.973 & -1.360 & 1.199 & -0.965 & -2.873 & 1.282 & 8.189 & 0.329 & -0.289 & -0.081 & -0.287 & -0.311 & -0.193 \\
0.006 & -2.836 & 0.649 & 0.126 & -0.133 & 0.432 & -0.188 & 0.914 & -0.080 & -0.326 & 0.389 & -0.492 & 0.109 & 0.261 & 0.329 & 5.043 & -1.041 & 0.099 & -3.488 & -1.191 & 0.175 \\
-0.301 & 0.535 & 0.005 & 0.073 & 0.034 & -0.465 & 0.309 & -0.048 & 0.122 & 0.516 & -0.145 & 0.150 & -0.388 & -0.289 & -0.1041 & 2.050 & -0.356 & -0.309 & -0.167 & 0.199 \\
-0.947 & -0.918 & -0.262 & -0.147 & 0.294 & 0.509 & -0.283 & 0.791 & 0.061 & 0.341 & 0.496 & -0.500 & 0.576 & -0.122 & -0.081 & 0.099 & -3.356 & 2.152 & -0.441 & 0.085 & -1.189 \\
0.194 & 1.969 & -0.381 & -0.485 & 0.323 & 0.505 & -0.566 & -0.849 & 0.003 & -0.293 & -0.498 & -0.527 & -0.364 & -0.241 & -0.287 & -3.488 & -0.309 & -0.441 & 4.299 & -1.153 & -0.201 \\
-0.751 & -0.084 & 0.044 & 0.086 & -0.182 & -0.565 & 0.657 & 0.180 & -0.006 & 0.385 & 0.288 & -0.160 & 0.536 & -0.395 & -0.311 & -0.191 & 0.167 & 0.085 & -1.153 & 1.352 & -0.011 \\
-0.163 & -0.709 & 0.438 & 0.255 & 0.016 & -0.387 & -0.574 & 0.411 & 1.200 & -0.275 & -0.031 & -0.235 & 0.084 & -0.286 & -0.193 & 0.175 & 0.199 & -0.189 & -0.201 & -0.011 & 2.089 \\
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\textsuperscript{767} Own source.

XIX
## Appendix 4: Kolmogorov-Smirnov-test of goodness of fit

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a  the tested distribution is a normal distribution
b  calculated from the data

Table 43: Test for normality- Kolmogorov-Smirnov. \(^{768}\)
### Appendix 5: Test for normality

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*a Significance correction by Lilliefors

Table 44: Test for normality – Shapiro-Wilk.\(^{769}\)

\(^{769}\) Own source
## Appendix 6: Anti-Image-matrices

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</table>

a Measure of sample adequacy

Table 45: Anti-Image-matrix.\textsuperscript{770}

\textsuperscript{770} Own source.
Appendix 7: Factor matrix

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Extraction method: Principle component analysis
a 6 factors extracted. 18 iteration were needed.

Table 46: Factor matrix.\textsuperscript{771}

\textsuperscript{771} Own source.
Appendix 8: Factor transformation matrix

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<tr>
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</table>

Extraction method: Principle component analysis
Rotation method: Varimax with Kaiser-Normalization

Table 47: Factor transformation matrix.
## Appendix 9: Accounting-based measures of organizational performance

<table>
<thead>
<tr>
<th>Measure</th>
<th>Verbal explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash flow from operations</td>
<td>This accounting measure is used to examine whether cash flow differs significantly from earnings. It is defined as net operating profit plus non-cash expenses minus non-cash sales.</td>
</tr>
<tr>
<td>Earnings before interest and taxes (EBIT)</td>
<td>This basic measure is often recorded on accounting statements as operating profit. This is the firm’s profit, which is defined as revenues minus costs of goods sold and administrative and selling costs being associated with the firm’s operations. Interests and taxes the firm must pay are not deducted in the calculation of EBIT.</td>
</tr>
<tr>
<td>Earnings before interest, taxes, depreciation and amortization (EBITDA).</td>
<td>Like EBIT, EBITDA is defined as the firm’s operating profit and does not make any allowances for interest and taxes that must be paid. It is also adjusted to remove the effects of non-cash expenses such as depreciation and amortization (these are deducted from the cost component).</td>
</tr>
<tr>
<td>Net operating profits (also termed earnings)</td>
<td>This is equal to the firm’s revenues minus the costs of goods sold and minus sales, general and administrative expenses. Taxes and interest are removed to calculate this net figure.</td>
</tr>
<tr>
<td>Net operating profit less adjusted taxes (NOPLAT) also referred to as Net operating profit after tax (NOPAT)</td>
<td>This measure is similar to net operating profit, but is adjusted to remove several accounting distortions. It provides a cash-based measure of net operating profit. Typically this requires subtracting taxes after making adjustments for the impact of tax deferrals and taxes on interest and non-operating income, adding back-lease expenses and unwinding the amortization of goodwill. Some consultants make up to 160 adjustments. Interest costs are not subtracted, this is important as this measure is often used in EVA calculations that take interest costs into account by allowing for the cost of capital separately.</td>
</tr>
<tr>
<td>Profit margin</td>
<td>The ratio of net operating profit to sales.</td>
</tr>
<tr>
<td>Return on assets (ROA)</td>
<td>This is a very popular accounting measure of performance. It is defined as the ratio of net operating profit to the firm’s assets recorded on its balance sheet.</td>
</tr>
<tr>
<td>Return on capital employed (ROCE) and also known simply as return on capital (ROC)</td>
<td>ROCE is a measure of how well a firm is utilizing capital to generate revenue. It is defined as EBIT divided by employed capital. Employed capital includes long-term debt and is equal to total assets less current liabilities and the value of intangible assets.</td>
</tr>
<tr>
<td>Return on equity (ROE)</td>
<td>A measure of how much the firm generates for its owners, ROE is equal to net profit divided by the book value of shareholder’s equity. Shareholder’s equity usually includes the value of reserves because these could be cashed out to shareholders.</td>
</tr>
</tbody>
</table>
## Return on investment (ROI)
This is a leading traditional measure. ROI is usually defined as the ratio of net operating profit to the net book value of assets. The net book value of assets is equal to the firm’s assets less the value of intangibles and total liabilities. In recent times an increasing number of publications use NOPLAT and other adjusted profit measures as the numerator.

## Return on invested capital (ROIC)
This increasingly popular measure is defined as the ratio of NOPLAT to the firm’s invested capital. Invested capital is defined as total assets less excess cash and the value of non-interest bearing current liabilities. These two adjustments to total assets are intended to remove the effects of assets that do not need to be supported by capital.

## Return on net assets (RONA)
This measure focuses on the assets which the firm needs to generate its profit. It is calculated as the ratio of NOPLAT to net assets. Net assets are defined as fixed assets plus cash plus required working capital. This measure is closely related to EVA, as it is sometimes defined as EVA = (RONA – WACC) x Invested Capital.

## Return on Sales (ROS)
This is the ratio of net operating profit to sales made by the firm in the period.

## Return on total assets
This is the ratio of earnings available to common stock holders to the firm’s assets. This is virtually identical to return on assets, the use of ‘total’ in the name signals that net profit (earnings) is adjusted to remove dividends for preference shares and other non-residual claims (though most versions of ROA also do this anyway).

## Risk-adjusted return on capital (RAROC), also known as return on risk-adjusted capital (RORAC)
This measure is used primarily by financial institutions. It is defined as the ratio of risk-adjusted earnings to economic capital employed. Here the capital employed is evaluated relative to the market, credit and operational risk involved. The results of a RAROC model are then generally used in calculating EVA or another measurement that accounts for risk.

## Sales
This is the firm’s revenue from goods sold.

## Sales Growth
This is the change in sales over the period, expressed as the difference between sales of the last period and those of this period as a percentage of the sales of the last period.

## Variance in accounting profitability
A common accounting measure of risk is to use the variance in accounting profitability. This is often based on the volatility of one of the returns, such as ROA or ROI.

Table 48: Accounting-based measures of organizational performance.772

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**Appendix 10: Financial market measures of organizational performance**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Verbal Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return on Shareholder's Funds (ROSF)</td>
<td>A measure of how much the firm generates for its owners, ROSF is equal to net profit divided by the book value of shareholder’s equity. Shareholder’s equity usually includes the value of reserves as these could be paid out to shareholders. ROSF is equivalent to Return on Equity (ROE).</td>
</tr>
<tr>
<td>Change in market value (deltaMV)</td>
<td>This is the change in total value of a firm’s common stock (which represents the residual value of the firm’s resources) over the period of analysis (usually 1 year). It is equal to the number of outstanding shares multiplied by their current stock price.</td>
</tr>
<tr>
<td>Total shareholder return (TSR)</td>
<td>Captures the gain (loss) made by shareholders during the period (generally each year). TSR is the sum of the change in stock price during the year plus any dividends paid out, expressed as a percentage of the opening value of the stock.</td>
</tr>
<tr>
<td>Beta coefficient</td>
<td>The $\beta$-coefficient from the capital asset pricing model (CAPM). This is a measure of the level of systematic risk associated with the individual firm relative to the market portfolio.</td>
</tr>
<tr>
<td>Earnings per share (EPS)</td>
<td>This is a traditional measure of firm value. It is equal to net operating profit minus dividends paid to preference shares divided by the number of common stocks issued.</td>
</tr>
<tr>
<td>Jensen’s alpha</td>
<td>This is the $\alpha$-coefficient from the CAPM. Jensen’s alpha is a measure of a firm’s excess return over that associated with the systematic risk of its operations. That is, this captures unique exceptional positive or negative performance.</td>
</tr>
<tr>
<td>Market value (or market capitalization)</td>
<td>This is the total value of a firm’s common stock (which represents the residual value of the firm’s resources). It is equal to the number of shares outstanding multiplied by their current stock price.</td>
</tr>
<tr>
<td>Price-to-earnings ratio (P/E ratio)</td>
<td>The P/E ratio is a common method of comparing firm valuations. It is defined as the ratio of the current stock price to the annual earnings per share the firm pays out.</td>
</tr>
<tr>
<td>Stock price</td>
<td>This is the price of the firm’s listed common stock.</td>
</tr>
<tr>
<td>Total shareholder return (TSR)</td>
<td>Captures the gain (loss) made by shareholders during the period (generally each year). TSR is the sum of the change in stock price during the year plus any dividends paid out, expressed as a percentage of the opening value of the stock.</td>
</tr>
<tr>
<td>Tracking stocks</td>
<td>Securities issued which pay dividends based on the performance of some subset of the firm’s divisions (usually those from a single business unit). These provide a purer reflection of the performance of a firm’s divisions (and are especially useful for multi-industry firms).</td>
</tr>
</tbody>
</table>

Table 49: Definitions of different financial market measures.773

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### Appendix 11: Financial market measures of organizational performance

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Balanced scorecard</strong></td>
<td>The balanced scorecard is a framework that unites multiple measures aiming at financial performance, internal business processes, customer perspectives, innovation and learning. The aim is to empower firms to build a comprehensive performance measurement system.</td>
</tr>
<tr>
<td><strong>Cash flow per share</strong></td>
<td>This is defined as the cash flow from operations minus precedent stock dividends divided by the number of common outstanding shares. This is a measure of the cash flow being associated with each share.</td>
</tr>
<tr>
<td><strong>Cash flow return on investment (CFROI)</strong></td>
<td>This is an inflation-adjusted approximation of the internal rate of return earned by a company over all its operating assets. Normally this is done by discounting cash flow projections that are based on ROI.</td>
</tr>
<tr>
<td><strong>Cash value added (CVA)</strong></td>
<td>The CVA is the difference between a firm’s operating cash flow (OCF) and the operating cash flow demand (OCFD) that it must pay to shareholders. The OCF is the firm’s EBITDA (which only includes cash effects) less any working capital changes and non-strategic investments made during the period. The OCFD is defined as the investors’ opportunity cost of the investment in cash terms. This provides a dollar value estimate of the net performance of the firm.</td>
</tr>
<tr>
<td><strong>Discounted cash flows (DCF)</strong></td>
<td>This is the present value of future cash flows. These are discounted for the time-value of money, usually at the firm’s WACC. DCF models then compare future free cash flows to the debt and other cash investments required to support them.</td>
</tr>
<tr>
<td><strong>Economic Value Added (EVA), the generic name for this is economic profit</strong></td>
<td>This highly popular measure adjusts accounting earnings for the cost of capital. It is normally defined as NOPLAT-(WACC x Invested Capital). The WACC is usually calculated approximately, for example by the risk free-rate plus 6% multiplied by the firm’s beta.</td>
</tr>
<tr>
<td><strong>Free cash flows</strong></td>
<td>Free cash flows are the cash flows remaining for shareholders after all other claimants are being paid. For each period they are defined as the firm’s net operating profit minus taxes, operating investment required to sustain the firm, and any additional working capital requirements. These are key components of DCF calculations, which discount them back to present values.</td>
</tr>
<tr>
<td><strong>Internal rate of return (IRR)</strong></td>
<td>The IRR is the discount rate that results in the NPV of a series of future cash flows being generated from an investment with the value of zero.</td>
</tr>
<tr>
<td><strong>Market-to-book value</strong></td>
<td>The ratio of an organization’s market value to the book value of assets.</td>
</tr>
<tr>
<td><strong>Market value added (MVA)</strong></td>
<td>Is defined as the market value of the firm less the book value of debt and equity. Therefore, it represents the excess value of the firm over the capital used to support it.</td>
</tr>
<tr>
<td><strong>Net present value (NPV)</strong></td>
<td>NPV is the difference between the present value (PV) of discounted future cash flows and the investment required to earn them.</td>
</tr>
</tbody>
</table>
### Shareholder value analysis (SVA)
This measurement approach assesses shareholder value as the residual value of the firm. Shareholder value is equal to corporate value minus debt. Corporate value is calculated by discounting future earnings at the cost of capital (or weighted average of the cost of debt and equity) and adding a residual value to capture the present value of cash flows outside the discounted period plus the current value of any liquid assets (such as cash or marketable securities) (Rappaport, 1986).

### Tobin’s Q
This measure is the ratio of the market value of the firm’s assets to their replacement costs. The market-to-book value is often used as a proxy because the replacement cost of the firm’s assets is difficult to estimate.

### Total business return (TBR)
TBR is closely associated with CFROI. It adopts an approach similar to TSR but is based on cash flows. TBR is defined as the terminal value of business less cash investments made during the period plus cash flow received during the period.

### Warranted equity value (WEV)
WEV is a modification of EVA used by financial institutions. Here the cost of capital is calculated based on capital-at-risk (due to the prudential requirements applying to banks).

### Weighted average cost of capital (WACC)
This is a measure of the cost the firm must pay for the capital it employs. It is the weighted average of the cost of debt and the cost of equity. The cost of debt is usually adjusted to reflect the tax-deductibility of interest expenses.

### Z-score
Developed by Altman (1968), the Z-score provides an indication of the likelihood of a firm to go bankrupt. It is based on a linear model of 5 common financial ratios: working capital/total assets, retained earnings/total assets, EBIT/total assets, market value of equity/ book value of total liabilities and sales/total assets.

### Table 50: Mixed market and accounting measures

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774 Devinney, T. M., et al. (2005), pg. 31.
### Appendix 12: Item to total statistics

<table>
<thead>
<tr>
<th>Item-Scale-Statistic</th>
<th>Scale average if the item is removed</th>
<th>Scale variance if the item is removed</th>
<th>Adjusted Item-Scale-correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach’s Alpha, if the item is removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.EarningsBeforeInterestAndTaxesy07</td>
<td>-.07542961586</td>
<td>6.779</td>
<td>.890</td>
<td>.943</td>
<td>.938</td>
</tr>
<tr>
<td>ws.MarketValueAddedeyJ07</td>
<td>-.14447599398</td>
<td>6.175</td>
<td>.860</td>
<td>.813</td>
<td>.949</td>
</tr>
<tr>
<td>tf.NetIncomey07</td>
<td>-.12394544990</td>
<td>6.914</td>
<td>.922</td>
<td>.950</td>
<td>.931</td>
</tr>
<tr>
<td>tf.MarketValueConsolidatedy07</td>
<td>-.09816763465</td>
<td>6.265</td>
<td>.896</td>
<td>.829</td>
<td>.936</td>
</tr>
</tbody>
</table>

Table 51: Item-to-Scale-statistic for the performance dimension effectiveness.\(^{775}\)

<table>
<thead>
<tr>
<th>Item-Scale-Statistic</th>
<th>Scale average if the item is removed</th>
<th>Scale variance if the item is removed</th>
<th>Adjusted Item-Scale-correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach’s Alpha, if the item is removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.ReturnOnAssetesy07</td>
<td>-.07384529310</td>
<td>5.239</td>
<td>.849</td>
<td>.889</td>
<td>.835</td>
</tr>
<tr>
<td>tf.ReturnOnInvestedCapital5YrAvgy07</td>
<td>-.02851087487</td>
<td>6.004</td>
<td>.814</td>
<td>.691</td>
<td>.839</td>
</tr>
<tr>
<td>tf.WtdCostOfEquityy07</td>
<td>.00471691655</td>
<td>8.377</td>
<td>.719</td>
<td>.616</td>
<td>.892</td>
</tr>
</tbody>
</table>

Table 52: Item-to-Scale-statistic for the performance dimension efficiency.\(^{776}\)

<table>
<thead>
<tr>
<th>Item-Scale-Statistic</th>
<th>Scale average if the item is removed</th>
<th>Scale variance if the item is removed</th>
<th>Adjusted Item-Scale-correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach’s Alpha, if the item is removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.TotalAssetesy07</td>
<td>-.40783948308</td>
<td>14.414</td>
<td>.849</td>
<td>.819</td>
<td>.862</td>
</tr>
<tr>
<td>tf.Salesy07</td>
<td>-.42865936827</td>
<td>12.284</td>
<td>.931</td>
<td>.966</td>
<td>.842</td>
</tr>
<tr>
<td>ws.InternationalAssetesy07</td>
<td>-.44511595043</td>
<td>15.923</td>
<td>.587</td>
<td>.615</td>
<td>.888</td>
</tr>
<tr>
<td>tf.ForeignSalesy07</td>
<td>-.42203188666</td>
<td>13.254</td>
<td>.838</td>
<td>.876</td>
<td>.856</td>
</tr>
<tr>
<td>MAAnzahl2007</td>
<td>-.42433258519</td>
<td>15.798</td>
<td>.449</td>
<td>.438</td>
<td>.900</td>
</tr>
<tr>
<td>ws.BusinessSegment1Salesy07</td>
<td>-.42883589731</td>
<td>12.937</td>
<td>.831</td>
<td>.928</td>
<td>.856</td>
</tr>
<tr>
<td>tf.Employeeesy07</td>
<td>-.48312983954</td>
<td>14.087</td>
<td>.480</td>
<td>.678</td>
<td>.911</td>
</tr>
</tbody>
</table>

Table 53: Item-to-Scale-statistic for the market-driven complexity dimension size.\(^{777}\)

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\(^{775}\) Own source.

\(^{776}\) Own source.

\(^{777}\) Own source.
### Appendix

#### Table 54: Item-to-Scale-statistic for the market-driven complexity dimension product diversity.

<table>
<thead>
<tr>
<th>Item-Scale-Statistic</th>
<th>Scale average if the item is removed</th>
<th>Scale variance if the item is removed</th>
<th>Adjusted Item-Scale-correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach's Alpha, if the item is removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>dominateBSInverted</td>
<td>0.00877934317</td>
<td>1.003</td>
<td>.717</td>
<td>.514</td>
<td>(.a)</td>
</tr>
<tr>
<td>AnzahldeBSy07</td>
<td>0.01405777438</td>
<td>1.007</td>
<td>.717</td>
<td>.514</td>
<td>(.a)</td>
</tr>
</tbody>
</table>

*The value is negative since the average covariance between the items is negative. It is advised to check the item coding.*

#### Table 55: Item-to-Scale-statistic for the market-driven complexity dimension depth and breadth.

<table>
<thead>
<tr>
<th>Item-Scale-Statistic</th>
<th>Scale average if the item is removed</th>
<th>Scale variance if the item is removed</th>
<th>Adjusted Item-Scale-correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach’s Alpha, if the item is removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.ResearchAndDevelopme ntToSalesy06</td>
<td>-.03300176183</td>
<td>6.715</td>
<td>.775</td>
<td>.975</td>
<td>.866</td>
</tr>
<tr>
<td>tf.ResearchDevelopmentToSales5YrAvgy07</td>
<td>-.03328624003</td>
<td>6.690</td>
<td>.768</td>
<td>.975</td>
<td>.868</td>
</tr>
<tr>
<td>Costofgoodsoldtosalesinver ted5YAvrg</td>
<td>-.01765189126</td>
<td>6.615</td>
<td>.785</td>
<td>.966</td>
<td>.862</td>
</tr>
<tr>
<td>Costofgoodsoldtosalesinverterd</td>
<td>-.01726331714</td>
<td>6.738</td>
<td>.756</td>
<td>.965</td>
<td>.873</td>
</tr>
</tbody>
</table>

#### Table 56: Item-to-Scale-statistic for the market-driven complexity dimension technological intensity.

<table>
<thead>
<tr>
<th>Item-Scale-Statistic</th>
<th>Scale average if the item is removed</th>
<th>Scale variance if the item is removed</th>
<th>Adjusted Item-Scale-correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach’s Alpha, if the item is removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>tf.AssetsPerEmployeey07</td>
<td>-.04169828370</td>
<td>.949</td>
<td>.968</td>
<td>.938</td>
<td>(.a)</td>
</tr>
<tr>
<td>tf.AssetsPerEmployee5YrAvgy07</td>
<td>-.03783339062</td>
<td>.993</td>
<td>.968</td>
<td>.938</td>
<td>(.a)</td>
</tr>
</tbody>
</table>

*a The value is negative since the average covariance between the items is negative. It is advised to check the item coding.*

---

778 As mentioned at the beginning of the empirical study the indicator dominated business segment was inverted to have the same sign. This could cause this statistical problem.

779 Own source.

780 Own source.

781 Own source.
### Item-Scale-Statistic

<table>
<thead>
<tr>
<th>Item-Scale-Statistic</th>
<th>Scale average if the item is removed</th>
<th>Scale variance if the item is removed</th>
<th>Adjusted Item-Scale-correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach’s Alpha, if the item is removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAVolumentoSalesy07</td>
<td>.00854347908</td>
<td>4.339</td>
<td>.782</td>
<td>.613</td>
<td>.910</td>
</tr>
<tr>
<td>MAVolumen2007Total</td>
<td>.00715819342</td>
<td>4.126</td>
<td>.854</td>
<td>.740</td>
<td>.851</td>
</tr>
<tr>
<td>MAVolumen2007Verkäufe</td>
<td>.01529450882</td>
<td>4.172</td>
<td>.840</td>
<td>.723</td>
<td>.863</td>
</tr>
</tbody>
</table>

Table 57: Item-to-Scale-statistic for the market-driven complexity dimension organizational change.\(^{782}\)

\(^{782}\) Own source.
Appendix 13: Sample distribution

Figure 45: Sample distribution for the driver size.\textsuperscript{783}

Figure 46: Sample distribution for the driver depth and breadth.\textsuperscript{784}

\textsuperscript{783} Own source.
\textsuperscript{784} Own source.
Figure 47: Sample distribution for the driver organizational change.\textsuperscript{785}

Figure 48: Sample distribution for the driver technological intensity.\textsuperscript{786}

Figure 49: Sample distribution for the driver product diversification.\textsuperscript{787}

\textsuperscript{785} Own source.
\textsuperscript{786} Own source.
\textsuperscript{787} Own source.
## Appendix 14: Model quality criteria for median sub groups.

<table>
<thead>
<tr>
<th>Low complex</th>
<th>AVE</th>
<th>Composite Reliability</th>
<th>R Square</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change</td>
<td>0.8609</td>
<td>0.9488</td>
<td>0</td>
<td>0.9191</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.8347</td>
<td>0.9528</td>
<td>0.8221</td>
<td>0.9339</td>
</tr>
<tr>
<td>Financial health</td>
<td>1</td>
<td>1</td>
<td>0.3522</td>
<td>1</td>
</tr>
<tr>
<td>Geographic diversity</td>
<td>0.803</td>
<td>0.8906</td>
<td>0</td>
<td>0.7588</td>
</tr>
<tr>
<td>Organizational complexity</td>
<td>0</td>
<td>0</td>
<td>0.9773</td>
<td>0</td>
</tr>
<tr>
<td>Product diversity</td>
<td>0.8662</td>
<td>0.9283</td>
<td>0</td>
<td>0.8459</td>
</tr>
<tr>
<td>Shareholder value</td>
<td>1</td>
<td>1</td>
<td>0.2005</td>
<td>1</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.4991</td>
<td>0.83</td>
<td>0</td>
<td>0.7769</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.986</td>
<td>0.993</td>
<td>0</td>
<td>0.9861</td>
</tr>
<tr>
<td>Depth and breadth</td>
<td>0.5612</td>
<td>0.8316</td>
<td>0</td>
<td>0.7473</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.7806</td>
<td>0.9141</td>
<td>0.5625</td>
<td>0.8587</td>
</tr>
<tr>
<td>Organizational performance</td>
<td>0.5111</td>
<td>0.9007</td>
<td>0.1638</td>
<td>0.8723</td>
</tr>
</tbody>
</table>

Table 58: Model quality criteria for the low complex sub-sample of the multi-group comparison.  

<table>
<thead>
<tr>
<th>High complex</th>
<th>AVE</th>
<th>Composite Reliability</th>
<th>R Square</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change</td>
<td>0.848</td>
<td>0.9436</td>
<td>0</td>
<td>0.9104</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.8668</td>
<td>0.963</td>
<td>0.7913</td>
<td>0.9487</td>
</tr>
<tr>
<td>Financial health</td>
<td>1</td>
<td>1</td>
<td>0.2348</td>
<td>1</td>
</tr>
<tr>
<td>Geographic diversity</td>
<td>0.6836</td>
<td>0.8095</td>
<td>0</td>
<td>0.5685</td>
</tr>
<tr>
<td>Organizational complexity</td>
<td>0</td>
<td>0</td>
<td>0.9774</td>
<td>0</td>
</tr>
<tr>
<td>Organizational performance</td>
<td>0.8369</td>
<td>0.9112</td>
<td>0</td>
<td>0.8053</td>
</tr>
<tr>
<td>Product diversity</td>
<td>1</td>
<td>1</td>
<td>0.0208</td>
<td>1</td>
</tr>
<tr>
<td>Shareholder value</td>
<td>0.7747</td>
<td>0.9444</td>
<td>0</td>
<td>0.9238</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.9811</td>
<td>0.9905</td>
<td>0</td>
<td>0.9807</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.7164</td>
<td>0.9072</td>
<td>0</td>
<td>0.9067</td>
</tr>
<tr>
<td>Depth and breadth</td>
<td>0.8195</td>
<td>0.9316</td>
<td>0.6918</td>
<td>0.89</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.5208</td>
<td>0.8986</td>
<td>0.301</td>
<td>0.8617</td>
</tr>
</tbody>
</table>

Table 59: Model quality criteria for the high complex sub-sample of the multi-group comparison.  

---

788 Own source.; only the value for the average explained variance of the construct size is marginal below the limit value of .0.5.  
789 Own source.
### Appendix 15: Model quality criteria for quartile sub groups.

<table>
<thead>
<tr>
<th>1. Quartile</th>
<th>AVE</th>
<th>Composite Reliability</th>
<th>R Square</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change</td>
<td>0.9795</td>
<td>0.9931</td>
<td>0</td>
<td>0.9895</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.8451</td>
<td>0.9561</td>
<td>0.8327</td>
<td>0.938</td>
</tr>
<tr>
<td>Financial health</td>
<td>1</td>
<td>1</td>
<td>0.3431</td>
<td>1</td>
</tr>
<tr>
<td>Geographic diversity</td>
<td>0.8337</td>
<td>0.9092</td>
<td>0</td>
<td>0.8055</td>
</tr>
<tr>
<td>Organizational complexity</td>
<td>0</td>
<td>0</td>
<td>0.9673</td>
<td>0</td>
</tr>
<tr>
<td>Organizational performance</td>
<td>0.5211</td>
<td>0.9033</td>
<td>0.0328</td>
<td>0.8744</td>
</tr>
<tr>
<td>Product diversity</td>
<td>0.7931</td>
<td>0.8833</td>
<td>0</td>
<td>0.8033</td>
</tr>
<tr>
<td>Shareholder value</td>
<td>1</td>
<td>1</td>
<td>0.1698</td>
<td>1</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.5268</td>
<td>0.8377</td>
<td>0</td>
<td>0.7415</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.9593</td>
<td>0.9792</td>
<td>0</td>
<td>0.9576</td>
</tr>
<tr>
<td>Depth and breadth</td>
<td>0.4887</td>
<td>0.7741</td>
<td>0</td>
<td>0.6496</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.7309</td>
<td>0.8901</td>
<td>0.6315</td>
<td>0.8145</td>
</tr>
</tbody>
</table>

Table 60: Model quality criteria for the first quartile sub-sample of the multi-group comparison.

<table>
<thead>
<tr>
<th>2. Quartile</th>
<th>AVE</th>
<th>Composite Reliability</th>
<th>R Square</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change</td>
<td>0.8366</td>
<td>0.9386</td>
<td>0</td>
<td>0.8998</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.8666</td>
<td>0.9629</td>
<td>0.8001</td>
<td>0.9482</td>
</tr>
<tr>
<td>Financial health</td>
<td>1</td>
<td>1</td>
<td>0.4717</td>
<td>1</td>
</tr>
<tr>
<td>Geographic diversity</td>
<td>0.7986</td>
<td>0.8878</td>
<td>0</td>
<td>0.7549</td>
</tr>
<tr>
<td>Organizational complexity</td>
<td>0</td>
<td>0</td>
<td>0.9778</td>
<td>0</td>
</tr>
<tr>
<td>Organizational performance</td>
<td>0.5398</td>
<td>0.9108</td>
<td>0.2376</td>
<td>0.8862</td>
</tr>
<tr>
<td>Product diversity</td>
<td>0.8409</td>
<td>0.9135</td>
<td>0</td>
<td>0.8182</td>
</tr>
<tr>
<td>Shareholder value</td>
<td>1</td>
<td>1</td>
<td>0.2673</td>
<td>1</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.5154</td>
<td>0.8388</td>
<td>0</td>
<td>0.8073</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.9873</td>
<td>0.9936</td>
<td>0</td>
<td>0.9871</td>
</tr>
<tr>
<td>Depth and breadth</td>
<td>0.5</td>
<td>0.7686</td>
<td>0</td>
<td>0.6779</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.8039</td>
<td>0.9247</td>
<td>0.5797</td>
<td>0.8815</td>
</tr>
</tbody>
</table>

Table 61: Model quality criteria for the second quartile sub-sample of the multi-group comparison.

---

790 Own source.; Only the value for the average explained variance of the construct depth and breadth is marginal below the limit value of .0.5.

791 Own source.
### Table 62: Model quality criteria for the third quartile sub-sample of the multi-group comparison.

<table>
<thead>
<tr>
<th>3. Quartile</th>
<th>AVE</th>
<th>Composite Reliability Q²</th>
<th>R Square</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change</td>
<td>0.5896</td>
<td>0.7929</td>
<td>0</td>
<td>0.6185</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.7321</td>
<td>0.9161</td>
<td>0.8832</td>
<td>0.8785</td>
</tr>
<tr>
<td>Financial health</td>
<td>1</td>
<td>1</td>
<td>0.2806</td>
<td>1</td>
</tr>
<tr>
<td>Geographic diversity</td>
<td>0.7409</td>
<td>0.8504</td>
<td>0</td>
<td>0.6667</td>
</tr>
<tr>
<td>Organizational complexity</td>
<td>0</td>
<td>0</td>
<td>0.9867</td>
<td>0</td>
</tr>
<tr>
<td>Organizational performance</td>
<td>0.5425</td>
<td>0.9094</td>
<td>0.1214</td>
<td>0.881</td>
</tr>
<tr>
<td>Product diversity</td>
<td>0.7948</td>
<td>0.8855</td>
<td>0</td>
<td>0.7487</td>
</tr>
<tr>
<td>Shareholder value</td>
<td>1</td>
<td>1</td>
<td>0.0874</td>
<td>1</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.5844</td>
<td>0.8746</td>
<td>0</td>
<td>0.8665</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.989</td>
<td>0.9945</td>
<td>0</td>
<td>0.9889</td>
</tr>
<tr>
<td>Depth and breadth</td>
<td>0.4799</td>
<td>0.2631</td>
<td>0</td>
<td>0.6839</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.7828</td>
<td>0.9151</td>
<td>0.826</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Table 62: Model quality criteria for the third quartile sub-sample of the multi-group comparison.

### Table 63: Model quality criteria for the fourth quartile sub-sample of the multi-group comparison.

<table>
<thead>
<tr>
<th>4. Quartile</th>
<th>AVE</th>
<th>Composite Reliability Q²</th>
<th>R Square</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational change</td>
<td>0.863</td>
<td>0.9497</td>
<td>0</td>
<td>0.9206</td>
</tr>
<tr>
<td>Financial effectiveness</td>
<td>0.8597</td>
<td>0.9608</td>
<td>0.7803</td>
<td>0.9455</td>
</tr>
<tr>
<td>Financial health</td>
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<td>1</td>
<td>0.178</td>
<td>1</td>
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<tr>
<td>Geographic diversity</td>
<td>0.6659</td>
<td>0.7994</td>
<td>0</td>
<td>0.4991</td>
</tr>
<tr>
<td>Organizational complexity</td>
<td>0</td>
<td>0</td>
<td>0.9625</td>
<td>0</td>
</tr>
<tr>
<td>Organizational performance</td>
<td>0.5397</td>
<td>0.9095</td>
<td>0.1779</td>
<td>0.8823</td>
</tr>
<tr>
<td>Product diversity</td>
<td>0.8247</td>
<td>0.9034</td>
<td>0</td>
<td>0.8161</td>
</tr>
<tr>
<td>Shareholder value</td>
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<td>1</td>
<td>0.2046</td>
<td>1</td>
</tr>
<tr>
<td>Size / Interdependence</td>
<td>0.7657</td>
<td>0.9415</td>
<td>0</td>
<td>0.9188</td>
</tr>
<tr>
<td>Technological intensity</td>
<td>0.9804</td>
<td>0.9901</td>
<td>0</td>
<td>0.98</td>
</tr>
<tr>
<td>Depth and breadth</td>
<td>0.7833</td>
<td>0.9348</td>
<td>0</td>
<td>0.9179</td>
</tr>
<tr>
<td>Financial efficiency</td>
<td>0.8379</td>
<td>0.9394</td>
<td>0.7182</td>
<td>0.9034</td>
</tr>
</tbody>
</table>

Table 63: Model quality criteria for the fourth quartile sub-sample of the multi-group comparison.

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792 Own source.; Only the value for the average explained variance of the construct depth and breadth is marginal below the limit value of .0.5.

793 Own source.


VIII References


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