



PhD THESIS

Cooperative Competitive Advantages of International Supply Networks

How the structural complexities affect the competitiveness
on the network and the individual level

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Summary

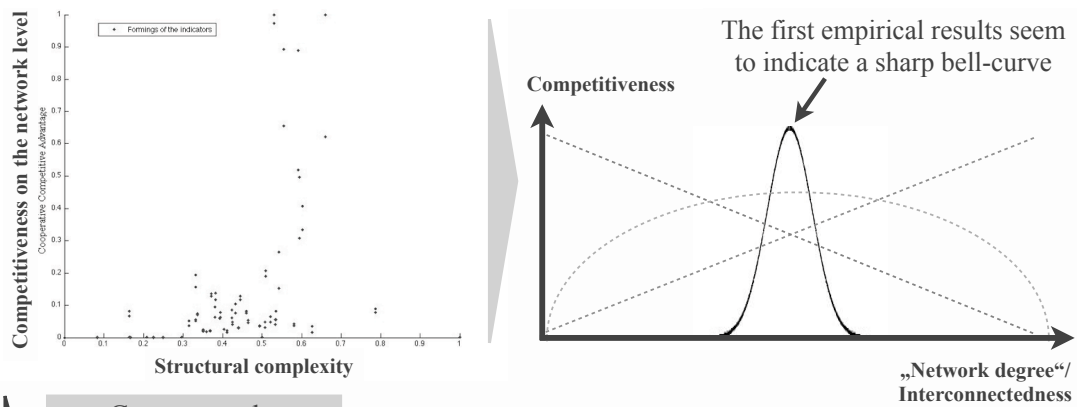
It is assumed that International Supply Networks (ISN) will compete with each other increasingly in the future because of the advantages of cooperation and of specialisation due to a division of work between different autonomously acting organisational units. Therefore, restrictions regard capital, time, resources or competencies of a single company can be conquered so that an ISN can offer more significant products or services. The offering of a product or a service for the end customer that is superior to those of a competitor, that is recognised by the end customer and that can be adhered durable is called a competitive advantage and the thesis will consider a competitive advantage of the entity of an ISN as a Cooperative Competitive Advantage (CCA) due to the advantages of cooperation. In this regard, a CCA can be differentiated from a competitive advantage with regard to the level of perspective. While a CCA might emerge as a new quality on the network level as the result of the cooperative interplays within an ISN, a competitive advantage refers to the entity of a company on the individual level that tries to optimise its company success. Therewith, a multilevel consideration is needed for investigating the potential emerging characteristics on the network level and the effects of an ISN on the company success that can be summarised in the following **two research questions**: What are Cooperative Competitive Advantages and what are the causal relations between an International Supply Network and the company success?

The theoretical relevance of these two research questions is the result of an identified gap of knowledge concerning definitions about Cooperative Competitive Advantages and a gap of knowledge about theoretical explanations in the meaning of cause-and-effect relations between International Supply Networks and the company success as well as assigning competitiveness to a whole ISN. Therefore, a multilevel-based perspective is needed that is also reflected in the practical relevance about missing approaches for managing a win-win situation between the individual and the network level. Therefore, it is the overarching objective to develop an explanation approach capable of describing Cooperative Competitive Advantages as well as the causal relations between an International Supply Network and the company success. With regard to the scientific *modus operandi* a research model, a measurement approach and an empirical validation will be accomplished because of the outlined epistemological, ontological and methodological scientific positions. Secondary to the underlying theoretical framework of Systems Theory, a complexity-based research model is developed about how the structural complexities may affect the competitiveness on the network and on the individual level. In this regard, a negative causal relation between the structural complexity and the company success is derived with the help of the Resource-Dependence-Approach from the field of Strategic Management. A positive causal relation is derived between the structural complexity and the competitiveness on the network level and between the competitiveness

on the network level and individual level because of the stylised considerations with the help of the Relational View and the Supply Chain Valuedriver Decomposition. For testing this complexity-based research model, a Network Science-based Structural Equation Model is developed. This Structural Equation Model consists of the ego network connectivities as a measurement model for the structural complexity, the ego network composition as a measurement model for Cooperative Competitive Advantages and the profit-based corporate group composition as a measurement model for the company success. Therefore, the methodological aspect of these Network Science-based measurement models is differentiated from their content-oriented specification from the field of logistics and finance. For the empirical validation, an empirical data set is collected from secondary data from a content analysis for the supply relationships of the German automotive industry in which 69 brands, 787 car models, 564 suppliers and 592 components are contained that are related with each other through plurivalent assignments of over 55000 supply relationships. The information contained in the empirical data set is transformed into metrical nature in the form of a three dimensional matrix so that with the help of a programming with MATLAB the ratios can be computed. With the help of this empirical data set and its computation, the falsifiable assumptions of the complexity-based research model cannot be completely statistically falsified because of the intermingled statistical results for the quality criteria. Therefore, the directions of the causal relations are probably only confirmed by trend, but implications for the Strategic Complexity Management can be drawn because of the mathematical concepts of the projection and mirroring the outlined visualisations so that the expected formings can be translated into potential functional relations.

As a result, the research contributes to the gain of scientific insights to that effect that an explanation approach is developed that is able to draw conclusions concerning the two research questions. Future research will focus on a deepening and widening of the research with respect to the theoretical, methodological and empirical aspects. Therefore, this thesis should be understood as an important step towards a future research program.

Figure 5-1: Contributions for the gain of scientific insights



Consequently,

the research **contributed** to the gain of scientific insights to that effect that an explanation approach - including the causal model as a CCA - about how the structural complexities of an ISN can affect the competitiveness on the network and the individual level could be developed and partly validated.

Source: Own illustration.

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List of Abbreviations

ISN	International Supply Network(s)
CCA	Cooperative Competitive Advantage(s)
SEM	Structural Equation Model
MBV	Market-based View
RBV	Resource-based View
CBV	Competence-based View
DC	Dynamic Capabilities
RV	Relational View
RDA	Resource-Dependence-Approach
CNS	Complex Network Science

1 Introduction: Cooperative Competitive Advantages of International Supply Networks

1.1 Research question: What are Cooperative Competitive Advantages of International Supply Networks?

International Supply Networks (ISN)¹ can appear on the market as a single competitive entity (Hülsmann & Cordes, 2009, p. 77; Hülsmann & Lohmann, 2009, p. 4) because of the **advantages of cooperation** (Arndt, 2010, p. 183 et sqq.; Ring & Van de Ven, 1994, p. 91 et sqq.) and of specialisation due to a division of work between different autonomously acting organisational units (Prahalad & Hamel, 1990, p. 84; Siebert, 2010, p. 10; Sydow & Möllering, 2009, p. 146). Therefore, restrictions regarding capital, time, resources or competencies of a single company can be conquered so that an ISN can offer more significant products or services for the end-customer (Harrison & van Hoek, 2008, p. 9; Rösler, 2003, p. 35). For this reason, it can be assumed that not companies but **ISN will increasingly compete with each other** in the future (Bach, Buchholz, & Eichler, 2010, p. 17). For example, the development of Electric Mobility² might be such a case in which ISN will compete with each other more and more over time. The reason for this is that besides the traditional value creation system of the automotive industry with cooperation (e.g. in the form of supply relationships³), the car manufacturers have agreed upon new cooperation, including developments in the area of the lightweight construction, the powertrain for the electric motor or lithium-ion-batteries for the storage of electric energy.⁴ Additionally, energy suppliers (e.g. for developing new forms of accounting) and IT-companies (e.g. for the development of services of the so-called connected car⁵) were uninvolved in the automotive industry until this point

International Supply Networks will compete with each other increasingly in the future

¹ The term of an International Supply Network will be further specified in Section 2.1. At this stage, it shall refer to the value creation system as a „network of connected and interdependent organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users“ (Christopher, 2005, p. 29).

² Due to the increasing side-effects of fossil fuels, an increasing dependency of oil from often politically instable regions and changed customer requirements the Government of the Federal Republic of Germany has – amongst others – installed the National Development of Electric Mobility for the development of battery electric vehicles (BEV) comprising an electric motor and batteries for the storage and transformation of electricity (from renewable energy sources) (Die Bundesregierung, 2009).

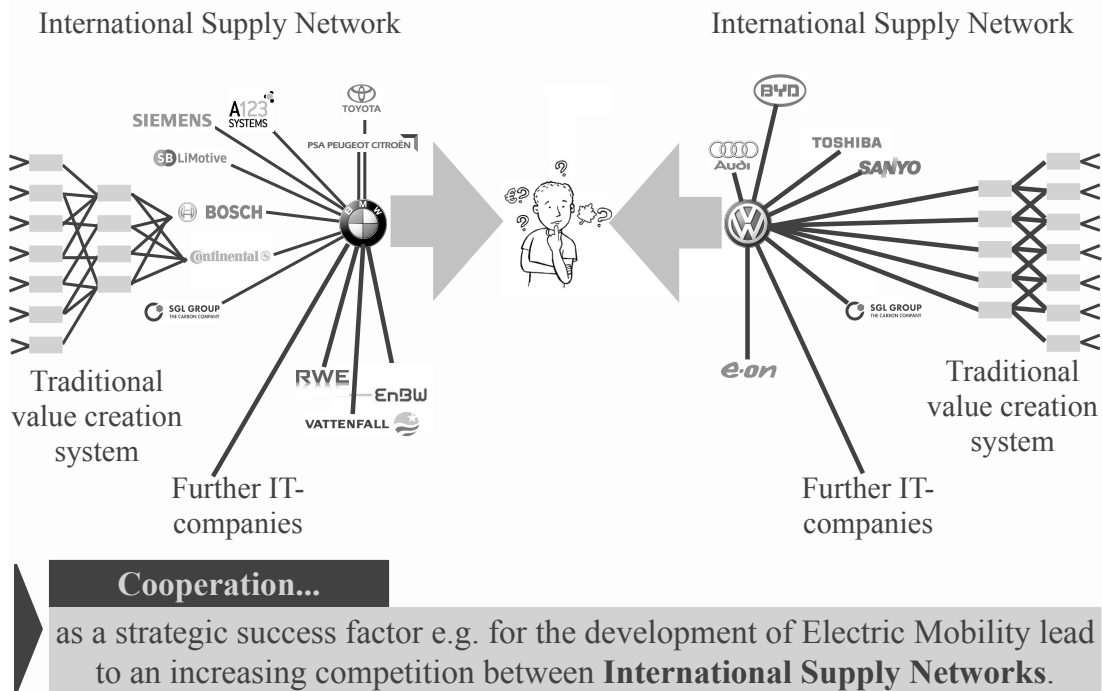
³ According to (Porter, 2004, pp. 50–52) the supply relationships e.g. in the automotive industry are labelled as vertical forms of cooperation (cf. also (Bea & Haas, 2005, pp. 435–436; Grant, 2010, p. 362).

⁴ In (Colmorn et al., 2013) cooperative strategic partnerships as a strategic success factor for the development of Electric Mobility have been identified and illustrated with regard to above-mentioned areas of the lightweight construction, the powertrain, Lithium-Ion-Batteries and energy supplier.

⁵ IT-companies aim to develop IT-based services for the so-called “Connected Car” with e.g. Car-2-Car-, Car-2-infrastructure- or Car-2-business-communications (cf. e.g. (Anderer, 2011; Köpplinger, 2011; Menzel, 2011; D. Urban, 2011).

(Sigl, 2011; Wallentowitz, Freialdenhoven, & Olschewski, 2010, pp. 156–160). Thus, it can be assumed that these different types of cooperation will be a strategic success factor for the development of e.g. Electric Mobility that can lead to an increasing competition between International Supply Networks (Figure 1-1).

Figure 1-1: Increased competition amongst ISN over time



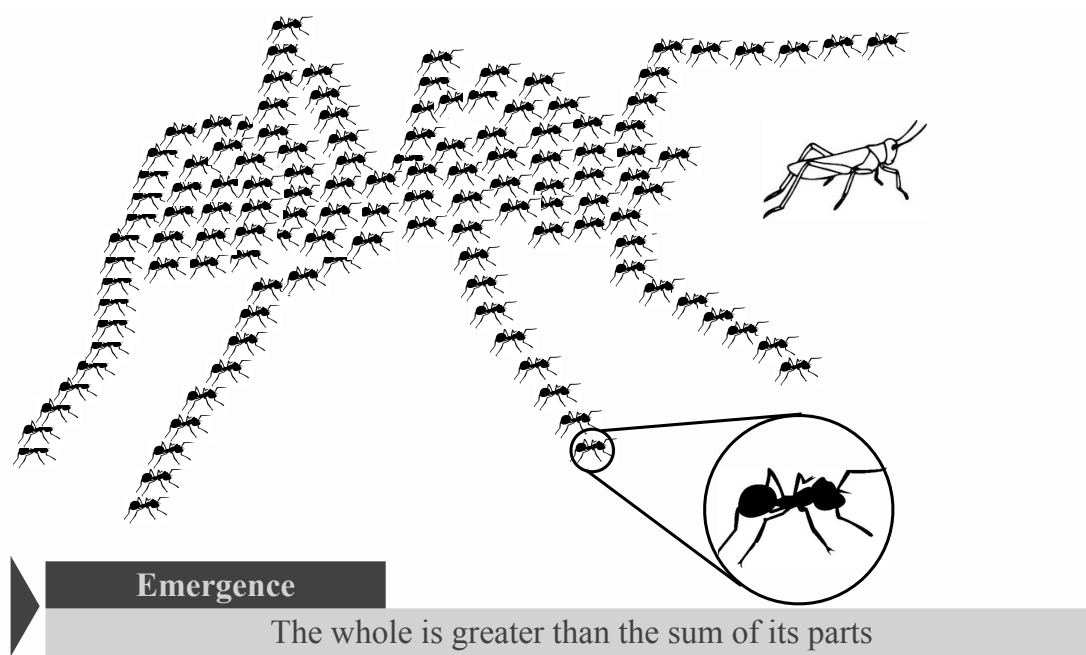
Source: Own illustration (exemplary cooperation are taken from (Colmorn, Hülsmann, & Brintrup, 2013) cf. also footnote 4).

Cooperative
Competitive
Advantages and
the effects of ISN
on the network
level

These International Supply Networks can compete with each other by offering a product or a service for the end-customer that is superior to those of a competitor, that is recognized by the end-customer and that can be adhered durable (Simon, 1988, p. 4). This approach as a way to differentiate from a competitor is called a **competitive advantage (CA)** (Porter, 2004, p. 37 et sqq.). Therefore, as outlined above it can be assumed that an ISN – identical to an individual company – aims at gaining and maintaining a competitive advantage, too. Given the advantages of cooperation and specialisation due to the division of labour between different autonomously acting organisational units, this thesis will consider competitive advantages of the entity of an International Supply Network as a **Cooperative Competitive Advantage (CCA)**. But what is the difference between a Cooperative Competitive Advantage and a competitive advantage? For example, as can be seen in Figure 1-1 the product of the car as a result of all the cooperation in the ISN is still recognized by the customer through the car manufacturer (e.g. of BMW or VW) so

that the results of the cooperation within an ISN can still be addressed as a competitive advantage.

Figure 1-2: Illustration of emergence



Source: Own illustration.

A Cooperative Competitive Advantage can be differentiated from a competitive advantage with regard to the level of perspective because it has been approached to assign a CCA to the entity of the whole ISN while a competitive advantage refers to the entity of a single company. Therefore, competitive advantages and CCA can be separated from each other in dependence of the **individual level**⁶ of a single company or the **network level** of the whole ISN. With the help of this separation between a network and an individual level a CCA can be differentiated from a competitive advantage if the entire cooperative interactions within an ISN can lead to a **new quality or characteristic on the network level** that is formed or expressed as a CCA. This new quality or characteristic on the network level would refer to an emerging behaviour of the whole ISN so that it is clearly differentiated from the behaviour on the individual level of a company. The reason for this is that an emerging CCA refers to the concept of emergence that is generally depicted as a macroscopic characteristic of a dynamic system (here the ISN) that does not appear in the microscopic elements of the system (here the individual companies or cooperation) and that cannot be derived from so that the “whole might be bigger than the sum of its elements” (Bar-Yam, 1997, pp. 10–12; Duden, 1997, p. 222; Mainzer, 2008, p. 119; Mitchell, 2009, p. 13). As a consequence, a Cooperative Competitive

⁶ This differentiation between an individual and a network level will be outlined through the theoretical framework of Systems Theory in Section 1.5.

Advantage refers to the behaviour of the whole ISN on the network level that emerges as a result of all the cooperation within an ISN so that a new quality or characteristic arises that cannot be simply reduced to the behaviour on the individual level. For example, the behaviour of a population of ants comprises the intelligence to collectively adapt to changing environmental conditions that cannot be reduced to the less intelligent behaviour of individual ants⁷ (cf. Figure 1-2). Therefore, the effects of an ISN through its cooperative interplays on the network level are of special interest while not diminishing the particular importance of the ISN's effects on the individual level.

The effects of an
ISN on the
company success
on the individual
level

This formulation highlights the essential meaning of the effects of an International Supply Network because besides the question if an ISN can create a CCA on the network level, it is also of essential importance to determine which effect an ISN can have on the company, for example on the car manufacturer and on the individual level. Finally, it is the objective for every free market economy oriented company to maximise profit in the long run and to survive on the market, i.e. the company success (Grant, 2010, p. 34 et sqq.; Perridon & Steiner, 2007, p. 8; Wöhe, 2000, p. 41). For this reason, all the companies evaluate the costs and benefits to participate in such an ISN. For example, the reason why the car manufacturer e.g. of BMW does not develop and produce the car totally on its own is that without the above-mentioned concentration on the core competencies of the participating companies it could never offer the same quality for the same costs of a car. Nevertheless, a quantification of the so-called network's effect on the company success is still missing and a determination of the best degree of the shift of the value creation is hard to determine.

Additionally, the company success is influenced by many more factors such as political regulations or socio-cultural preferences that are not influenced by an ISN.⁸ Due to the focus of this thesis on ISN, an attempt will only be made to determine how an ISN might effect the company success on the individual level: success of a car manufacturer through a potential realisation of a CCA on the network level. For this reason, a multi-level consideration is needed for investigating the potential emerging characteristics on the network level and the effects of an ISN on the company success. Finally, the characteristics⁹ of an ISN have not been specified at this point so that different formings or causal dependencies of a CCA from an ISN are reasonable to consider. In consequence and against the background of these

⁷ For example, (Cruse, Dean, & Ritter, 2001) introduce extensively the collective intelligence of ants that are able to systematically attack larger insects such as grasshoppers.

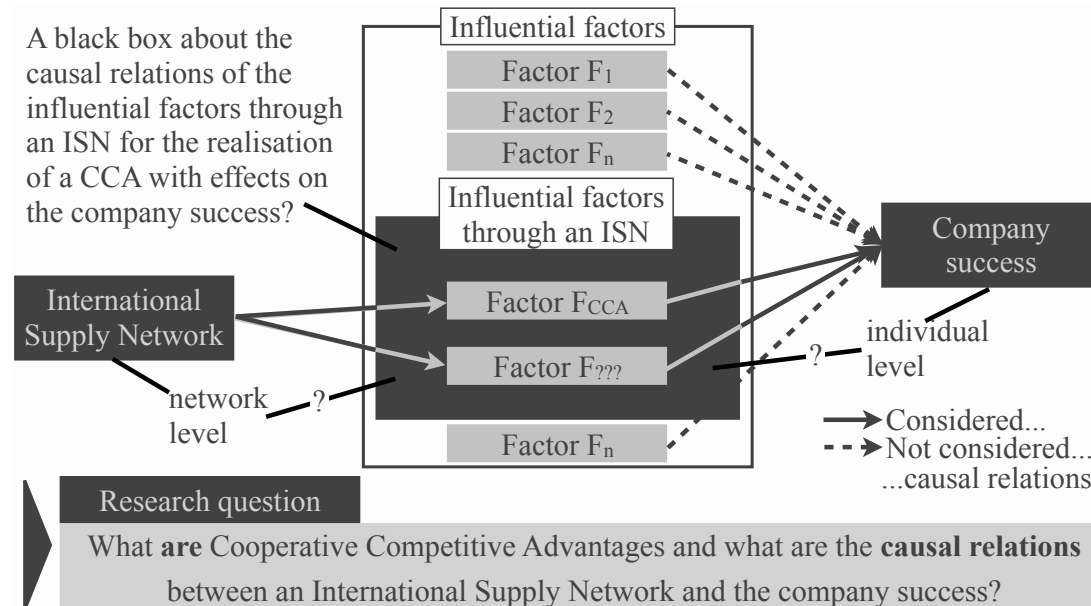
⁸ A method for determining factor from the environment that are not influenced is e.g. the PESTEL-analysis in which political, economic, social, technological, ecological and legal factors are systematically identified (cf. e.g. (Kerth et al., 2009).

⁹ According to (Chmielewicz, 1979, pp. 43–45) a characteristic refers to the attributes, criteria or features that identify, classify and/or specify a subject of scientific consideration (cf. also the ontological scientific position in section 1.5).

assumptions, the two **research questions** can be derived as follows and as illustrated in Figure 1-3.

What are Cooperative Competitive Advantages and what are the causal relations between an International Supply Network and the company success?	Research questions
--	--------------------

Figure 1-3: Illustration of the research questions



Source: Own illustration.

In order to figure out whether these research questions are worth working on, (Hülsmann, 2003, p. 17 et sqq.) introduces **two perspectives for the relevance of a research topic**. The **theoretical relevance** aims to demonstrate the meaning of the presented topic or problem for the academic world. Therefore, the theoretical relevance deals with the question whether the presented topic or problem has been extensively analysed and explained so that corresponding **cause-and-effect relations** have been generated. If this has not been done, then a **gap of knowledge** in the field of science exists because a causal explanation approach of this special topic or problem is needed. Additionally, (Hülsmann, 2003, p. 17 et sqq.) points out that the **practical relevance** is intended to prove if, based on the previously derived cause-and-effect relations, end-means combinations exist in order to derive practical recommendations. Therefore, from an application-oriented perspective the practical relevance indicates if the topic merits such a focus since a **gap of knowledge** concerning the **end-means combinations** can be assumed. Consequently, in order to determine whether the **topic merits further exploration from a scientific perspective**, the **theoretical and practical relevance** of the approached research questions shall be shown.

Introducing two perspectives for deciding whether the topic merits further exploration

1.2 Theoretical relevance: Gaps of knowledge regarding Cooperative Competitive Advantages of – and their dependence on the characteristics of – International Supply Networks

Two perspectives
for gaps of
knowledge

Therewith, it is the **aim** of this section to determine the **theoretical relevance** of the two research questions because it has to be investigated if gaps of knowledge exist. These potential gaps of knowledge can be **differentiated** with the help of the general objectives of scientific working into descriptive and analytic ones¹⁰ (Bea & Haas, 2005, pp. 22–24; Chmielewicz, 1979, p. 8,17). In this conjunction, **a gap of knowledge with regard to the descriptive objective** shall refer more to the first research question given its demand for precision regarding the definition of Cooperative Competitive Advantages. **A gap of knowledge with regard to the analytic objectives** refers more to the second research question given its inquiry about the causal relations implies the theoretical explanation approach for identifying cause-and-effect relations. As a result, it shall be examined, firstly whether Cooperative Competitive Advantages have been **defined** in the scientific literature. Secondly, it has to be investigated if **theoretical approaches** exist that are able explain the creation of CCA as a result of the characteristics of ISN¹¹.

Definitions about
Cooperative
Competitive
Advantages

Before the definitions about CCA will be investigated, a differentiation with the terminology of “Coopetition” shall be done because one might mistake these two concepts with each other. In general, the terminology of co-opetition expresses the duality of cooperation and competition in a business relationship between companies that are usually on the same step of the value creation (Brandenburger & Nalebuff, 1996; Dagnino & Rocco, 2009, pp. 1–2; Sydow & Möllering, 2009, pp. 202, 216).¹² For example, car manufacturers that are competing with each other commonly develop a production platform for a modular construction technique (Sydow & Möllering, 2009, p. 216). Therewith, it can be seen that the terminology of co-opetition does not refer to the entity of a whole ISN and mostly neglects vertical forms of cooperation¹³ so that a differentiation between CCA and coopetition can be asserted.

¹⁰ (Bea & Haas, 2005, pp. 22–24; Chmielewicz, 1979, p. 8,17) also mention pragmatic and normative objectives while the search for the end-means combinations of the pragmatic scientific aims will be dealt with in the next subsection the normative aims are neglected because they refer to morally or ethically justified reasons that are not subject of science.

¹¹ Due to the fact that the term of International Supply Networks has not been specified yet, the following elaborations will focus on the more generalized term of networks so that a wider perspective e.g. of the relevant literature can be taken.

¹² A discussion about the terminology of Co-opetition can be found e.g. in (Dagnino & Rocco, 2009; H. Stein, 2010; Wilhelm, 2009).

¹³ In Section 2.1 and 2.3 vertical and horizontal cooperation will be introduced.

In order to determine whether the terminology of a Cooperative Competitive Advantage has been used in the scientific literature, the term of a “Cooperative Competitive Advantage” was searched for via the databases of EBSCO, Google Scholar and the Jacobs University Catalogue. The reason for using these databases is that the search is conducted with the help of the resources of the institution from which this thesis has been written, of a private Internet company and of a private information service provider specialising in scientific publications such that the coverage of a broad spectrum of the scientific literature can be assumed. Of the three databases searched, none returned a finding which used the terminology Cooperative Competitive Advantage; we therefor assume that no definition about CCA exists to date. It is possible, however, that different authors may have referred to the same phenomena or idea but might have decided to describe or define said concept in an alternative manner or with alternative terminology. Therefore, in order to determine whether Cooperative Competitive Advantages have been indirectly addressed in the scientific literature, it seems promising to start with the search for theoretical approaches that might be able to explain the creation of competitive advantages of an ISN.

Do theoretical approaches exist that are able to explain the creation of Cooperative Competitive Advantages based on the characteristics of International Supply Networks? In order to answer this question, potential theoretical approaches have to be assigned to the field of Strategic Management given according to (Hungenberg, 2001, p. 4; Rumelt, Schendel, & Teece, 2007, p. 5,9) the field of strategic management is targeted towards the gain and maintainence of durable competitive advantages. This concept of competitive advantages has been **traced back** to Porter (1985) who defines a competitive advantage as the “extent to which an organization is able to create a defensible position over its competitors” (Porter, 2004). Thereby, the “quest for competitive advantages” can be assigned within the evolution of strategic management as one of the dominant economic themes in the 1980s and 1990s (Grant, 2010, p. 17). As a consequence, different approaches have been developed in the field of strategic management in order to explain competitive advantages, e.g. the **market-based view**, the **resource-based view**, the **competence-based view**, the **relational view**, the **dynamic capabilities approach** and the **resource-dependence-approach**.¹⁴

Theoretical explanation approaches for the creation of competitive advantages

The **aim** of the **market-based view (MBV)**¹⁵ is to take an “outside-in”-perspective for the conformation of an organisation to the environmental conditions

Market-based view

¹⁴ A narrative review about different theoretical approaches can be found in (Klumbies, Bausch 2011).

¹⁵ The MBV mainly goes back to (J. Bain, 1956; Mason, 1939) so that their works can also be considered as an introduction into the MBV.

in order to gain a competitive advantage (J. S. Bain, 1971; Bea & Haas, 2005; Mason, 1939). Its **main assumptions** comprise the so-called structure-conduct-performance hypothesis and the **idea** that strategic success would be the result of a rational process (J. S. Bain, 1971; Bea & Haas, 2005; Mason, 1939). Hereby, the market structure determines the strategic behaviour of the organisation (i.e. the conduct) and thereby the development of an organisation (i.e. the performance) (Hungenberg, 2001, p. 15). The **central conclusions** of the market-based view remain that in order to adequately react to opportunities and threats of the environment product-market strategies must be enacted (Hülsmann & Lohmann, 2009, pp. 58, 90). Therefore, companies shall react with three different generic competitive strategies (Porter, 2004). The strategy of the overall cost leadership aims to be the cheapest competitor on the market. The strategy of differentiation aims to offer a product to set oneself apart from the products of the competitors. The strategy of focus to create a niche in the market aims to orientate of a special and clearly defined segment of customers. These generic competing strategies are also considered to be the **main contributions** of the market-based view because of their successful ability to gain competitive advantages. Hence, its **limitations** comprise the one-sided preoccupation with the market without considering internal potentials of success for actively influencing the market (Hülsmann & Lohmann, 2009, pp. 58, 90). Furthermore because of the high-fluctuating dynamic of today's International Supply Networks these competing strategies may lead to only brief competitive advantages (Hülsmann & Lohmann, 2009, p. 90) thus implying that the **MBV** does not seem promising for explaining the creation of potential CCA.

Resource-based
view

Based on (Barney & Clark, 2007; Penrose & Slater, 1980; Pfeffer & Salancik, 1978; Wernerfelt, 1984), the **aim** of the **resource-based view (RBV)** is to change the perspective from the outside-in to the inside-out perspective so that competitive advantages are the result of specific internal resources of companies (Barney & Clark, 2007; Blohm & Schreyögg, 2000; Penrose & Slater, 1980). Its **main assumption** comprises the **idea** that some companies are more successful than others despite of the same positioning at the market (Hülsmann & Lohmann, 2009, p. 59). Therefore, the **central conclusion** of the resource-based view is that a competitive advantage is not the result of differences in the market structure but it is the result of specific, internal resources of a company (Blohm & Schreyögg, 2000, p. 73; Hülsmann & Lohmann, 2009, p. 59). Its **main contribution** lies in the possibility to reduce a competitive advantage of the organisational structure of an International Supply Network to tangible (e.g. fleet, storage capacity) and intangible (e.g. patents, delivery time reliability) resources (Hülsmann & Lohmann, 2009, p. 91). **Hence**, the resource-based view does not provide an explanation about the fact that differently

performing International Supply Networks can consist of the same resources (Hülsmann & Lohmann, 2009, p. 91). Furthermore, it does not provide an explanation about the causal relationship between resources and competitiveness (Freiling, 2004, p. 6). Therefore, the resource-oriented perspectives gives a first hint towards the creation of a competitive advantage as a result of cooperation, but it does not explain the creation of a CCA on the network level.

The **aim** of the **competence-based view (CBV)** is to integrate the inside-out and outside-in perspective (Freiling, 2004; Prahalad & Hamel, 1990; Sanchez, Heene, & Thomas, 1996; Sanchez & Heene, 1997). Its **main assumption** comprises the idea that the internal competencies and resources have to survive and fit to the environmental conditions at the market (Freiling, 2004, p. 7). Therefore, the **central conclusion** of the competence-based view is that internal resources have to be combined and integrated into the meaning of organisational competencies (Hülsmann & Lohmann, 2009, p. 60). Its **main contribution** lies in the integration of the inside-out and outside-in perspective by explicitly considering time as an important component so that a processual thinking is supported. Hence, the competence-based view focuses on the competencies as an explanation of competitive advantages on the level of the individual companies without considering the competitive advantages on the level of the whole network (Hülsmann & Lohmann, 2009, p. 60). Finally, (Duschek, 2004) explains that in current approaches competencies are only temporarily integrated for a very short time without integrating and coordinating these competencies sustainably into the network (Duschek, 2004, p. 60). Therefore, according to (Freiling, 2004) the need for a coordination and control mechanism of the specific cooperation is mostly neglected (Freiling, 2004, p. 22).

Competence-
based view

The **aim** of the **dynamic capabilities approach (DCA)** is to integrate the resource-based and competence-based view by tracing competitive advantages back to organisational resources and the capabilities to use and combine these resources in a dynamic environment (Teece, 2009). Its **main assumption** involves the **idea** that the capability to “shape, re-shape, configure and reconfigure the firm’s asset base so as to respond to changing technologies and markets” (Augier & Teece, 2008, p. 175) would be essential for gaining competitive advantages (Augier & Teece, 2008; Schreyögg & Kliesch-Eberl, 2007) while its **main contribution** lies in its concentration on the dynamism of capabilities to gain competitive advantages by taking dynamic aspects explicitly into account (Schreyögg & Kliesch-Eberl, 2007). The **main limitation** of this approach is in the lack of evidence regarding a unified understanding of how to effectively develop and employ dynamic capabilities

Dynamic
Capabilities
Approach

(Schreyögg & Kliesch-Eberl, 2007).¹⁶ Therefore, it can also be assumed that the DCA does not take the creation of a CCA on the network level explicitly into account.

Resource- Dependence- Approach

The **Resource-Dependence-Approach (RDA)** is a theory to explain the intercompany behaviour that is considered with respect to the critical resources of the company and its **aim** is to investigate the dependency of a company from its organizational, i.e. its network, environment (Brunner, 2009, p. 31). Its **roots date back** to the discipline of social sciences in which the social behaviour on the individual level is explained through its dependence from its environment (Brunner, 2009, p. 31).¹⁷ (Pfeffer, Salancik 1978) are often referred to as the authors that provided the first formalization in the field of strategic management (Boyd, 1990, p. 420; Davis & Cobb, 2009, p. 3; Pfeffer, 2005). It is the **central assumption** of the RDA that resources are essential for the company's survival and functioning and that these resources are mainly obtained from the organisational environment of the company through interactions that lead to dependencies (Brunner, 2009, pp. 32–33). Therefore, it is the **central conclusion** that the strength of a vertical (i.e. transactional) or horizontal (i.e. competitive) dependency is an essential driver or determinant for the behaviour of an organisation because this limits its autonomy. As a result, the relative share of the resource in the input and output relations of the organisation determines the relative dependence or independence of the resource-controlling organisation. Therewith, the **Resource-Dependence-Approach (RDA)** **contributes** to this research by pointing to the concept of cooperation because if companies are not able secure their autonomy they develop distinct strategies for influencing the behaviour of the companies they are dependent on such as integration, cooperation, coopetition, and joint ventures. Furthermore, the **RDA** takes the network beyond the focus on the organisational environment explicitly into account. Finally, as will be shown in Subsection 2.4.3 and 3.5.2, the **RDA** provides two nominal scales for classifying the type of relationship and the type of environment. With these it will become possible to derive assumptions about the formation of complexity-based ratios because the **RDA** is still **limited** by the fact that an operationalisation does not take place. Additionally, the **RDA** only considers dyadic relations from the perspective of a single company so that the analysis of integrated networks is difficult.

Relational View

The **aim** of the **relational view (RV)** is to shift the perspective from the individual level of the company to that of the ISN in order to explain competitive

¹⁶ (Cordes-Berszinn, 2013) & (Austerschulte, 2013) present an overview about the DCA.

¹⁷ For example, according to (Emerson, 1968) an actor *A* is dependent on an actor *B*, if *B* controls a resource or a service that has a high importance for *A* that cannot be obtained from other sources.

advantages (Hülsmann & Lohmann, 2009). Its **main assumption** is that competitive advantages are the result of interorganisational relationships in and of International Supply Networks (Dyer & Singh, 1998, p. 661). The relational view **originates** from the works of (Dyer & Singh, 1998) and was developed further by (Lavie, 2006). It is the **central conclusion** of the relational view to analyse networks and dyads of firms to explain relational rents, i.e., superior individual firm performance generated within that network/dyad. What are the **contributions** of the relational view with respect to this course of research? First, with reference to (Hülsmann & Lohmann, 2009) the **relational view** enables the identification of four potential sources for competitive advantages, i.e. **relational rents** of International Supply Networks, namely relation-specific assets¹⁸, knowledge-sharing routines¹⁹, complementary resources/capabilities²⁰ and effective governance²¹. Relational rents are defined as “a supernormal profit jointly generated in an exchange relationship that cannot be generated either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners (Dyer & Singh, 1998, p. 662). Secondly, the relational view supplements existing views, where the industry structure view explains superior returns with a firm’s membership in an industry with specific structural characteristics and the resource-based view explains superior returns with firm’s heterogeneity, the relational view argues that idiosyncratic interfirm linkages are a source of relational rents (Hülsmann & Lohmann, 2009, p. 60 et sqq.). Thirdly, with the help of the **RV** it will be possible to derive assumptions for an operationalisation (cf. Subsection 3.5.2) because with the help of the **preliminary studies** (Hülsmann & Lohmann, 2009) point out that this approach has not been adequately considered in the scientific literature. Thus, a mechanism for operationalisation would be missing and it would be unclear if the sources are independent variables, if and how they interact with each other and if they are in a hierarchic relationship (Hülsmann & Lohmann, 2009, p. 60). For this reason, a **main limitation** exists with regard to the research about these interorganisational resources that only the result of the network structure can lead to relational rents as an attribute of the ISN.

Consequently, the RV and the RDA take the network perspective explicitly into account. While the RV is considered to be a theoretical approach for explaining the

¹⁸ **Relational specific competencies** refer to the competencies that are created through common investment and shared knowledge during the cooperation.

¹⁹ **Routines** advantaging the transfer of knowledge refer to the competencies that promote the informational capacity and enable the placement of knowledge and competencies.

²⁰ **Complementary resources or abilities** refer to the important aspect of the combination of valuable and hardly imitable competencies.

²¹ **Effective governance of the network control** refers to the management of the network from a self-organizing perspective.

creation of a competitive advantage (on the network level), the RDA is considered to explain the behaviour of an organisation in light of dependence on its network environment. Therefore, these two theoretical approaches seem to be a promising starting point for going deeper into the scientific literature. Before doing so, it shall be shortly introduced about how networks are considered in the field of managerial economics in general in order to derive implications regarding the theoretical relevance of the research questions. These theories will focus on the structural relations because of their constituting feature of being a network and because of the implications of the RV with regard to the structural relations.

Network theories
in the field of
managerial
economics

It is the **intent** to start with an overview about **network theories in the field of managerial economics aiming** elucidate whether a **gap of knowledge exists** with respect to the **structural relations**. This uncertainty merits a response since it must first be determined if theoretical approaches in the field of managerial economics are sufficient to appropriately manage the effects of the network structure (e.g. on the behaviour of the whole network such as the competitiveness) or if another framework would be needed.

Social Network
Theory

To begin, the **social network theory** will be considered given (Schwaiger & Meyer, 2009, p. VIII) count it as an **essential theory in the field of managerial economics** alongside other **different theoretical approaches** such as constructivistic approaches from the field of organisational theory, the resource-dependence-approach, industrial economics, the resource-based-approach, the contingency theory, the diffusion theory, the transaction-costs-approach, the principal-agent-theory, the property-rights-theory, the normative as well as the descriptive decision theory, the prospect-theory, game theory (and its application in managerial economics), motivational theories, theory of justice, the attribution theory and theory of self-determination (Schwaiger & Meyer, 2009, pp. VII–VIII). Furthermore, the **social network theory** can be considered as a starting point for theories with an explicit focus on networks because of its **origin**. The **origin** of the term of social network can be traced back to the field of formal sociology by (Simmel, 1998) who considered the forms of socialisation, i.e. the analysis of the geometry of relationships between individuals in the core of sociology, so that with this setting of priorities it could be justified that the **social network theory** would be a scientific discipline unto itself (Ahrens, 2009, p. 301). Against this background, according to (Ahrens, 2009, p. 301) the **social network theory** can also be **applied to the field of social sciences** which investigates theoretically and empirically-driven phenomena of the human social and relational experience. In this conjunction, the research about the social network theory can be generally **differentiated into a**

methodologically oriented and a **theoretically oriented network research**. According to (Ahrens, 2009) the **methodologically oriented network research**, or the analysis of networks, has its origin in the field of quantitative sociology. Its structural foundation is considered to be a valuable contrast to the rational choice-approach in the field of sociology that focuses on the observation of randomly selected individuals. Hereby, mathematical concepts and methods help to precisely describe the network through e.g. special ratios such as the density of the number of connections so that it can also be used for classifying networks. This approach would be considered to be the self-reliant part of the network research with a high degree of institutionalisation. The theoretically oriented network research is based on the sociological theories for explaining social networks (Ahrens, 2009, p. 302).

The **social network theory**, however, proposes understanding a social network through relationships in which individuals or abstract social entities are embedded (Ahrens, 2009, p. 301). Therefore, with reference to (Jansen, 2003), it is the **aim** of the **social network theory** to explain the behaviour of an individual through social structures (i.e. its relationships) and vice versa (Ahrens, 2009, p. 301). The reason for this can be explained in the context of a shift of the scientific understanding from isolated or atomic explanation approaches to relational or systemic theoretical approaches because the behaviour of the whole network would comprise features that cannot be owned by single individuals (Ahrens, 2009, p. 301). This is **based** on the **assumption** that every network shows a constituting behaviour because of its unique combination of actors and the corresponding structural relations (Ahrens, 2009, p. 302 et sqq.). Therefore, it is one **central conclusion** that the **structural relations** are essential for explaining the behaviour of the system as a result of these inherent interdependencies of the network so that networks can be investigated in their entirety mostly towards structural aspects or on the individual level of the elements (Ahrens, 2009, p. 301).

An overview of the field of such **network theories with a focus on the structural relations** is provided by (Windeler, 2005). This overview will be used as a reference work because it is targeted towards the conclusions of a relational shift (i.e. to highlight the structural relations as an essential) and due to its combination as a unique characteristic of the network (Windeler, 2005, p. 214,229). Therefore, the **relational shift** will be introduced based on this text (Windeler, 2005).

Network theories
with a focus on
structural
relations

It is the **idea** of the **relational shift** according to (Windeler, 2005) to take a relational perspective on networks because of the results of his discussions about the network theories of the **structural approach**, the **transactioncost-theoretical approach** and the **theory of structuration** (cf. the comparison in Table 1) (Windeler, 2005, p. 228 et sqq.).

Relational shift

Structural approach	Transactioncost-theoretical approach	Theory of structuration
Term		
Special set of social relation between actors. No form of governance.	Hybrid from between market and hierarchy. Hybrid form of governance.	Social systems that coordinate interactions in time and space for longterm relationships. Separate form of governance.
Contextual embedment		
Embedment in sets of relationships of individual levels. Actors are unimportant maximizing their benefits or flexible opportunists.	Embedment as a measurement of influence of a superordinate on subordinate level. Limited rational, opportunistics and future-oriented actors.	Recursive-reflexive production and reproduction of a contextual embedment of “knowledgeable agents” into social systemsand institutions.
Theoretical perspective		
Structure-theoretical Static view No relational perspective	Function-theoretical Comparative-static view No relational perspective	Practical/Theoretical Dynamic-processul view Relational perspective

Table 1: Comparison of theoretical approaches (Windeler, 2005, p. 229).

Therewith, it is the **aim** to overcome their limitations – especially with respect to their static view – to take a relational perspective explicitly into account, focusing on dynamic processes in relation to or dependent on the corresponding context in which they are embedded (Windeler, 2005, p. 228,229). This is grounded in the **main assumption** that social actions, including economic ones, can be analysed as a characteristic of the structural relations from a set of social relations because such an e.g. economic action would be neither primarily explained through ideas, values and cognitive landscapes nor through other variables (Windeler, 2005, p. 215), such as age or gender, so that the structural patterns of the relationships must be at the center of any analytic explanation (Windeler, 2005, p. 214). Against this background, the **central conclusions** are, firstly, that a reductionistic and static view is deficient, and, secondly, that similar positions in a network would provoke similar forms of behaviour of the keeper possessing this position so that the web of interwoven relationships becomes the central aspect for any analysis (Windeler, 2005, p. 216) and thirdly, that networks have to be analysed in their entirety on the network level and on the individual level in addition to an analysis of their dependence on each other. What are the **main contributions**? The **network theories with a focus on the structural relations** in general and the conclusion hints according to (Windeler, 2005) of the **relational shift** in particular consider the elements as nodes and their connecting relationships as links in an abstract way so that it is in accordance with the underlying theoretical framework of Systems Theory (Windeler, 2005, p. 216). Secondly, an analysis of interorganisational networks always considers relationships between more than two organisations so that by including the relationships and the characteristics of the whole network a more general perspective is taken (Windeler, 2005, p. 215). Thirdly, taking the network perspective is not normative per se

because the question whether networks are efficient or lead to profit is unlikely said so that the difference is also possible (Windeler, 2005, p. 215). What are the **main limitations**? Firstly, the network perspective is only pointing to an initial idea of interconnections without the proof of a network theory. Despite of the fact that it is not completely without a theory, the question about how actors produce and reproduce network still needs an additional theoretical explanation (Windeler, 2005, p. 215). Secondly, two further theoretical problems exist because with reference to a literature review the question about bridging the gap between the micro- and macro-level is still missing. Furthermore, an understanding about deriving implications for the interrelation between action and structure remains unanswered (Windeler, 2005, p. 215). Therefore, with respect to the **network theories in the field of managerial economics** it can be **concluded** that these theoretical approaches with focus on the structural relations are not able to fully or sufficiently explain the causal relation between the individual and the network level. Hence, besides the **limitation** that this short overview that was only based on few sources, these **network theories in the field of managerial economics contribute** to this research from an Systems Theory-based perspective to focus on the **structural relations** or the **structural shift in the field of managerial economics** because measurable approaches of the structural relations in and of an ISN seem to be needed. As a result, with regard to the consideration of network theories in the field of managerial economics, a gap of knowledge can be concluded because the interplay between the individual and the network level seems to lack a theoretical foundation.

In order to ground this first impression regarding a gap of knowledge towards the research question, a literature review shall be conducted by using EBSCO, Google Scholar and the Jacobs University Catalogue again. This approach will reveal scientific publications that may contain new insights that are not covered in these general introductions to relevant theoretical frameworks. To start, the literature review focuses in literature reviews because of the wide spectrum of articles and because of the insights of researcher that are specialised in this topic that can be covered with this approach.

Literature review

(Judith, 2007) presents a literature review about interfirm relationships by collecting the notions and concepts related to them and by evaluating current questions of debate. While different forms of cooperation and their success factors are introduced and discussed in an attempt to synthesise the knowledge about different forms of interfirm relationships, a consideration of the whole network does not take place. Therefore, a separation between a network and an individual level is not covered in most of the discussions about the cooperative relationships.

A literature review about interorganisational networks with special focus on the network level is provided by (Provan, Fish, & Sydow, 2007) through an introduction to the distinction between egocentric and network-level research. By doing so, they introduce a typology of interorganisational network research in the form of a matrix with the two categories of organisational variables and the network or relational variables for the input focus and individual organisations and collective organisations as the output focus. With the help of this typology, they are able to identify inter alia research about the impact of networks on individual organisations and about the impact of individual organisations on the network so that the two research questions are addressed. From over 50.000 articles about networks in general, (Provan et al., 2007) identify 26 empirical studies during a more substantiative review process that deal either with “network properties and processes associated with whole networks, such as structure, development or evolution and governance” as well as “network outcomes”. They demonstrate that most research about the network level comprises ratios for empirically investigating the properties of the whole network, but they highlight that “little work on business networks” has been done which is “surprising in light of the large number of organisational network studies that have been published in business sectors during the last 20 years” (Provan et al., 2007, p. 506). In this conjunction, the “broadest conclusion that can be drawn from the empirical literature on whole networks, or interorganizational networks studied at the network level, is that there is simply not very much of it” (Provan et al., 2007, p. 506). Additionally, future research would have to focus more on the effects of the structural relations on the effectiveness of the behaviour of a whole network. Consequently, the broad literature review of (Provan et al., 2007) implies that an empirical study (e.g. of the competitiveness) on the network level is missing.

A multilevel conceptual model relating key network properties to competitive forms of behaviour of individual organisations that are embedded within a network is presented by (Gnyawali & Madhavan, 2001). They highlight that the network approach would advance addressing the competitive dynamics, but their model including the effects of the centrality, of the structural autonomy and of the structural equivalence of a single actors lacks a consideration of the competitiveness of the entity of a network. They suggest that a connection of the structural embeddedness with a Resource-oriented perspective enriches the understanding of competitive dynamics.

(Borgatti & Foster, 2003) review and typologise the network paradigm in organisational research by “developing a set of dimensions along which network studies vary, including direction of causality, levels of analysis, explanatory goals, and explanatory mechanisms”. For doing so, the explanatory mechanisms of

structuralist versus connectionist and the network consequences of explanatory goals and explanatory mechanisms are introduced. In this conjunction, the connection of the structuralist and explanatory goal seems to address the research questions. In this category, for the network level of analysis, so-called structural capital “studies seek to relate the network structure of a group to its performance”. The articles of (Brass & Burkhardt, 1993; Burt, 1992, 2001; Powell, Koput, & Smith-Doerr, 1996) that were also found during the search for literature can be addressed to this category as the starting works. Therefore, extensive research about the influence of the network structure on an individual company has been conducted, but the consideration of the competitiveness of a network and of the competitiveness of an individual company at the same time is missing so that “the micro-macro gap” has still to be “bridged”.

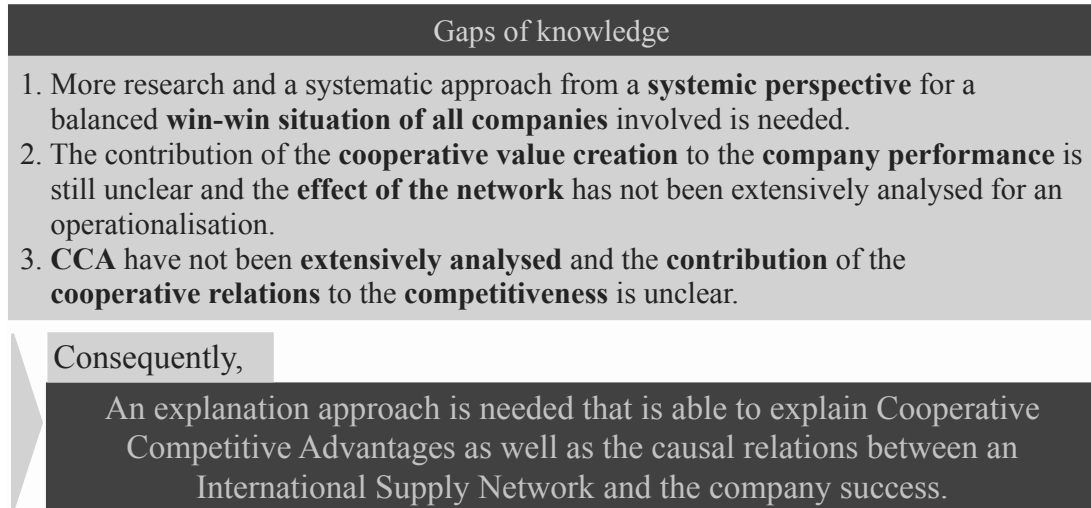
With regard to these literature reviews, the two research questions do not seem to be covered in the scientific literature. Perhaps, the scientific literature about the RV that was identified as a theoretical approach for explaining competitive advantages through relational rents of networks provides insights about how to operationalize these relational rents. Finally, (Duschek, 2004, p. 68) pointed out that the question about how “exactly the process of rent generation (and core competencies) takes place still remains more or less outside the field of the strategic management focus of the relational view” despite of some “borrowing from social network theory”.

A scientific review of the relational view theory is provided by (Turkmen, 2013). Despite of the empirical studies confirming the effectiveness of the relational view in network environments, the decision-making processes for generating relational rents were only of conceptual nature so that further research would be needed for operationalizing them in the context of the relational view. This limitation is also shared through the results of the literature review by (Wu, 2010) who further points out the criticism of other researchers that the negative aspects of the cooperation (e.g. with regard to the dependencies) are often neglected in the RV. Based on a survey with 67 buyers and 99 suppliers, (Miguel, Brito, & Reis, 2010) could verify the relationship between the relational resources from the RV and the economic value creation so that the “higher the relational benefit, the higher the value appropriated by the firms”. Therefore, the potential power of the RV was tested in general, but due to the focus of dyadic relationships a testing of the relational rents of the whole network remains unanswered.

Which conclusions can be drawn towards the two research questions? First, more research and a systematic approach from a systematic perspective for a balanced win-win situation of all companies involved seem to be still needed. Secondly, the contribution of the cooperative value creation to the company success is still unclear and the effect of the network has not been extensively analysed for an

operationalisation of the relational rents. Finally, CCA have not been extensively and the contribution of the cooperative relations to the competitiveness on the level of a whole network is still unclear (cf. Figure 1-4). The reason for this is that simultaneous (i.e. a multilevel) considerations are neglected and that there is simply a lack of consideration of the competitiveness of the entity of a whole network in the scientific literature.

Figure 1-4: Illustration of the theoretical relevance



Source: Own illustration.

Consequently, the **theoretical relevance** of the research question can be consolidated in the following way:

Conclusions for
the theoretical
relevance

A theoretical relevance of the two research questions can be assumed because a gap of knowledge concerning definitions about Cooperative Competitive Advantages as well as a gap of knowledge about theoretical explanations in the meaning of cause-and-effect relations between International Supply Networks and the company success from a multilevel-based perspective has been identified.

1.3 Practical relevance: How to manage the cooperative interplay between the individual and the network level?

As outlined in Section 1.1, the practical relevance seeks to provide an **end-means combinations** response to the research questions. This search for the end-means combinations for the practical relevance shall be accomplished by first **selecting an industry** as an area of application because the research question has been introduced on a very general scale so that a stepwise approach, or starting with a single industry, seems promising for drawing closer to the research topic. Secondly, it must be determined whether the selected industry is **challenged with an increasing importance of ISN** as expressed in the research questions because the increasing importance of ISN should lead to problems for handling the ISN such that end-means combinations are needed. Finally, one must assess if **management approaches are needed with regard to the research questions** in particular because of a gap of knowledge as outlined with reference to the theoretical relevance.

In search for the end-means combinations

The practical relevance of the research question shall be shown by using the example of the **international value creation system of the German automotive industry** because of the following reasons: First, the international value creation system of the German automotive industry can be considered as an ISN for reasons delineated in Section 2.1.1. Secondly, it is an industry of great **importance to the German economy** secondary to its premier total revenue in Germany, a high direct and indirectly employment rate as well as the fact that it is the fourth largest automotive industry in the world (Bundesministerium für Wirtschaft und Energie, 2014a, 2014b; Diez, 2012, pp. 34–40; Wallentowitz, Freialdenhoven, & Olschewski, 2009, pp. 1–7). Thirdly, the supply chains or logistic networks²² of the automotive industry count to be the reference for other industrial supply chains and logistic networks because of their versatile production, their high standardisation and their high process optimisations (BVL e.V., 2011; Gehr & Hellingrath, 2007, pp. V–IX; Klug, 2010, pp. vii–viii; G. Urban, 2007, p. 1). To be certain, Henry Ford (1863 – 1947) considered the automotive industry as “the industry of the industries” (Cited with reference to (Bildtsen, 2010, p. 11)). Therefore, the German automotive industry is a crucial element of the German economy, but is the – German – automotive industry also challenged with an increasing importance of ISN?

High relevance of the German automotive industry

²² Cf. the disambiguation about International Supply Networks in Subsection 2.1.1.

Increasing
importance of
ISN

The German automotive industry is **challenged with an increasing importance of ISN** because of an **increasing shift of the value creation towards the supplier, cooperative strategic partnerships as a success factor** for the development of Electric Mobility and an **increasing interconnectivities of worldwide supply chains**.

The German automotive industry is confronted with an **increasing shift of the value creation towards the suppliers** because of the advantages of cooperation (cf. Section 1.1) through the specialisation on certain products or services. For example, the modular construction technique for the Smart of the Daimler AG is based on manifold external labour and pre-assembly services so that 35 so-called system partners deliver 35 pre-assembled major modules to the final assembly step whereby the MINI, produced in Oxford, is finally assembled with 2415 different parts (Sydow & Möllering, 2009, pp. 1–5). Therewith, the in-house production depth of a car manufacturer decreases so that the car manufacturer as the so-called focal firm in such a network organisation focuses on the planning and control of the final production steps and the supply chains as well as on the integration and the management of the relationships to the system partners for the development of new technologies. As a result, the ability to develop products on their own is becoming less important while the competence to evaluate and manage or control the current and potential system partners is becoming more and more important (Mößmer, Schedlbauer, & Günthner, 2007, p. 7; Sanz, Semmler, & Walther, 2007, p. 5,15 et sqq.; Voss, 2007, p. 219 et sqq.; Wallentowitz et al., 2009, p. 28 et sqq.).

Cooperative partnerships have been identified as a **strategic success factor** by using the example of the development of Electric Mobility because e.g. it is connected with certain risks about the sustainable market success and high investments as well as the integration of new companies for developing new customer services and products. Therefore, approaches are needed for managing the whole ISN from a company- and industry-wide perspective. As a result, the value of the network planning for the company success and the competitiveness can also be illustrated through the development of Electric Mobility because it will critically depend on the ability to configure and control the cooperative partners from a company-wide perspective.²³

The German automotive industry is also **challenged with an increasing interconnectivity of the worldwide supply chains** because of globalisation. For example, with reference to (Brintrup, Kito, New, & Reed-Tschochas, 2011), the disaster of Fukushima in March 2011 resulted in a production stop not only of the

²³ (Colmorn et al., 2013, pp. 47–49).

Japanese but also of the European and North-American car manufacturers leading to a loss of one third of the global daily production. Such a magnitude of effect was seen because the cooling agent “Xirallic”, required for the production of a metallic brilliance, was only produced in a single production plant on the world next to Fukushima so that a blackout in this production plant resulted in a production stop of Chrysler, Ford and Toyota after their stocked supply had been exhausted. Another example of the consequences of the Fukushima-earthquake can be found in the shutdown of the entire factory of the car manufacturer GM in the USA because one single component from a Japanese supplier was missing – the base price of this single component per unit accounted for \$2,000. For this reason, the chief of Toyota Europe drew the conclusion to breakdown the long cultivated but highly fragile supply chains with only one supplier so that Toyota is going to bow out or soften the famous Keiretsu-policy that has been practised for decades. The reason for this worldwide production stops and significant shift in the procurement strategy of Toyota can be traced back to the structural interrelations of the Supply Chains. Despite of the fact that the Supply Chains of the European and North-American car manufacturers did not contain for the most part Japanese suppliers directly on the first and second step of the value creation, the suppliers of the European and North-American Supply Chains of the third value creation step were delivered from the Japanese supplier. Therefore, once these suppliers had used up their production stocks, they had no choice but to halt production. Consequently, because of these worldwide interrelations of the Supply Chains, dependencies develop that cannot be understood and captured through an isolated consideration of a single Supply Chain of one car manufacturer. Therefore, the nature of these structural interrelations and the potential for significant losses and impacts on market competitiveness merits further investigation and increased awareness in this arena.²⁴

Accordingly, the automotive industry is challenged with an increasing importance of ISN so that e.g. Diess as a member of the Board of Management of the BMW AG with responsibility by that time for ‘purchase and supplier network(s)’ highlights that the complexity and risk management will become a core competencies of the car manufacturers (Kümmerlen, 2012). In this regard, (Sanz et al., 2007) describing the position of Garcia Sanz as a member of the Board of Management of the Volkswagen AG with responsibility for ‘Procurement’ (Volkswagen, 2012) draw the conclusion that the competence of the network management (i.e. the ability to successfully plan, manage, integrate and control the company-wide collaboration in

²⁴ This passage is adapted from (Colmorn & Hülsmann, 2013, p. 535).

global networks) would be become an essential core competence for the car manufacturers.²⁵ Therefore, the question about management approaches arises.

Supply Chain Management

In general, **strategies for managing ISN**²⁶ can be **classified** by organisational principles for their coordination and control. The reason for this is that according to (Sydow, 2010a), ISN can be understood from an institutional point of view as a hybrid organisation between the forms of market and hierarchy that are characterised by relatively stable cooperative relationships between legally independent but economically interdependent companies in which the partners act as value-creating units that contribute to the ISN by bringing specific competencies and resources in order to optimise the value creation of the whole network.²⁷ In this conjunction and because of this organisational network structure, the value creation system of the automotive industry (i.e. the ISN) is typically further **characterised** as a so-called strategic network in which the car-manufacturer as the focal firm (i.e. the OEM) coordinates amongst the partners within the network by initializing formal contracts for a longer period (Bea & Haas, 2005, pp. 437–438). For this reason, it is the **idea** of the **network management in the field of Strategic Management** that the OEM strategically coordinates the whole International Supply Network targeted towards the **aim** to fulfil the four **specific tasks of the network management**, including the selection, the allocation, the regulation and the evaluation (Sydow, 2006, p. 406 et sqq.). The first task of the network management defines the **selection** of the activities to take place and of appropriate partners for the value creation while the second task of the **allocation** specifies the distribution of tasks, resources and responsibilities to the partners of the value creation. The third task of the network management defines the **regulation** of actuating variables with regard to a closed loop control of company-wide supply chains. Finally, the fourth task of the network management refers to the **evaluation** of the costs and usages for a company to participate in the development of electric mobility through cooperation. With the help of this **characterisation** of the network management in general, the **Supply Chain Management** can be **classified** as an approach that takes the tasks of the network management from a company-wide perspective into account.

The **Supply Chain Management** can be **assigned into the field of Strategic Management** as a sub-discipline about the **logistics research** because it has been widely accepted that their strategies can help gaining a competitive advantage (Schulte, 2009, p. 7,17,523 et sqq.). In this conjunction, the meaning of logistics for

²⁵ Summary according to (Sanz et al., 2007, pp. V–VI).

²⁶ The word “management” has its etymological origin in the two Latin words *manus* meaning hand and *agere* meaning to do. For this purpose, the two criteria of effectivity (“to do the right things”) and efficiency (“to do things right”) are mostly used in the context of the Strategic Management (cf.

²⁷ Cf. Subsection 2.1.1.

the discipline of managerial economics has been widely accepted because it can significantly influence the performance of a company (Schönsleben, 2004, p. 36). In order to manage this influence on the performance of a company by controlling, coordinating and organising logistics processes, **two main management concepts can be distinguished**: logistics management and supply chain management. While the concept of **logistics management** considers the flow of objects independently from institutional arrangements, the **concept of Supply Chain Management (SCM)** takes the structure and coordination of autonomously acting organizations explicitly into account. According to (Arndt, 2010, p. 46; Meyer, 2007, p. 12; Schulte, 2009, pp. 14–16), the concept of Supply Chain Management is **defined**²⁸ as the company-wide coordination and optimization of the flow of materials, information and capital along the whole value creation process from the raw materials to end-customer focusing on the needs of the customers. Against this background, it is the **idea** of the **Supply Chain Management** to integrate all the participating partners along the value creation processes through cooperation into the overall tasks so that a holistic and process-oriented design of the core processes and coordination of the flow of information and material is achieved for the benefit of all cooperating partners (Schulte, 2009, p. 524). Therefore, the **Supply Chain Management** is **targeted towards** the relations between the network partners for optimising the fulfilment of the needs of the end customer (Christopher, 2005, p. 14; Harrison & van Hoek, 2008, p. 6 et sqq.). This is grounded on the **main assumption** that the value creation for the end customer is optimised by **coordinating** all the partners so that a win-win-situation for all partners can occur (Schönsleben, 2004, p. 74). This conclusion about the coordination and optimization from a company-wide perspective refers to a **coordination mechanism**. According to (Xu & Beamon, 2006, p. 4), a coordination mechanism is a set of methods used to manage interorganizational dependencies within the supply chain. The german word “**controlling**” (engl.: management accounting) refers to such a coordination mechanism because its function consists in the support for the strategic management (Göpfert, 2005, p. 53). Hereby, a **strategic controlling** that is targeted towards the realisation of potentials of success has to be distinguished from an **operative controlling** targeted towards the profitability (Meyer, 2007, p. 20).

²⁸ Besides this definition, (Schulte, 2009, pp. 15–16) introduces five schools of thought based on an analysis of different concepts:

- The **(Functional) Chain Awareness School** focusses on the existence of a supply chain with different parts between supplier and customer (flow of mate)
- The **Linkage/Logistics School** focusses on the continuous harmonization of all activities aiming to reduce the stocks (flow of material).
- The **Information School** focusses on the bi-directional flow of information so that the feedback from the customer about the performance is considered.
- The **Integration/Process School** focusses on the integration of all business process towards the needs of the end-customer.
- The **Future School** focusses on the management of relations based on partnership. Replace SCM through “seamless demand pipeline”.

With regard to logistics, (Weber, 2002, p. 14 et sqq.) differentiates between a controlling for traditional logistic processes of transportation, transaction and storage, for a coordination-oriented controlling, for a flow-oriented controlling and for a supply chain. The **Supply Chain-Controlling** focuses on the interplay of different companies in order to support the collaboration of lawfully and economically independent organisations for improving their cooperation. One main characteristic of such a Supply Chain Controlling is the narrowed focus on common parameters that concern all cooperative partners and a shared understanding of processes (Meyer, 2007, p. 20). Secondary to this focus, the **main contributions** can be summarised as follows: Firstly, it is widely accepted that an effective SCM has “become a potentially valuable way of securing competitive advantage and improving organisational performance” (Li, 2002). Secondly, it offers a framework within the field of Strategic Management for the network management because it takes the company-wide coordination and control explicitly into account. Thirdly, it is based on cooperation and with regard to the Supply Chain Controlling, such that parameters are targeted and are able to reflect the quality and quantity of the cooperative collaboration that fits to the outlined scientific *modus operandi*. Conversely, some **main limitations** must be disclosed. (Meyer, 2007; Weber, 2002) highlight that only primary theoretical concepts in the literature and few practical applications can be found (Meyer, 2007, p. 21; Weber, 2002, p. 185). For example, the **supply chain operations reference (SCOR)-approach** is a widely accepted and commonly used approach. With reference to (Höbig, 2006; Supply Chain Council, 2003), its aim is to describe, to evaluate and to analyse supply chains from a company-wide perspective. Its main assumption is that the efficiency of a supply chain can be measured with the help of ratios and the comparison with industry-sector-specific parameters. Its central message is to consider five elementary processes – source, plan, make, deliver and return – on three different levels. Hereby, the first level defines the scope and content for the SCOR approach so that competitive targets are set. The second level configures the operative strategies and the third level specifies the ability to compete successfully, defines process elements and their information inputs and outputs, sets process performance metrics and defines best practices. The SCOR approach contributes successfully to the evaluation of the efficiency of the flow of materials by considering traditional logistic processes transportation, transaction and storage. Its limitations consist of the neglect of an informational flow. Therefore, the transfer of knowledge through cooperation is not adequately considered so that the postulate of the value creation is not represented. Therefore, the SCOR approach is not sufficient enough with regard to the research questions. Furthermore, by investigating the scientific journals “International Journal of Logistics”, “Journal of Business Logistics”, “Supply Chain

Management Review” and “Sloan Management Review”, (Göpfert, 2005) highlights that no articles discussing Supply Chain Controlling can be found. Additionally, (Göpfert, 2005, p. 61 et sqq.) points out that the corresponding questions concerning the which information should be available in a network, how an International Supply Network should be planned and managed and how suitable organisational solutions for the network management could look like are not adequately answered in the scientific literature. Finally, by considering (Eßig, Hofmann, & Stölzle, 2013; Fandel, Giese, & Raubenheimer, 2009; Lenz & Kramer, 2008; Münch, 2009; Pollmeier, 2008; Weber, 2002), it can be derived that ratios for evaluating the organisational structural relations in an International Supply Network are only marginally considered or not at all. Hereby, approaches for investigating the ability of International Supply Networks to “adapt to changing environmental conditions in order to avoid failures” are only focussing on the traditional logistic processes transportation, transaction and storage (Choi, Dooley, & Rungtusanatham, 2001; Hicks & Gullet, 1975). For example, (Hülsmann, Colmorn, & Bakhrudtzinava, 2011) developed an analytical model to reflect the complex adaptive behavior of International Supply Networks to formally analyse its consequences for the logistics management with respect to variabilities of the amount of produced goods (cf. (Wycisk, Mckelvey, & Hülsmann, 2008)). For this reason, despite of the fact that the increasing relevance and the chances that can be gained through a selection of an effective coordination mechanism for a supply chain (e.g. resource sharing structure, decision style, level of control, and risk/reward sharing) a gap of knowledge about International Supply Networks and adequate control mechanisms for the network management – especially with regard to the automotive industry (Towill, Childerhouse, & Disney, 2002) – concerning the research questions can be assumed (Xu & Beamon, 2006, p. 4). Finally, (Christopher, 2005, p. 44; Eßig et al., 2013, p. 10; Schönsleben, 2004, p. 74) point out that the behaviour or the optimal configuration e.g. with respect to the value-added depth for a company might not be necessarily optimal for the whole network so that approaches for managing a balanced win-win situation with regard to the economic feasibility for all companies involved and based on cooperation would be needed.

Consequently, a practical relevance of the two research questions can be assumed because it seems that approaches for managing a win-win situation between the individual and the network level are missing. This can be traced back to a lack of an operationalisation of the effects of an ISN on the competitiveness that takes both levels explicitly into account.

Practical
relevance

1.4 Objectives: The development of an explanation approach

Correspondingly to the research question and its outlined theoretical and practical relevance the **overarching objective** can be formulated as it follows:

Overarching
objective

It is the overarching objective to develop an **explanation approach** capable of describing Cooperative Competitive Advantages as well as the causal relations between an International Supply Network and the company success.

Such an explanation approach enables the identification and explanation of the multi-level causal relations of an International Supply Network on the individual level (i.e. on the company success) and on the network level through the realisation of Cooperative Competitive Advantage. Its purpose consists of outlining the underlying cause-and-effects-relations on the basis of assumptions that reflect the directional relations between the variables of International Supply Networks and the company success. In order to achieve this **overarching objective** (Bea & Haas, 2005, pp. 22–24; Chmielewicz, 1979, p. 8 et sqq.; Wolf, 2008, p. 8 et sqq.) introduce general principles of scientific research so that the **overarching objective** can be divided into the **descriptive**, the **analytic** and the **pragmatic research task**.

Descriptive
research task

The **descriptive research task** aims to describe reality. Therefore, it is the overarching **descriptive scientific aim** to depict the nature of the research problem, the solution approach and its empirical validation including their corresponding subjects of consideration such as theories or concepts like Cooperative Competitive Advantages of International Supply Networks.

Analytic research
task

Based on this, the **analytic research task** are targeted towards the cause- and effect-relations so that the overarching **analytic scientific aim** consists of the analysis of phenomena with the help of theoretical frameworks. Therewith, the main contribution of this PhD-thesis is targeted towards addressing the existing gap of knowledge about the effects of the ISN, particularly in the sense of cause-and-effect relationships on competitiveness as a dependent variable.

Practical research
task

With the results of the identified cause-and effect-relations the **practical research task** shall help to derive implications for the strategic network management so that appropriate end-means-relations can be identified for recommended courses of actions.

1.5 Scientific *modus operandi*: Systems Theory for the Strategic Management

This work is written to fulfil the requirements of a **PhD-degree** in ‘**International Logistics**’ in the working group ‘**Systems Management**’ of Prof. Dr. Michael Hülsmann at Jacobs University Bremen gGmbH, Germany. A PhD degree constitutes an academic doctoral degree certifying a **self-reliant scientific working** of the candidate (cf. (Jacobs University Bremen gGmbH, 2014a)) while the aspect of the self-reliant working is testified in the Affidavit, the aspect of the scientific working, or the scientific *modus operandi*, shall be explained in this section.

PhD in
‘International
Logistics’ in the
working group
‘Systems
Management’

Interdisciplinarity can be defined as the usage of different approaches, modes of thoughts and methods of different scientific disciplines (Duden, 1997, pp. 369–370; Jacobs, 2014, p. 1 et sqq.; Jungert, Romfeld, Sukopp, & Voigt, 2010). This PhD Thesis can be characterised as an **interdisciplinary PhD Thesis** because different research topics and scientific disciplines will be approached, including competitive advantages from the field of Strategic Management, the logistic target areas from the field of logistics and Supply Chain Management and complexity from the field of natural sciences.²⁹ Therefore, the limitations of writing an interdisciplinary PhD-thesis shall be shortly outlined in order to avoid misconceptions that could be the result of the interdisciplinary perspectives.

An
interdisciplinary
PhD-Thesis

In order to determine the limitations of such an interdisciplinary PhD thesis the **philosophy of science** is introduced with reference to (Chalmers, 2007) because he gives an introduction into the philosophy of science in his standard book *What is this thing called science* so that a general understanding of science and its requirements can be derived. According to (Chalmers, 2007, pp. 1–2) science is held in high esteem because it implies a special credibility. The reasons for this special credibility can be traced back to the concept of a scientific method of the natural sciences. Even social scientists would argue that the success of physics during the last 300 years is the result of their specific scientific method in order to reach similar successes in other fields so that its way of functioning should be understood and applied. This functioning of the scientific method implies the **idea** that only the experimental approach would be a demonstration of the reality in nature (Chalmers, 2007, pp. 1–2). In this regard, even the poet Goethe has argued that “[t]hrough words we neither express completely the objects nor ourselves” so that language is not able to exactly match the reality and that “abstractions conceived by the mind can therefore be misleading” (cited according to (Watson, 2011, p. 205)). The experimental approach

Philosophy of
science

²⁹ These topics and research fields will be introduced in more detail in the corresponding sections.

or an experiment serves to prove facts occurring in reality about assumed causal relationships by eliminating other overlapping influences. Hence, this focus on the experiment points to the critical rationalism (cf. below), but other **approaches** or schools of thoughts such as e.g. the constructivism in the field of scientific theory also exist.³⁰ By considering the German word for **science**, i.e. *Wissenschaft* which refers to the creation of knowledge because it combines the two words *knowledge* (= Wissen) and *schaffen* (= create) so one can imagine that the **overarching objective** of science can be defined as to create knowledge. For achieving this overarching objective, the two **assumptions** of objectivity and measurability play an important role because objectivity refers to the requirement that the incidents of events are reproducible under exactly the same conditions while measurability refers to the requirement that the same incidents of events can be reproduced in numerical form (T. A. E. Ebert & Raithel, 2009, p. 514). Therefore, the particular importance of causality can be **concluded** because both requirements refer to the cause-and-effect relations that the incident of an event can be reproduced (i.e. measured), if all influencing variables stay the same (objectivity). In this regard, (Van Doren, 2002, p. 241,246) highlights that the scientific method of natural sciences was the most valuable **contribution** of the Renaissance to the world because whenever people were able to measure things (i.e. to refer to numbers) they were able to make progress. Therefore, it can be concluded that the scientific method is of particular importance for the scientific *modus operandi* that points to the critical rationalism according to (Popper, 1998).

Epistemological
scientific
position

The critical rationalism according to (Popper, 1998) can be identified as the **epistemological scientific position** of this thesis because the philosophical discipline of the epistemology generally deals with the evaluation and justifiableness of knowledge (Duden, 1997, p. 232) and it is the **idea** of the critical rationalism to use the method of the falsificationism³¹ in order to evaluate and justify knowledge (Chalmers, 2007, p. 51; Popper, 1998, p. 59 et sqq.). The **falsificationism** is grounded on the basic assumption that a hypothesis can never be proved but in some cases it might be disproved or falsified (Chalmers, 2007, pp. 53–55; Popper, 1998, p. 13 et sqq.). Against this background, it is the central conclusion of the falsificationism that the falsifiability is a characteristic of a scientific statement (i.e. a statement is falsifiability) if a set of observations exist that contradict the scientific statement (Chalmers, 2007, pp. 53–55; Popper, 1998, p. 13 et sqq.). Therefore, the major contribution of the falsificationism consists of separating empirical from non-

³⁰ Cf. the introduction into different approaches of (Chalmers, 2007).

³¹ An introduction into the falsificationism can be found in e.g. (Chalmers, 2007, pp. 51–86; Pies & Leschke, 1999)

empirical statements so that a theory is empirical if at least one set of observations exists with whom its empirical examination can lead logically to a contradiction (Chalmers, 2007, pp. 53–55; Popper, 1998, p. 13 et sqq.). Hence, the falsificationism has some limitations regarding the power of explanation because it cannot provide a criterium for a rational acceptability, a scientific acknowledgement or a sensibility of a statement and, secondly, it is not a criterium for the quality or goodness of a statement (Chalmers, 2007, pp. 56–57).³²

Consequently, with regard to the two research questions and the corresponding overarching objective the need for falsifiable causal assumptions can be derived. As a result, the development of a causal model containing assumptions about positive or negative directions of causal relations has to be developed. Additionally, a measurement approach has to be developed for measuring and for, finally, empirically validating these causal assumptions in a third step. The question about how such falsifiable causal assumptions can be derived will be answered with the help of the ontological scientific position.

The **ontology** is **part of** the theoretical philosophy dealing with the basic structures of reality and the general application of terminologies for getting a system of fundamental types of entities such as subjects, characteristics or processes or their structural relations (Duden, 1997, p. 570; Störig, 1999, p. 645 et sqq.).³³ One such ontological approach is the **course of research** (German: “Forschungskonzeption”) according to (Chmielewicz, 1979) because he remarks that the field of managerial economics would not consist of a theory in a strict scientific sense (Chmielewicz, 1979, p. 8) so that it is the **aim** to make a scientifically correct contribution to the field of managerial economics by developing an ontological scientific position (Chmielewicz, 1979, p. 2). The **course of research** according to (Chmielewicz, 1979) is grounded on the **basic assumption** of the critical rationalism trying to achieve a falsifiability of statements (Chmielewicz, 1979, p. 5) so that it is in accordance with the outlined epistemological scientific position of Popper’s falsificationism. By considering that ontological systems and their way about how to perceive the “reality” (Stuckenschmidt, 2011, pp. 8–9), the **course of research** according to (Chmielewicz, 1979) offers a framework about how to perceive the subject of scientific consideration. The reason for this is that it approaches every subject of scientific consideration with the help of three perspectives (Chmielewicz, 1979, p. 8):

Ontological
scientific
position

³² A critical discussion about the falsificationism and the critical rationalism can be found in e.g. (H. Albert, 1977).

³³ An introduction into the ontology can be found e.g. in (Effingham, 2013).

- The essentialistic scientific aim is targeted towards a definition expressing the corresponding nature so that a so-called definiens for a definiendum is searched for (cf. (Chmielewicz, 1979, p. 50 et sqq.)).
- The theoretic scientific aim attempts to explain relations so that cause-and-effect relations are searched for (Chmielewicz, 1979, p. 80 et sqq.).
- The pragmatic scientific aim consists of applications as a way to describe end-means combinations (Chmielewicz, 1979, p. 169 et sqq.).

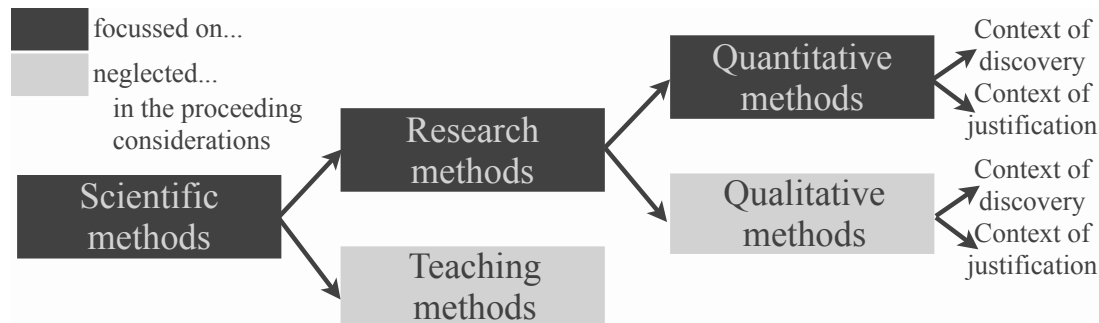
Consequently, with regard to the two research questions and the corresponding overarching objective the **course of research** according to (Chmielewicz, 1979) provides a framework about how to scientifically proceed for investigating a subject of scientific consideration. Therefore, three groups of research task – a descriptive, an analytic and a pragmatic research task – can be derived that have previously been employed for a subdivision of the overarching objective and that will build the framework for the structural scientific proceeding as will be outlined in Section 1.6. Additionally and with regard to the essentialistic scientific aim, (Chmielewicz, 1979, p. 43 et sqq.) points out that the nature of every subject of scientific consideration could be depicted with the help of its elements and its relations with other elements as well as its characteristics whereby functions are considered to be special form of a characteristic expressing its purpose. The elements, relations, characteristics and functions constitute the structure of a subject of scientific consideration (Chmielewicz, 1979, p. 45) and this way of perceiving refers to or supports the underlying theoretical framework. Hence before the underlying theoretical framework will be outlined, the methodological scientific position shall be introduced as it improves understanding about how the epistemological and ontological scientific position can be achieved.

Methodological scientific position

In general, the **concept of a method** refers to a systematic approach for gaining scientific insights based on a system of a rules (Duden, 1997, p. 515) and with reference to (Chmielewicz, 1979, pp. 36–37) the manner about how to proceed in a scientific discipline for gaining knowledge. Therefore, the concept of a method can be **assigned into the field** of science in which teaching methods that concentrate on the presentation are differentiated from research methods that are at the centre stage of theory development and are targeted towards gaining knowledge (Chmielewicz, 1979, pp. 36–37). By focussing on research methods secondary to the objectives of this thesis, **different approaches** can be further distinguished, on the one side with the type of methods and on the other side with respect to their goals. Methods for the context of discovery concentrate on the question which methods lead to new

knowledge while methods in the context of justification concentrate on the question with which methods new knowledge can be reasoned as true (Chmielewicz, 1979, p. 37). According to (Schwaiger & Zimmermann, 2009, p. 421) these research methods can be further separated into quantitative and qualitative methods (cf. Figure 1-5).

Figure 1-5: Overview scientific methods



Source: Own illustration.

The **origin** of the **concept of quantitative methods** can be traced back to the experimentation in the field of natural sciences because they were strived to reach their goal of knowledge through the application of measurements, tests and mathematical quantifications before these methods were transfered to the field of social sciences. It is the **idea** of **quantitative research methods** to describe and analyse real relationships in numerical, or measurable, form (Schwaiger&Zimmermann, S. 419). Therefore, it is the **aim** of **quantitative methods** to express the characteristics or features of objects through numbers with respect to certain rules because its **basic assumption** can be expressed through Galileo's words that the world is written in the language of mathematics (Fischer, 2002, p. 51). It is the **essential conclusion** of the quantitative methods that numerical information (i.e. data) constitute the corner stone of every statistical analysis and that the quality of such a statistical analysis is determined through the quality of the data (Backhaus, Erichson, Plinke, & Weiber, 2008, p. 6). Hereby, the quality of the data is determined through the manner of the measurements because the considered characteristics of the object determines how well it can be expressed through numbers so that the nominal, ordinal, the interval and the ratio scale are usually distinguished that are in a hierarchical order (Kromrey, 2009, pp. 224–227). The **main contribution** consists of being in accordance with the epistemological scientific position because of their inherent nature of measuring phenomena so that a falsification becomes possible. This is **limited** through the aspect that a focus on the quantification has a limited power of explanation because for example normative statements are rarely quantifiable so that an interpretation with the help of qualitative approaches is often needed (Chmielewicz, 1979, p. 207 et sqq.). **Consequently**, for

the **methodological scientific position** about which instruments to use for gaining knowledge the class of **quantitative methods** will be focussed on because they allow the testing of relationships with regard to Popper's falsificationism.

Underlying
theoretical
framework

Generally, a **theory** or a **theoretical framework**³⁴ is a system of statements for describing or explaining parts of the reality or for predicting developments in the future (Chmielewicz, 1979, pp. 11, 162). It is the aim of this passage to select an **underlying theoretical framework** because different theoretical approaches and therefore different system of statements exist that can lead to different explanations with regard to the overarching objective. For example, (Schwaiger & Meyer, 2009, p. VIII) introduce several approaches as essential theories in the field of managerial economics.³⁵ Hereby, constructivistic approaches from the field of organisational theory might be very problematic with regard to the introduced scientific positions because they are based on the assumption that insights would be the result of subjective conclusions so that it is in contrast with the position of the critical rationalism (Schempp, 2009, pp. 17–19, 26–27). Additionally, as it has been outlined in Section 1.2, the Resource-based View might be able to explain the creation of a competitive advantage on an individual level, but it has been argued that it is unable to explain a Cooperative Competitive Advantage on the level of the network. Therefore, with regard to the two research questions and the overarching objective the thesis is reliant on a theoretical framework which is ultimately selected based on its ability to meet the **requirements of this thesis**. Due to the two research questions these requirements comprise – besides the three above-introduced scientific positions – the interdisciplinary character of the topic and the consideration of an individual and a network level respectively their causal interplay. A theoretical framework that is able to meet these requirements is **Systems Theory**.

What is Systems Theory? Systems Theory³⁶ comprises the **idea** of providing an interdisciplinary theoretical framework for the study of different systems targeted towards the **aim** to find universal principles that can be applied to all types of different systems (Bar-Yam, 1997, p. xi; Gharajedaghi, 2006, pp. 25–27). Therefore, it is based on the **main assumption** that all these different types of systems such as

³⁴ An introduction into the field of scientific theories can be found in e.g. (Kuhn, 2012; Nola & Sankey, 2007). The word theory comes from the Latin word *theoria* meaning perception (Duden, 1997, p. 508) so that besides the above-introduced understanding in the epistemological scientific sense the word “theory” also refers to a more grounding understanding meaning about how to perceive the subject of scientific consideration.

³⁵ Constructivistic approaches from the field of organisational theory, the resource-dependence-approach, industrial economics, the resource-based-approach, the contingency theory, the diffusion theory, the transaction-costs-approach, the principal-agent-theory, the property-rights-theory, the normative as well as the descriptive decision theory, the prospect-theory, game theory (and its application in managerial economics), motivational theories, theory of justice, the attribution theory and theory of self-determination.

³⁶ An introduction into Systems Theory can be found in e.g. (Luhmann, 2013; Von Bertalanffy, 1976).

economic or biological ones would comprise the same features or the same phenomena, including self-organising patterns of behaviour (Malik, 2008, pp. 70–71; Meyer, 2007, pp. 12–14). In this regard, a development of different schools or different fields of studies can be distinguished over time. Ludwig von Bertalanffy (1950) developed the General System Theory that was extended with the help of a mathematical theory of communication and control of living, technical and social systems through feedback loops in the research area of cybernetics (cf. (Haken, 2007; Von Bertalanffy, 1976)). With the development of the Chaos Theory – a mathematical theory for describing the chaotic behaviour of nonlinear dynamic systems – in the 1970s and the 1980s, Systems Theory was expanded with the research about the emergence, adaptation and self-organisation of Complex Adaptive Systems, mainly conducted by the Santa Fe Institute through the works of e.g. John Holland and Murray Gell-Mann (cf. (Gell-Mann, 1995; Holland, 2006)).³⁷

Why to use Systems Theory? International Supply Networks cannot only be considered as systems but also as Complex Adaptive Systems as will be outlined in more detail in Section 2.2 (Cf. (Grapp & Hülsmann, 2005; Hülsmann et al., 2011; Wycisk et al., 2008)). As a result, the concept of Complex Adaptive Systems might be able to provide a framework for explaining the causal interplay between the individual and the network level because of the feature of emergent characteristics of Complex Adaptive Systems. In general, emergent characteristics are macroscopic characteristics of a dynamic system that do not appear in the microscopic elements of the system and that cannot be derived from them so that “the whole [might be] greater than the sum of its parts” (Bar-Yam, 1997, pp. 10–12; Duden, 1997, p. 222; Mainzer, 2008, p. 119; Mitchell, 2009, p. 13). Finally, **Systems Theory** seems to meet the requirement of the interdisciplinary nature of the Thesis because of its formalised approach to the concept of a system. The concept of a system was originally derived from the Grecian word *systema* meaning a “whole compounded of several parts or members” (Ludwig, 2001, p. 12) and it has the objective to extract an aperture for consideration so that structures of an event can be recognized and can be ordered across time and space (Rolf, 1998, p. 25). While the separation between a system and its environment that takes place by convention, the character of a system is approached through a formalised holistic thinking in order to find common similarities in a diversified set of systems (Meyer, 2007, pp. 12–13). This formalised approach comprises the differentiation between an individual or microscopic view and a network or system or macroscopic level as well as an abstract representation in the form of stylised models (Bossel, 2004, pp. 356–362; Gharajedaghi, 2006, p. 60 et

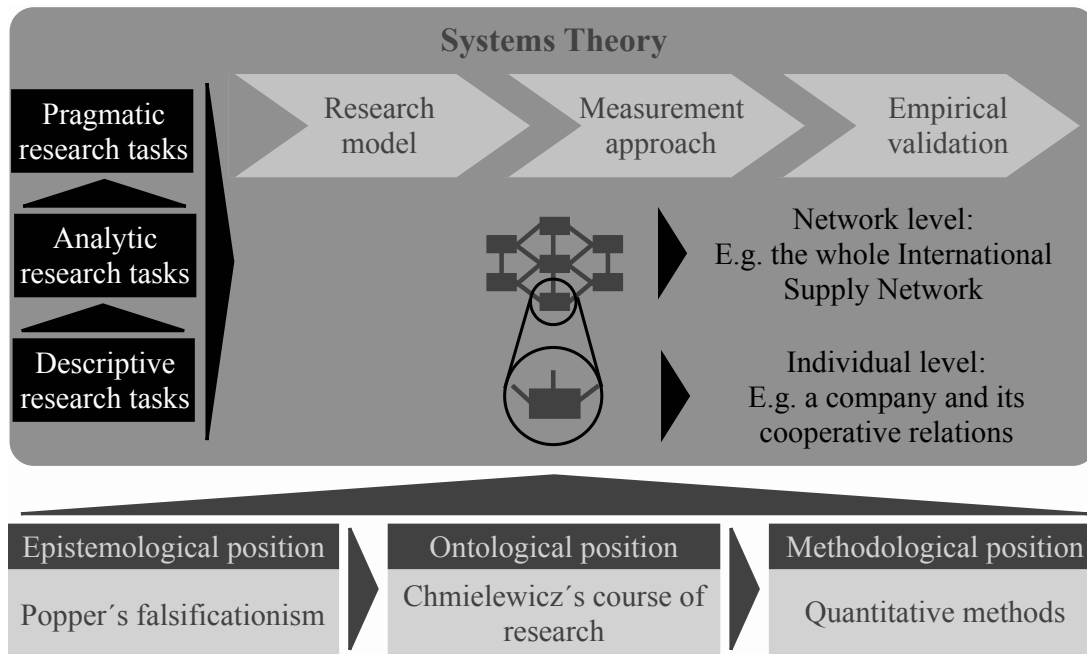
³⁷ This short list of different fields of studies in the area of Systems Theory do not claim to provide a complete overview that can be found e.g. (Zimmermann, 2010) who tries to conduct a historical synopsis.

sqq.; Neuberger, 2002, pp. 594–595). Another reason that is more of normative nature refers to the author's background of having received a German **diploma degree in Physics** with a diploma thesis about the “Self-organisation of multiagentsystems in a market-similar modell”. According to (Buckingham & Clifton, 2011, pp. 11–12, 16–19) who conducted a research project over 25 years with more than two million participants to establish the necessary talents for personal development, they hold the view that someone should focus on her or his strengths because these are the areas where one can fulfill overachievements. From a normative point of view the author is aware that he will never be able to appropriately follow the requirements of a social scientific approach, but he can focus on his strengths to think in an abstract and analytical way to develop models through the process of simplification.

This refers to the question of **how best to employ Systems Theory**. **Systems Theory** and theoretical approaches such as the shortly addressed framework of Complex Adaptive Systems will be used for developing the research model. Hereby, these will help derive causal assumptions e.g. about the causal interplay between the individual and the network level or between the ISN and the individual level. This will be accomplished by connecting these interdisciplinary aspects e.g. with theories from the field of Strategic Management which has the potential to ground the developed research model on a much stronger theoretical basis if it is able to translate or transform implications from Systems Theory-based approaches through theoretical insights from the field of Strategic Management. In order to do so, the development of a research model will focus on the abstract approach of Systems Theory to develop a stylised model with the help of simplifications. Consequently, the following references for support the statements will not claim to provide an extensive substantiation with the scientific literature, as is the common approach in the field of social sciences. For example, (Cordes-Berszinn, 2013) provides a marvellous example about how to conduct a hypothesis-generating approach that is based on an extensive review of the corresponding literature. In contrast, this thesis intends to develop a simplified research model, e.g. through the formal representation of a system through elements and relations, in a first step that is operationalised through an empirical validation. The reason for this is that with regard to Popper's falsificationism and the scientific method, conclusions about the auspicious or validity of the causal relations can be drawn. Therewith, it can be evaluated if the developed research model merits continued work or not. This is a common approach in the field of physics which comprises the background education of the author as well as his experience in research.

Figure 1-6 shall illustrate the scientific modus operandi by integrating the outlined scientific positions as well as their implications and the underlying theoretical framework of Systems Theory.

Figure 1-6: Illustration of the scientific modus operandi



Source: Own illustration.

Consequently, with regard to the scientific modus operandi a research model, a measurement approach and a empirical validation shall be accomplished because of the outlined epistemological, ontological and methodological scientific positions. Secondary to the underlying theoretical framework of Systems Theory, the research model shall be developed with the help of an abstract or stylised approach so that the International Supply Network is formally represented through elements, relations, characteristics and functions. Therefore, the thesis is reliant on a systematic and scientific procedure.

Consequences
for the scientific
modus operandi

1.6 Structural proceedings: Different logics as structuring principles

Finally, the **structural proceedings** of this PhD-Thesis will be presented because the structural and therewith goal-oriented presentation of the content (i.e. the structural proceedings) is an essential part of the scientific performance so that systematic approaches as structuring principles must be proposed.

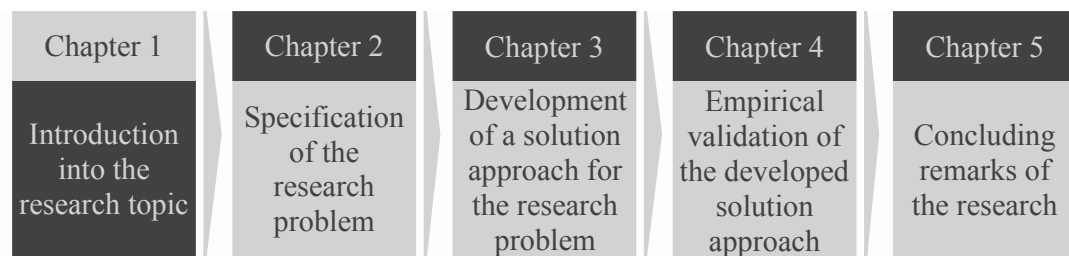
Minto's pyramid principle as an overarching logic

The **pyramid principle** of (Minto, 2005) provides an **overarching logic**:

- “The human brain automatically arranges information in separate pyramide groups for getting a better understanding.
- Every group of ideas is easier to understand, if it is presorted into a pyramide for the receiver of the message.
- As a result, every written composition should be intentionally structured as a pyramide of ideas” (Translated from (Minto, 2005, p. 17)).

Therefore, the structural proceedings will follow where possible this **top-down-approach** according to (Minto, 2005) as an **overarching logic**. With the help of this top-down approach, **three different levels** of considerations – the levels of the **chapters**, **sections** and **subsections** – can be distinguished for the structural proceeding and different goals of knowledge can be assigned to them.

Figure 1-7: Structural proceedings on the level of the chapter



▶ The **chapters** follow a logical **structure** in which they **build up on each other**
Source: Own illustration.

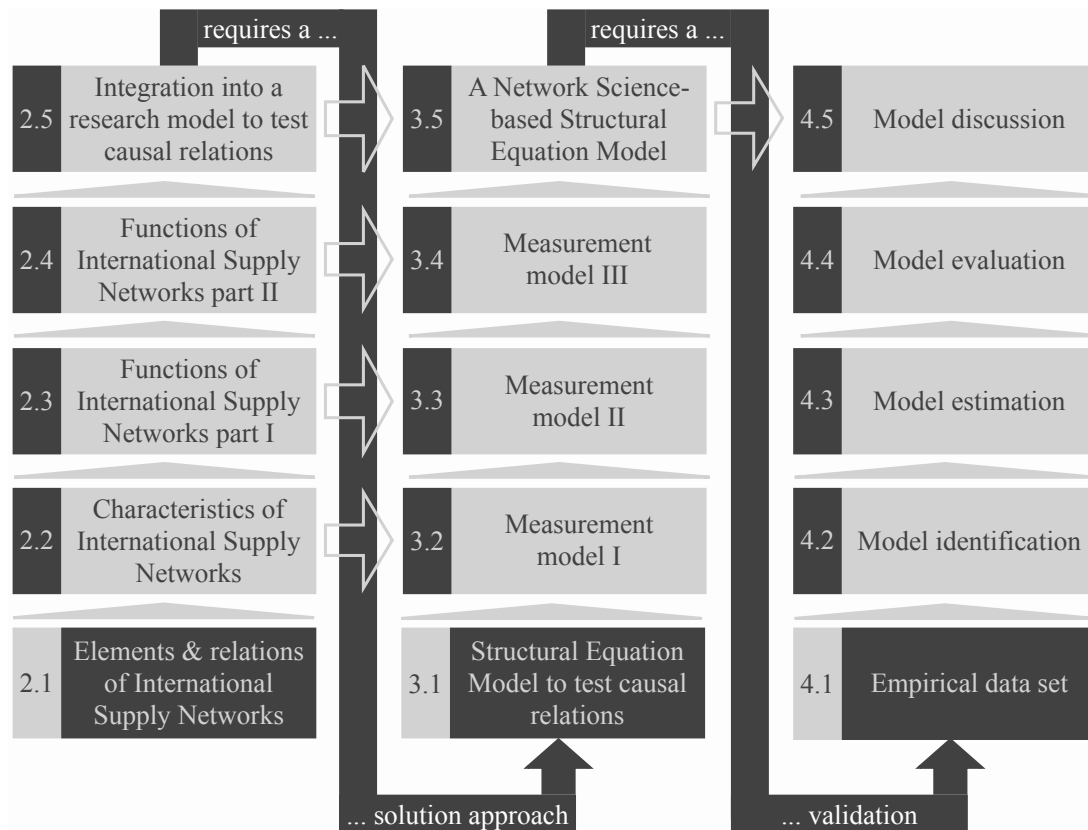
Chapter level

On the **level of the chapters**, the proceedings are structured in five chapters because it is a logical approach in the working group ‘Systems Management’. The first chapter intends to introduce the topic by outlining the research question, the objectives and the scientific *modus operandi*. The second chapter is targeted towards the specification of the research problem so that based on this the third chapter can develop a solution approach for this research problem. Based on this, the fourth chapter will empirically validate the proposed solution approach before the fifth chapter concludes with a summary of the scientific contributions (cf. Figure 1-7).

Section level

On the **level of the sections**, the structure for the 1st and 5th chapter differs from the other ones because they cover a more general level by introducing and concluding the research of this thesis (cf. above). In general, the structure on the level of the sections for the second, third and fourth chapter is the result of the subject of consideration in the introductory section of each chapter as the exemplary illustrated in Figure 1-8. Hereby, as well as for the solution approach and the empirical validation the first section determines the logical proceeding either because of the ontological scientific position in the second or the proposed systematic proceeding of the Structural Equation Modeling approach in the third and fourth chapter (cf. Figure 1-8).

Figure 1-8: Structural proceedings on the level of the sections



► The **structure on the level of the sections** follows a logic in which the sections are **based on the first section of the corresponding chapter** ◀

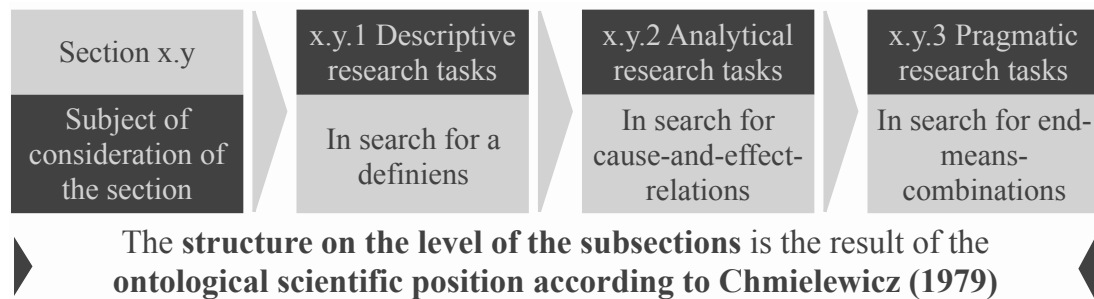
Source: Own illustration.

On the **level of the subsections**, the structural proceeding will be held uniquely – as far as possible and appropriate – because it is the result of the course of research according to (Chmielewicz, 1979) so that a systematic proceeding according to the descriptive, analytic and pragmatic research task is followed (cf. Figure 1-9). Hereby, it must be mentioned that the definiens outlined in the first subsection of

Subsection level

each section is mainly targeted towards the subject of consideration that stands in the core of cause-and-effects-relations of the second subsection so that two perspectives – a cause- and an effects-perspective – arise. The final aspect of these analytic considerations is then usually the subject of consideration of the end-means combination of the third subsection because it has to be outlined what kind of conclusions can be drawn towards the development of the research model (in Chapter 2) respectively the measurement model and the empirical validation (Chapter 3 and 4).

Figure 1-9: Illustration of the structural proceeding on the level of the subsections



Source: Own illustration.

Conclusions for
the structural
proceeding

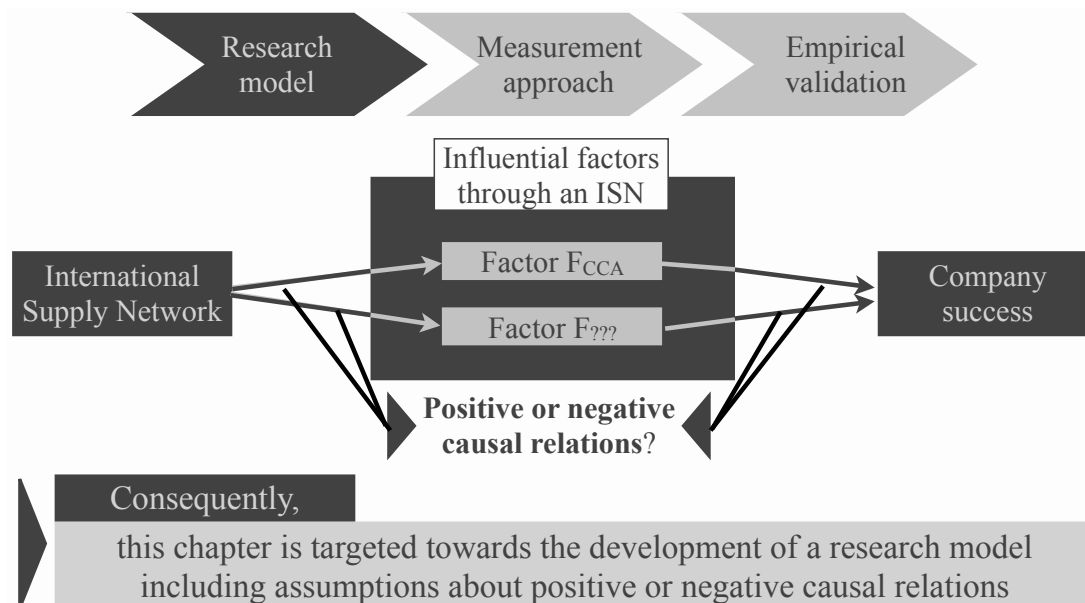
Consequently, the structural proceeding of this thesis follows a logical procession using Minto's pyramid principle as an overarching guiding approach as well as a system of objectives connected with the three different levels of the thesis followed – where possible and appropriate – so that a systematic procedure is applied.

2 A Complexity-based Research Model for Explaining Cooperative Competitive Advantages and the Causal Relations between an International Supply Network and the Company Success

This chapter is **targeted towards the development of a research model** because of the overarching objective of this thesis comprising the development of an explanation approach for explaining Cooperative Competitive Advantages (CCA) as well as the causal relations between an International Supply Network (ISN) and the company success. In this regard, the explanation approach has to consist of **assumptions in terms of assumed positive or negative causal relations between the constructs of interest** contained in the research model. Therefore, the research model as the result of this chapter shall serve as the initial point for the development of a measurement approach in Chapter 3 (cf. Figure 2-1).

Overview over
Chapter 2

Figure 2-1: Aim of Chapter 2



Source: Own illustration.

To do so, the **structural proceeding of this chapter** is the result of the ontological scientific position according to (Chmielewicz, 1979) because it provides a framework for specifying every subject of scientific consideration. This framework states that every subject of consideration can be specified with regard to its elements, relations and characteristics respectively functions (Chmielewicz, 1979, pp. 43–45).

For this reason, **Section 2.1** will deal with the elements and relations of ISN that will allow explaining the existence or creation of ISN. Therewith, Section 2.1 will also comprise a multi-level consideration because the elements and relations have been addressed with the help of the theoretical framework of Systems Theory to the individual level while the purpose or its functions address the network level. ISN can be characterised in many different ways. **Section 2.2** will focus on the complexity because of the underlying theoretical framework of Systems Theory in which the studies of Complex Adaptive Systems had been introduced as one major field of study (cf. Section 1.5). As a result, the structural relations of ISN will be identified as the structural complexities that can influence the functions of an ISN on the individual and the network level. The function of ISN to contribute to the competitiveness on the network level is subject to consideration of **Section 2.3**. In this section, the concept of Cooperative Competitive Advantages as a result of cooperation will be addressed while **Section 2.4** will deal with the competitiveness on the individual level through the consideration of the competitiveness. Due to the fact that these two functions will be examined with regard to the framework of Complexity Science and theoretical approaches from the field of Strategic Management, assumptions about their causal relations can be derived. Therefore, it will become possible to integrate these considerations into a complexity-based research model in **Section 2.5** so that a model containing assumptions about the directions of the causal relations arises. This research model shall serve as working hypotheses towards the two research questions that will be operationalised in the next chapter.

Due to the outlined scientific *modus operandi* this chapter will not focus on an extensive literature review for covering the research about the research topics. Instead, it aims at figuring out reasons to build a research model that is by definition a stylised abstraction of the reality. Due to this methodological approach to abstract and to simplify a wide spectrum of aspects will be neglected. The fruitfulness of this approach should be evaluated in the empirical validation.

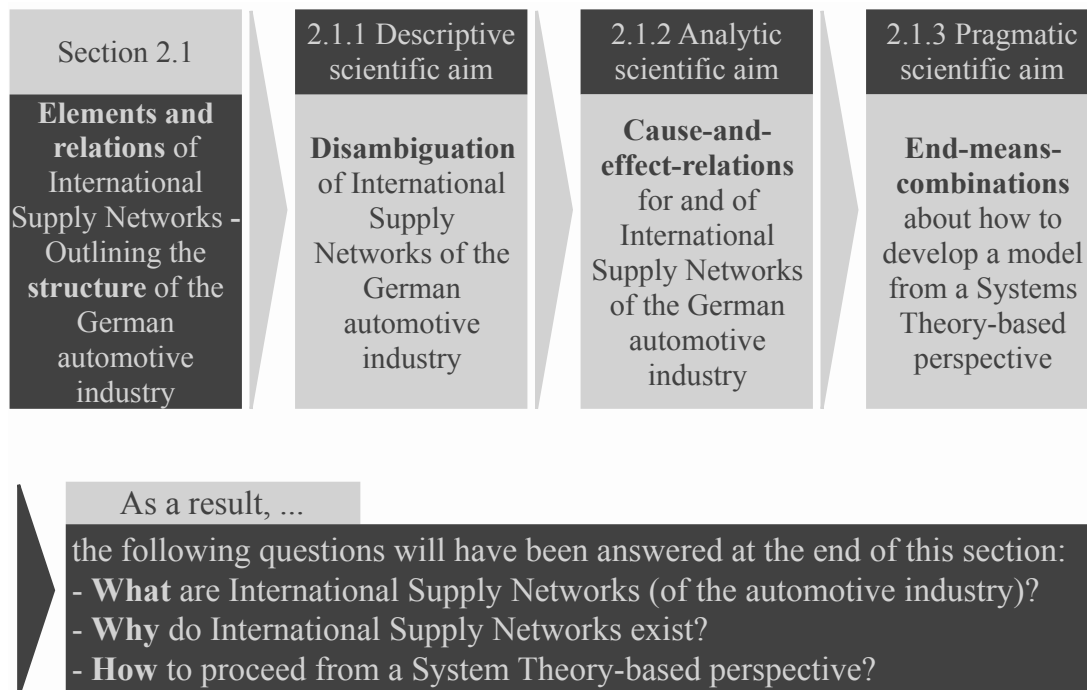
2.1 Elements and Relations of International Supply Networks – Outlining the structure of the German automotive industry

It is the **aim of Section 2.1** to clarify the International Supply Networks of the German automotive industry as a central subject of consideration of this thesis. For this reason, ISN will be disambiguated at first (Subsection 2.1.1) because of the descriptive research task according to the course of research of (Chmielewicz, 1979) before the cause-and-effect relations for the existence of ISN will be dealt with as part of the analytic research task (Subsection 2.1.2). Finally, with regard to the pragmatic research task it has to be outlined about how to proceed from a Systems Theory-based perspective so that end-means combinations for developing a research model have to be addressed (Subsection 2.1.3). As a result, the following questions will have been answered by the end of this section (cf. Figure 2-2):

Overview over
Section 2.1

- What are International Supply Networks in the context of the – German – automotive industry?
- Why do International Supply Networks exist?
- How to proceed from a System Theory-based perspective?

Figure 2-2: Overview over Section 2.1



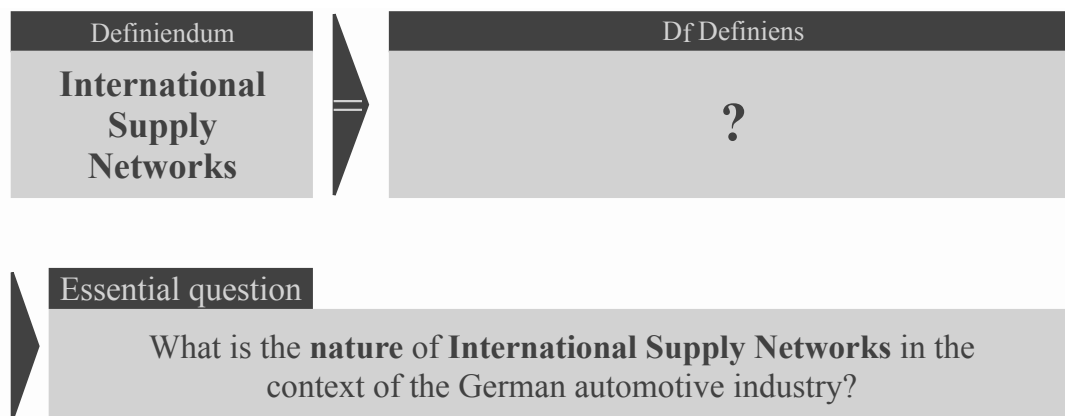
Source: Own illustration.

2.1.1 Descriptive research task: What are International Supply Networks of the German automotive industry?

The **descriptive scientific aim** of this subsection comprises a **disambiguation** of the concept of International Supply Networks for the application area of the German automotive industry. Therefore, because of the course of research according to (Chmielewicz, 1979), the corresponding definiendum of the **definiens** of International Supply Networks of the German automotive industry is **searched for** (cf. Figure 2-3). In order to do so, the elements and relations have to be identified for answering the essential question about the nature of International Supply Networks of the German automotive industry.

Descriptive
scientific aim of
Subsection 2.1.1

Figure 2-3: In search for the definiens of ISN



In search for the
definiens of
International
Supply Networks

Source: Own illustration.

The **definiendum of International Supply Networks** can be assigned into the **field of logistics** because (Hülsmann & Grapp, 2005; Hülsmann & Lohmann, 2009) introduce International Supply Networks to subscribe it as the fifth stage of the development of the term of logistics. These stages of the development of the term of logistics can be traced back to the question about the **identity of logistics** since it's beginning of the discussion in the field of managerial economics (Göpfert, 2005, p. 3; Meyer, 2007, pp. 9–10). For this, (Göpfert, 2005, pp. 3–14) differentiated approaches with the help of the categories “empirical-inductive” and “logical-deductive” whereby the first category defines the objects and tasks of logistics while the second category approaches a differentiation of logistics in the scientific discipline and its sub-disciplines of business economics with the help of the criteria of logistic functions, -targets and –tasks. In this conjunction, (Weber, 2002, p. 5) defines **four different stages of development of logistics**. Against the background of these different stages of the development of logistics, the **definiendum of**

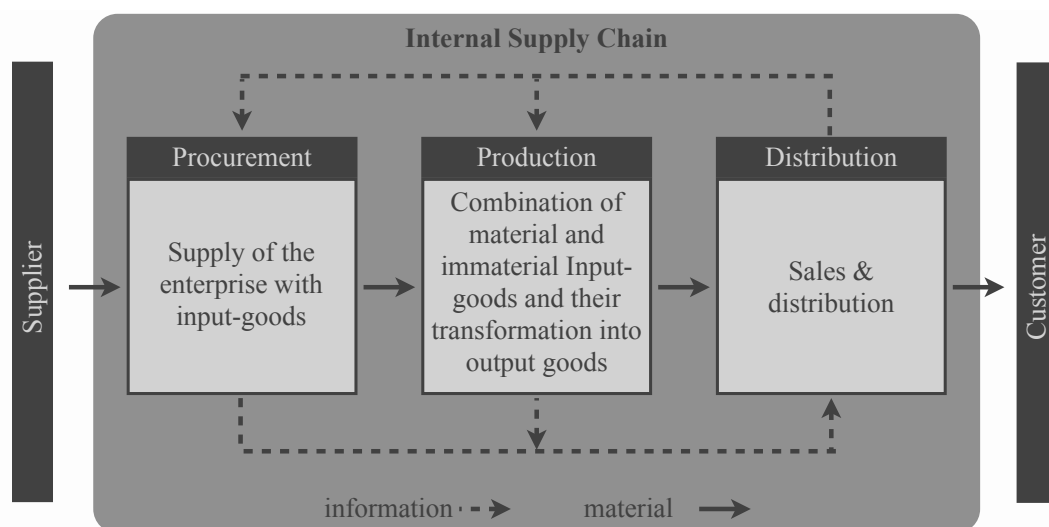
Definiendum of
International
Supply Networks

International Supply Networks expresses the **idea** that the field of logistics has passed through the meanings of a service function of flow of materials over the flow-oriented coordinatory function to a flow-orientation of a whole company and finally reached the meaning of a flow-orientation of company-wide supply chains. Therefore, it can be seen that this idea is based on the concept of a **traditional Supply Chain**.

Traditional Supply Chains

Originally, the traditional concept of a Supply Chain comprised the “analogy to the flow of water in a river” that organisations near the source of raw-materials are called upstream and those near the end-customer are called as downstream so that these organisations “are connected with each other in the different value creation processes and activities in the form of products and services through upstream and downstream linkages” (Harrison & van Hoek, 2008). Herewith, it becomes also possible to systematically identify each step in the value creation because the concept of the Supply Chain can be transferred to the internal Supply Chain of each organisation. In the center of the value creation stands the production as the combination of material and immaterial input factors and their transformation into output factors (Arndt, 2010, p. 72). Located on the upstream site is the procurement for organising the input factors while downstream is the distribution. Therewith, a framework of the internal supply chain of each organisation consisting of procurement, production and distribution is given (cf. Figure 2-4).

Figure 2-4: Illustration of a traditional Supply Chain



Source: With reference to (Bea & Haas, 2005, p. 513).

In this context, it is the **basic assumption** of the **definiendum of International Supply Networks** that the association of a sequential chain has become more and more insufficient because of the high number and variety of interconnected

companies that can be involved in diverse supply chains (Hülsmann & Lohmann, 2009, pp. 34–35). Therefore, by transferring this internal Supply Chain to each organisation that is connected through upstream and downstream linkages with other companies for quite some time, a fifth stage of development about the meaning of logistics can be observed as a result. Hereby, the idea of a **network character** with a horizontal and vertical integration of different companies in the different value creation processes is associated with logistics (Hülsmann & Lohmann, 2009, pp. 34–35). For this reason, (Christopher, 2005, p. 15) understands a supply chain as a “network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer”. Therefore, a “supply chain is a ... network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage. Each partner in a supply chain is directly responsible for a process that adds value to a product. “ Therewith, Supply Chain Figure becomes an extended perspective because there is a collective as well as an individual role to play in the conversion of basic commodity into finished products (Figure 2-5). As a result, the **aim** of the **definiendum of International Supply Networks** consists of extending the understanding of a Supply Chain from a linear to a network-based understanding. Therefore, by considering the **preliminary studies in the working group of Prof. Hülsmann** it is the **central conclusion** to define the **definiendum of an International Supply Network** as it follows:

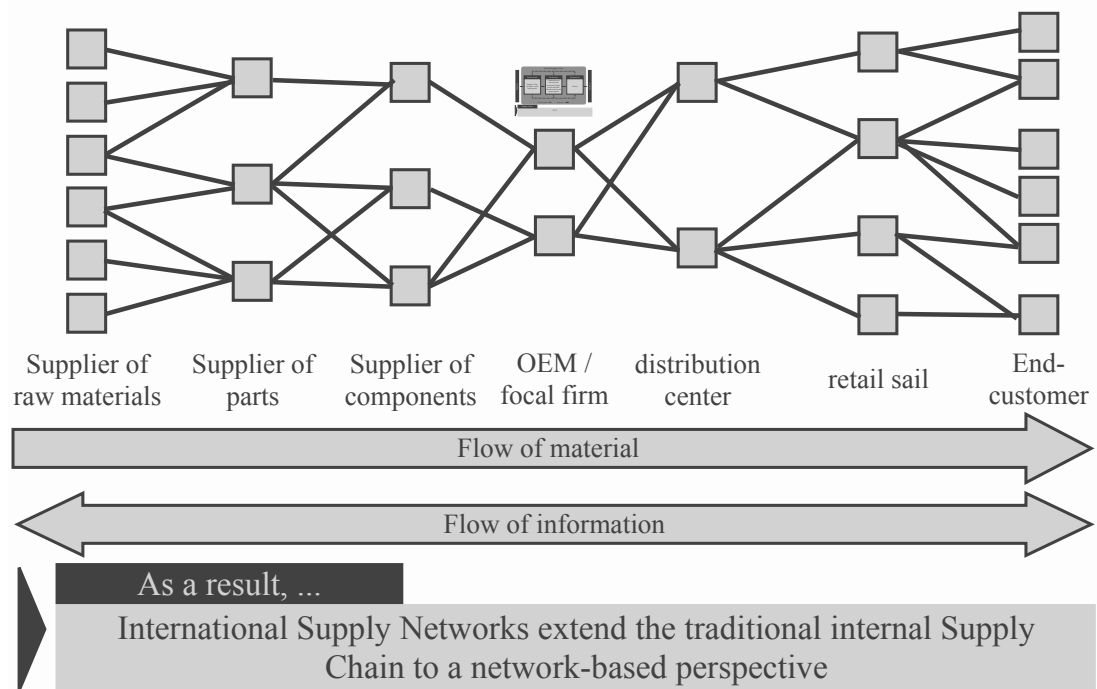
The ... term of an International Supply Network ... shall be understood as a group of international active companies that are connected with each other through the flow of material and information in terms of vertical or horizontal cooperation. Hereby, the participating companies have specialised on different activities in the value creation processes through the concentration on their core competencies and an international division of labour. Through the collaboration and the coordinated exchange of material and information in a complex, dynamic and company-wide context the competitiveness of the whole network shall be improved targeted towards a safety of the supply, a reduction of costs, flexibility and improvement in performance. Therewith, the right amount, in the right state, at the right time, at the right place and to the right costs shall be offered.

Def. (1)

(Hülsmann & Lohmann, 2009, p. 37)

Therewith, a definition has been derived but can it be used in the context of the automotive industry?

Figure 2-5: Illustration of a Supply Chain Network



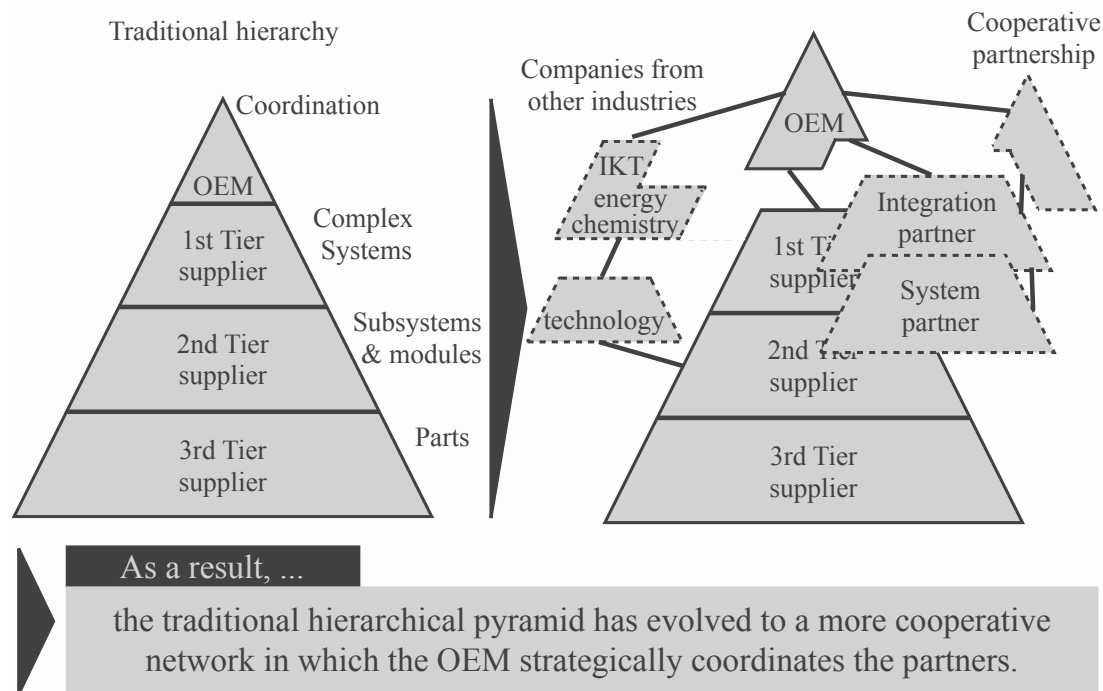
Source: With reference to (Harrison & van Hoek, 2008, p. 9).

Automotive industry

The **etymological origin** of the concept of an **industry** can be traced back to the Latin word *industria* meaning activity, sedulity and it can be defined as the part of an economy that is **characterised** through the production of material goods in production plants through machines connected with a high degree of mechanisation and automatisisation (Duden, 1997, p. 357; Wallentowitz et al., 2009, p. 1). Because of this focus on the production, the automotive industry refers to the production of a car so that it can be **further differentiated** with the help of the location of the production. According to (Diez, 2012, p. 12) the term of the **German automotive industry** can be defined and circumscribed in two different ways that is to say a site-specific and a company-specific consideration. Hereby, a **company-specific consideration** views only companies that produce cars or components for them by having their headquarters located in Germany so that, for example, Opel and Ford or foreign suppliers would not be part of the German automotive industry. In contrast, a **site-specific consideration** allocates all the companies to the German automotive industry that produce cars or components for them – independently from the place of their headquarter so that for example Opel as an affiliated company of General Motors and several other suppliers having their headquarter in a foreign country are to be considered as part of the German automotive industry. This site-specific consideration will be selected because of the outlined focus on the German automotive industry so that a more general perspective is taken. In order to further specify this aspect, the value creation system of the – German – automotive industry

is often **characterized as a strategic network** in which the car manufacturer as the focal firm (i.e. the OEM) strategically coordinates the partners within the network by initializing formal contracts for a longer period. This strategic network is often represented as a pyramidal hierarchy in which the OEM stands at the top, but it has been extended to a network because the cooperation would become more and more important (Mößmer et al., 2007, p. 8) (cf. Figure 2-6).

Figure 2-6: Illustration of the old and new hierarchy



Source: With reference to (Mößmer et al., 2007, p. 8).

Against these backgrounds, the **definiendum of the German automotive industry** comprises the **idea** to consider the entirety of all economic units participating at the production, distribution and usability of the car, i.e. in terms of the value creation, targeted towards the **aim** to provide a framework for identifying the elements, relations and characteristics of International Supply Networks of the German automotive industry (Bea & Haas, 2005, pp. 437–438). This is **based on the assumption** that despite of the fact different terms can be found in the German-speaking literature – for example, (Wallentowitz et al., 2009, p. 1) mention the “Automobilwirtschaft” and the “Automobilbranche” – they can be used as synonymous terms so that the English-speaking term of the “automotive industry” can work as a superordinate concept. The reason for this is that in the context of the automotive industry different definitions for the value creation system highlight the aspect of the production that can be defined as combination of material and immaterial input goods and their transformation into output goods (Bea & Haas,

2005, p. 521). In this conjunction, the term of production is closely related with the concept of the value creation because the value creation is defined as the difference between the value of the product and the value of the incoming goods for its production so that the value creation is the amount that a company “produces” through its activities (Arndt, 2010, p. 152). For example, the *Verband der Automobilindustrie* (VDA) is the association of the German automotive industry in which more than 600 companies are organised that operate in the field of the automotive production within the Federal Republic of Germany (VDA, 2013). Hereby, members are assigned into one of the three groups of vehicles and their motors, vehicle parts and accessories as well as trailer, constructional systems and busses. Due to the fact that the Federal Statistical Office of Germany as an official institution also uses this allocation it can be assumed that this assignment is a commonly accepted one so that the primary concentration of the production is done (Wallentowitz et al., 2009, p. 1). Therefore, it can be **concluded** that the – **German – automotive industry** can be mainly considered as an **international value creation system** because of the focus on the production of a car. Thus, with respect to International Supply Networks it can be further considered as a subordinate concept because it specifies the application area of the International Supply Network to be considered. Consequently, with regard to the **definiendum of International Supply Networks** the following **main contributions** can be drawn: Firstly, this definition Def (1.) highlights the network based-approach because (Hülsmann & Grapp, 2005) prefer the term of an International Supply Network in order to accommodate the idea that every company that is horizontally or vertically integrated supplies and is supplied within a network. Secondly, in the field of managerial economics a diversity of **synonym network terms** exist. While (Judit, 2007; Provan et al., 2007) provide a literature review about interorganisational networks in which they outline similarities of different network terminologies, exemplary definitions shall be introduced:

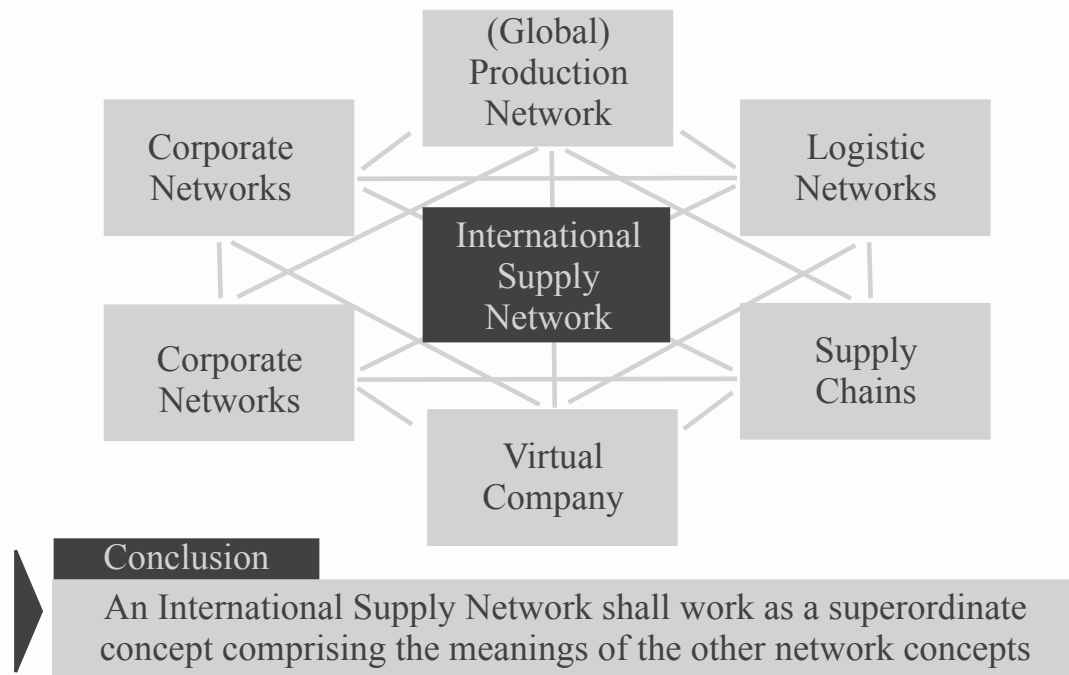
- **Company networks:** According to (Sydow, 2010b, p. 1) company networks are an organisational form of economic activities aiming at realising competitive advantages that distinguish themselves through complex-reciprocal, more cooperative than competitive and relatively stable relationships between lawfully independent, but mostly economically dependent companies. From an institutional point of view they can be understood as a hybrid form of organisation between market and hierarchy that is characterised through cooperative relationships between value creating units that are bringing competencies and resources in for optimizing the overall value creation.

- **Network of Supply Chains:** (Otto, 2002, p. 88) speaks of Supply Chain Networks as vertically allied companies between legally independent companies that behave on an operational, tactical and strategic level in a collective way.
- **Logistic networks:** According to (Bretzke, 2008, p. 47) a logistic network is a system of hierarchically and geographically ordered nodes of resources and their connecting links that are continuously targeted towards to economically connect suppliers and customers.
- **Production networks:** Production networks of globally distributed production plants are a strategic option for globally operating producing companies. They offer competitive advantages due to cost efficiency, a better access to valuable resources and new markets as well as flexibility for adapting into changing market environments (Zahn, 2011, p. 11).
- **Virtual enterprise:** “A virtual organization is a short-term form of cooperation for the development and manufacturing of a product among legally independent co-entrepreneurs in a logistics network of long-term duration of potential business partners. This is true for procurement and production as well as for product and process innovation.” (Bea & Haas, 2005, p. 534; Schönsleben, 2004, p. 88)
- **Value Added network:** “A logistic network, or a supply chain, is the joining of the logistics of several “co-makers” to form comprehensive, transcorporate logistics.” “Production network or procurement network can be used as synonyms of logistics networks.” “Value-added network is used today as a general term for all types of networks mentioned above.” (Schönsleben, 2004, p. 13)

These exemplary definitions do not claim to provide an extensive overview or to represent the main paradigm about each of these terminologies. Instead and with respect e.g. to (Judith, 2007; Provan et al., 2007) it shall be assumed that all of these terminologies represent mostly companies as organisational units that are connected with each other different forms of cooperation as linkages between them. Therefore, from a Systems Theory-based perspective all of these terminologies can be abstractally represent through a network in which the organisational units constitute an element that are connected with each other through links (cf. Section 1.5). Therefore, by considering that according to (Chmielewicz, 1979) a definition or a prescribed terminology can never be true or untrue, but only appropriate or inappropriate (Chmielewicz, 1979, p. 49), the definition Def. (1) shall work as a **superordinate concept** as outlined in Figure 2-7 because the above-mentioned definitions about these synonymous network terms comprise the same features about

the above-introduced characteristics.

Figure 2-7: ISN as a superordinate concept



Source: Own illustration.

Thirdly, the definition Def. (1) allows an identification of the elements, relations and functions of ISN according to the ontological scientific position because its constituting sentences can be assigned to one of the three categories as shown in Table 4. Therefore, from an Econophysics-based perspective companies are the elements, forms of cooperation are relations and the goal of competitiveness is a function/characteristic of International Supply Networks. In contrast, some **main limitations** have to be mentioned. Firstly, despite of the fact that the term of an International Supply Network can be found in the scientific literature, it does not seem to be “commonly used” because by using EBSCO, Google Scholar and the Jacobs University Catalogue only (Camuffo, Furlan, Romano, & Vinelli, 2006; Dyker, 2006; Er & MacCarthy, 2002; Grapp & Hülsmann, 2005; Harland, Brenchley, & Walker, 2003; Kreowski, Scholz-Reiter, & Haasis, 2008; Lamming, Johnsen, Zheng, & Harland, 2000; MacCarthy & Jayarathne, 2012; Srai & Gregory, 2008; Wang, 2010; Windt & Hülsmann, 2007; Zhou, 2009) use the term of an International Supply Network. Therewith, it can be assumed that the understanding of the fifth stage of development of logistics (cf. above) and its expression through the term of an International Supply Network is not uniquely and widely accepted. Additionally, the definition lacks a specification because it only refers to the competitiveness in general without separating e.g. an intra-individual, individual,

intra-network, network or inter-network level. Therewith, the further proceedings will have to deal with this gap.

In summary, the International Supply Networks of the German automotive industry can be described from an Econophysics-based perspective as it follows: Elements constitute organisational units, i.e. companies and their production plants, as value creating units that are related through horizontal and vertical forms of cooperation targeted towards its functions to gain and sustain competitiveness for the procurement, production or distribution of cars.

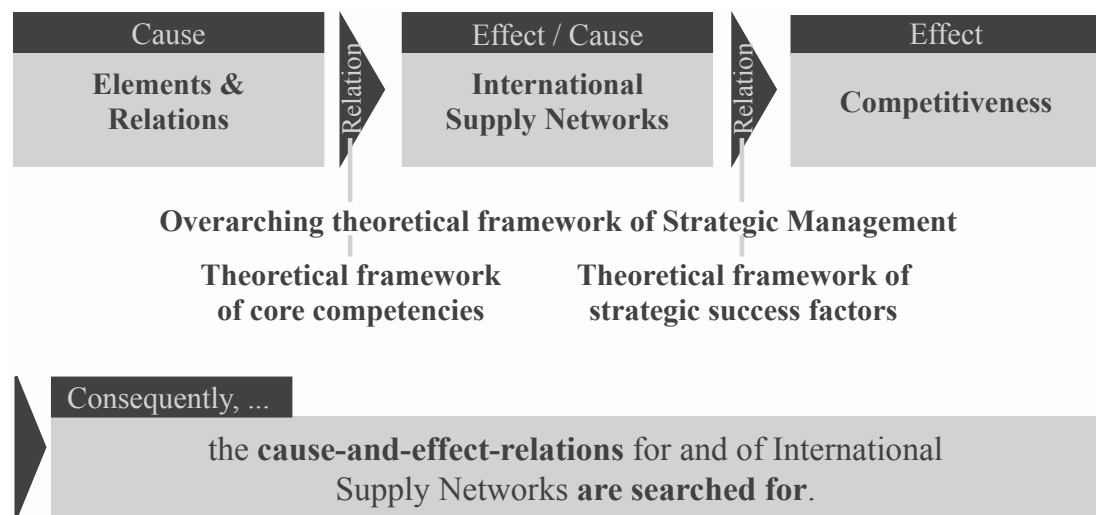
Conclusions for
the descriptive
scientific aim

2.1.2 Analytic research task: Why International Supply Networks?

Analytic
scientific aim of
Subsection 2.1.2

It is the **analytic scientific aim** of this subsection to investigate the cause-and-effect relations for and of the International Supply Networks with the application area of the German automotive industry because an explanation is needed why they exist so implications towards the research questions can be derived. Therefore, the **cause-perspective** deals with reasons of the elements and relations while the **effects-perspective** broaches the issue about the effects of the ISN to contribute to the competitiveness. In order to do so, the **overarching theoretical framework** of the Strategic Management will be introduced because they will provide a theoretical basis for understanding the behaviour of the organisational units towards the competitiveness. As a result, they will enable to select frameworks for explaining the cause- and effect-perspectives (cf. Figure 2-8).

Figure 2-8: In search for the cause-and-effect-perspectives of ISN



Source: Own illustration.

Scientific
discipline of
Strategic
Management

According to (Bea & Haas, 2005, pp. 7,12–15) the **scientific discipline of Strategic Management** has its **origins** in the 1980s because they refer to (Ansoff, Declerck, & Hayes, 1976) who published the book *From Strategic Planning to Strategic Management* and mention that the Strategic Management Journal and the Journal of Business Strategy were firstly published in 1980. Hereby, the Strategic Management is introduced as a fourth stage of development that evolved from the first phase of the planning (1945-1960) over the second phase of the longterm planning (1960-1973) to the Strategic Planning (1973-1980) and finally reached the fourth phase of the Strategic Management (1980-1995) as a result of the respective requirements on the companies so that management science would have to take these

developments into account. (Bea & Haas, 2005, p. 7,14) trace the **development** of SM back to certain requirements in the company's environment and the resulting requirements on them and conclude that the dynamic and the complexity of environmental changes have increased so that the companies are increasingly dependent on their environment so that new requirements arise. Against this background, the **basic idea** of the **Strategic Management** can be expressed through an increased meaning of an integrative-systemic thinking in order to goal-orientedly control, i.e. to manage, the company-environment-relationships, whereby in general an inside-out- and an outside-in-perspective can be distinguished. Therefore, it is the **aim** of the **Strategic Management** to realise a so-called strategic fit between the company as an organisation and its environment for developing the organisational system into the intended direction (Bea & Haas, 2005, p. 10). The reason for this can be explained through the **basic assumption** that a company can only survive on the market in the longterm if it is able to adjust its strategic potentials with the requirements of the – competitive – environment. Nevertheless, **different schools or research fields** can be distinguished that focus on different aspects and ideas because e.g. (Mintzberg, Ahlstrand, & Lampel, 2005) differentiate in their book *Strategy safari – A guided tour through the wilds of Strategic Management* so-called “Ten Schools of Thought”.³⁸ Therefore, depending on the school one is willing to base the considerations upon one might come to different aspects. Hence, by using the example of the fable of *The Blind Men And the Elephant* (Mintzberg et al., 2005) point out that these schools do not have to be understood as a neither-nor-decision but more as an as-well-as because they just mention on which to focus without neglecting the other things.³⁹ In this conjunction, instead of adding a further definition for the Strategic Management, (Hungenberg, 2001, pp. 4–6) mentions different typical **characteristics** of strategic decisions of the Strategic Management for deriving a common understanding:

- Strategic decisions are those that have a **long-term/sustainable** and essential influence on the development of the company.

³⁸ Directly cited from (Mintzberg et al., 2005, p. 5):

- “The Design School: strategy formation as a process of *conception*
- The Planning School: strategy formation as a *formal* process
- The Positioning School: strategy formation as an *analytical* process
- The Entrepreneurial School: strategy formation as a *visionary* process
- The Cognitive School: strategy formation as a *mental* process
- The Learning School: strategy formation as an *emergent* process
- The Power School: strategy formation as a *process* of Negotiation
- The Cultural School: strategy formation as a *collective* process
- The Environmental School: strategy formation as a *reactive* process
- The Configuration School: strategy formation as a process of *transformation*.”

³⁹ “We are the blind people and strategy formation is our elephant. Since no one has had the vision to see the entire beast, everyone has grappled hold of some part or other and “railed on in utter ignorance” about the rest. We certainly do not get an elephant by adding up its parts. An elephant is more than that. Yet to comprehend the whole we also need to understand the parts.” (Mintzberg et al., 2005, p. 3).

- Strategic decisions aim at gaining **advantages** against the competitors.
- Strategic decisions try to secure the future success by determining the internal and external adjustments of the company by designing its resource base dependent on the company's environment..
- Strategic decisions try to **create success potentials** for initialising concrete actions in the market or in the company.
- Strategic decisions refer to a **complex task** because an organisational-wide perspective has to be taken into account.

Therefore while for example (Hungenberg, 2001, p. 4) highlights that the **Strategic Management** is targeted towards the gain and maintain of durable competitive advantages, (Bea & Haas, 2005, p. 20) points out that

[T]he Strategic Management is targeted toward the goal-oriented planning and control under strategic, i.e. long-term, global, environmental-related and development-oriented aspects. It comprises the analysis and mutual adjustments of planning, control, information, organisation, company culture and strategic performance potentials.

What are the **main contributions** of the **overarching theoretical framework of the Strategic Management**? The **overarching strategic framework of the Strategic Management** offers a framework because different types of strategies in the field of Strategic Management are classified with respect to the different levels of the strategic planning system. Therefore, this strategic planning system shall be introduced with regard to the **corporate level**, **business level** and **functional level** (Grant, 2010, pp. 18–19). The corporate strategies such as a strategy of growth, stabilisation or deinvestment on the **corporate level** determine the general direction of a company while the business strategies on the **business level** such as the generic competitive strategies according to (Porter, 2004) determine how the competition shall take place. The functional strategies on the **functional level** are targeted towards concrete measurements in the functional areas of the performance potentials for realising the selected strategies on the other two levels so that a strategic planning system arises (Bea & Haas, 2005, pp. 170–171, 188–189). This level of the strategy will work as guiding framework for the following considerations.

Conclusions for
the overarching
theoretical
framework

Consequently, with regard to the research questions the strategic planning system offers a theoretical framework for analysing the cause-and-effects-perspectives of International Supply Networks about how to achieve competitiveness.

Level of the strategic planning system		Types of strategies				
Corporate Level	Corporate strategies					
	Growth - Product-market-strategy - Local, national, international a. global strategies - Autonomy, cooperation, integration		Stabilisation		Deinvestment	
Business Level	Business strategies					
	Cost leadership		Differentiation		Focus (Niche)	
Functional Level	Functional strategies					
	Procurement strategies	Production strategies	Distribution strategies	Financial strategies	Personal strategies	Technology strategies

Table 2: Types of strategies according to the levels of the strategic planning system (according to (Bea & Haas, 2005, p. 170)).

The **cause-perspective** broaches the issue of the **causal relation between the elements and relations constituting an International Supply Network** because the disambiguation of elements and relations in the previous subsection has pointed to the existence of International Supply Networks. Therefore, the **theoretical framework of core competencies** will be introduced for analysing this causal relation.

Cause-
perspective

(Smith, 2008) explains in his book *An inquiry into the Nature and Cause of the Wealth of Nations* published in 1776 that a marginal cost **advantage** in one country justifies the international division of labour due to specialisation. David Ricardo developed this theory of the absolute advantage further in 1817 in his work *Principles of Political Economy and Taxation*. Ricardo's theory of comparative advantages explains that as long as two countries have different relative efficiencies, the country with an absolute advantage (i.e. it is more efficient in the production of all goods) can still achieve with a less-efficient country. Both works pick advantages – between countries – out as a central theme. Furthermore, they can be considered as the cornerstone of the foreign trade theory and offer first explanations for an international division of labour due to the specialisation and international trade by alluding to an **economic globalisation**.⁴⁰

⁴⁰ With reference to (Fontius, 2008, p. 5).

According to (Joshi, 2011, p. foreword) the concept of economic globalisation refers to an **increasing economic crosslinking** of “national economies and globally active companies across the world through a rapid increase in cross-border movement of goods, services, technology and capital”. The literature has been quite consistent to identify the liberalisation of trade (e.g. through a progressive cutback of trade barriers), the developments of information and communication technologies (e.g. through the dispersion of the World Wide Web especially since the 90’s) and the advancement of global transportation systems (e.g. through a clear cost reduction of the diverse mode of transportation) as driver for an ascending economic crosslinking (Fontius, 2008, p. 9; Steger & Schwandt, 2010, p. 16). Such an ascending economic crosslinking is notably characterised through the following impacts, e.g. through ...

- a simplified accession to new markets (Hülsmann & Lohmann, 2009, p. 1),
- a global division of labour that has “drawn ... emerging and developing countries” (Steger & Schwandt, 2010, pp. 14–15),
- a “variety of (foreign) direct investments ... (that) has removed ... capital shortage” (Steger & Schwandt, 2010, pp. 14–15),
- an increased number of globally active companies and intensity of integration (Steger & Schwandt, 2010, pp. 14–15) and
- the strategies of global sourcing to produce at the cheapest places (Arndt, 2010, p. 10).

In particular, these impacts have resulted in an enormous increase of the international trade with an increased flow of goods and an increased number of offerer (Fontius, 2008, p. 9; Hülsmann & Lohmann, 2009, p. 1). Due to the increased flow of goods, increased number of offerer and increased transportation times an increased – cost- and time-based – **stress of competition** can be derived as a result of an increased economic globalisation (Hülsmann & Lohmann, 2009, pp. 1–2). As a further result of an increased economic globalisation, the customer needs have also increased and an individualisation has led to a shorter Product Life Cycle and a broader portfolio of products and services (Hülsmann & Lohmann, 2009, p. 2). Therefore, (Klaus & Kille, 2005, p. 23) argue that the success of a company depends more and more on the flexibility to react immediately and adequately to changes on the market. Additionally, (Schönsleben, 2004, p. 37,54) mentions the ability to achieve qualitatively high requirements on the products and services as another important characteristic to differentiate from the competitors. Generally, this competition refers to the point that companies compete with each other by offering a product or a service for the customer that is superior to those of a competitor that is recognized by the customer and that can be adhered long lasting (Hülsmann &

Cordes, 2009, p. 89). This superiority of a product or a service is called a **competitive advantage** of a company (Porter, 2004). By considering according to (Günther & Tempelmeier, 2005, p. 9) the **task of logistics** to bridge the spatial and timely as well as the pricing structures and quantitative differences between offer and demand along the whole value creation process and by considering according to (Pfohl, 1972) the **objective of logistics** of the so-called “6 R” to deliver the right products and services in the right amount and right quality to the right place at the right time and the right price (Pfohl, 1972, p. 29), the meaning of logistics – as a possibility to differentiate from competitors and to gain a competitive advantage – has also increased (Schönsleben, 2004, p. 36). Hereby, logistics targets on the safeguarding of supply facilities because the **logistic target areas** of costs, delivery time and flexibility can influence the performance of a company essentially (Schönsleben, 2004, p. 36). Furthermore, (Göpfert, 2005; Hülsmann, Grapp, & Li, 2008; Pfohl, Köhler, & Röth, 2008) highlight the shift of the meaning of the term logistics from the traditional logistics processes as transportation, turnover and storage to the fourth target area of quality. This aspect to actively contribute to the final value for the end-customer shall be labelled as the postulate of the value creation as a further possibility to gain a competitive advantage.

One way for companies to improve in the above-mentioned logistic target areas is the concentration on their **core-competencies** (D. Arnold, Isermann, Kuhn, Furmans, & Tempelmeier, 2008, p. 604; Prahalad & Hamel, 1990, p. 7; Vahrenkamp & Siepermann, 2007). According to (Prahalad & Hamel, 1990, p. 84) core competencies are the competencies that a company controls at best and can offer at a cost-effective level. For this reason, core competencies contribute significantly to the satisfaction of customer needs and to the business objectives because they enable a company to sustainably differentiate from its competitors (Freiling, 2004, p. 33). As a further result, **boundary competencies** are **outsourced** to other companies that are specialised in these products and services. One **advantage of the specialisation** of processes consists inter alia of the **economies of scale**, e.g. because ...

- ... more efficient production technologies are financeable,
- ... employees are more qualified for their special task,
- ... necessary research is more up to date and
- ... of learning effects due to an higher output (Arndt, 2010, p. 10).

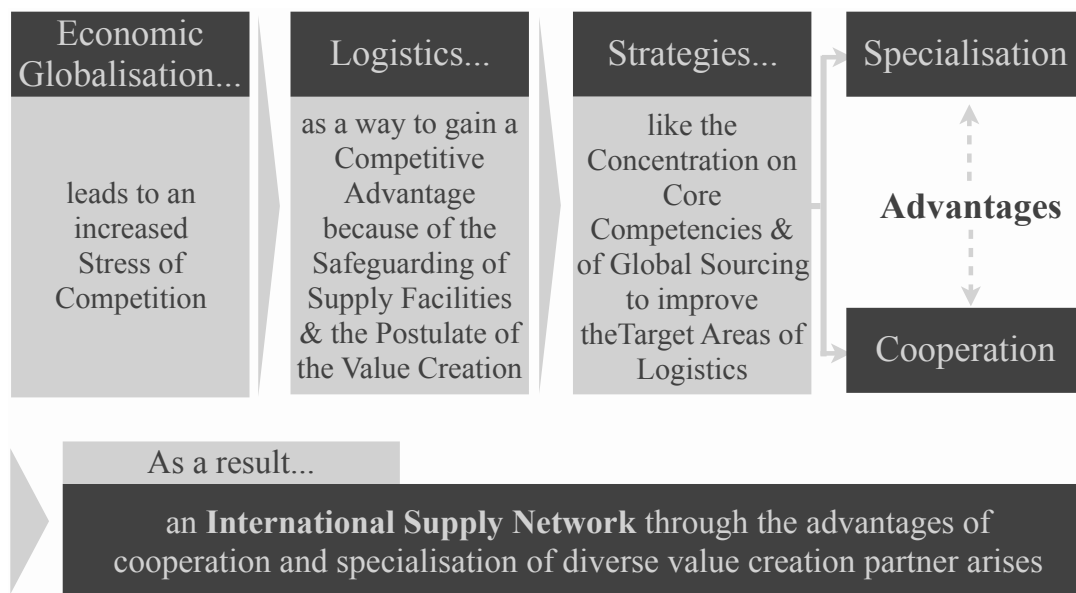
Therefore, the concentration on core competencies and the outsourcing of boundary competencies lead to the **advantage of specialisation** due to a division of work between different autonomously acting organisational units. As a result, a fragmentation of the corporate landscape arises that is characterized through a spatial

and timely separation of the value creation so that companies are only responsible for one part of the process (Hülsmann & Lohmann, 2009, p. 2). Another advantage as a result of the strategies of global sourcing and the concentration on core competencies comprises the **advantages of cooperation** because goods and services can be brought together and offered based on the division of labor that could not be offered by a single company because of restrictions regarding capital, time, competencies or size of a single company (Rösler, 2003, p. 35). According to (Bretzke, 2008; Hülsmann et al., 2008; Hülsmann & Lohmann, 2009; Schönsleben, 2004) such a cooperation of the logistics of diverse Co-Maker define a logistic network so that from a company-wide perspective an **International Supply Network (ISN)** of shared logistics of companies through cooperation arises (cf. Figure 2-9). Herewith, it is possible to acquire missing competencies and to avoid uncertainties regarding the safety of supply facilities within the organization of the ISN. Hereby, the organisations “are involved through upstream and downstream linkages in the different value creation processes and activities”, e.g. through the exchange of information, materials and time (Christopher, 2005). This ISN can be seen as a system of interdependent processes, “where actions in one part affect those of all others” and its scope extends from a so-called focal firm in the centre “across supplier and customer interfaces” so that it expends across different functions and organizations (Harrison & van Hoek, 2008, p. 1). As a result, the involved companies within the **ISN can appear on the market as one single competitive entity** and can offer more significant products and services that meet the need of the demanding customer (Hülsmann & Cordes, 2009, p. 77; Hülsmann & Lohmann, 2009, p. 4).

Conclusions for
the cause-
perspective

Consequently, with regard to the research questions the existence of International Supply Networks has been traced back to the advantages of cooperation and specialisation with the help of the framework of the core competencies. Therefore, the following considerations have to focus on the interplay between the advantages of cooperation and their effects on the competitiveness.

Figure 2-9: Reasons for the existence of International Supply Networks



Source: Own illustration.

The **effects-perspective** picks the **causal relation between International Supply Networks and the competitiveness** out as a central theme because the outlined disambiguation of the elements and relations of International Supply Networks pointed to the function of competitiveness. For this, the **theoretical framework of strategic success factors** will be introduced for analysing this causal relation.

Effects-
perspective

The question about the **effects of International Supply Networks on the competitiveness** points to the **field of Strategic Management** (cf. above). In contrast to the theory of competition that offers guiding principles for the competition-oriented organisation of whole markets (with regard to the efficiency of the participants), the approaches within the field of the Strategic Management offer an analytical frame in the form of a system or potential approach as well as a social and stakeholder approach in order to reach resource-based system goals and the market-oriented goals of competition (Bea & Haas, 2005, p. 12 et sqq.). For clarifying the resource-based system of goals and the market-oriented goals of competition, (Bea & Haas, 2005) introduce the so-called **strategic fit** as the guiding principle of the Strategic Management in which the company is considered as system including a system's environment (Bea & Haas, 2005, pp. 18–20). Therefore, the question about the **competitiveness** refers both to an analysis of the environment and the company. For example, according (Kerth, Asum, & Stich, 2009, pp. 1–2) frameworks for analysing the external – market – environment are e.g. environmental analysis, target group analysis, competitor analysis, analysis of substitutes, stakeholder analysis, benchmarking and the analysis of the industry

structure while for example the analysis of the core competencies or the so-called SWOT-analysis are frameworks for the analysis of the internal situation.

Despite of the fact that the question about the **competitiveness**⁴¹ has already been referred to through the introduction of the **scientific discipline of the Strategic Management** (cf. above) the following considerations not only in this section but also in the following sections and chapter, will be based upon (Diez, 2012). The reason for this is that (Diez, 2012, p. 6) runs a industry-specific analysis of the competitiveness of the German automotive industry so that specific knowledge can be assumed. Furthermore, the question about the competitiveness is done with respect to three different levels of consideration so that a level-wide analysis is done as it is approached in this thesis. Finally, the derived definition of (Diez, 2012) is based upon a literature review so that a foundation with the current state of research can be assumed. Therefore, it is the **basic assumption** to understand the competitiveness in and of the – German – automotive industry as it follows:

The German automotive industry has to be considered as competitive, if the companies belonging to are in total sustainably able to sell their products on the world market with an appropriate profit (Diez, 2012, p. 6).

Therewith, it can be seen that key features of the competitiveness are the aspects of selling **products** and **profitability** that will be outlined in Section 2.3 and 2.4. Against this background, it is the **idea** to use the framework of the **strategic success factors** targeted towards the **aim** to explain the competitiveness as an effect of ISN.

Strategic success
factors

Strategic success factors are part of the **Strategic Management** because they constitute a framework for the analysis of the company trying to bridge a gap by connecting this framework with the market environment (Bea & Haas, 2005, pp. 114–119). According to (Bea & Haas, 2005, p. 114), (Gälweiler 1974) was the **first** who introduced the term because they constitute potentials referring to the **idea** that they are reservoirs of specific strengths enabling the company to successfully position itself, i.e. competitive, in a dynamically changing environment. Therefore, it is the **aim** of the concept of the **strategic success factors** to make a company successful by strategically fitting its potentials with the requirements of its market environment, i.e. the competition, because the discipline of the Strategic Management is **based on the assumption** of a self-contained strategic function of the subsidiary systems: strategic planning, strategic control, information, organisation, company culture, strategic performance potentials. All of these

⁴¹ The etymological origin of the Latin word competition or competere means to dispute for something. In combination with (Smith, 2008) who is sometimes referred to as being the first who used this concept in economics it was introduced as the “Streben von mindestens zwei Akteuren (Wirtschaftssubjekten) nach einem Ziel, wobei der höhere Zielerreichungsgrad eines Akteurs einen niedrigeren Zielerreichungsgrad des anderen bedingt”.

subsidiary systems can work as a reservoir for potentials for strategic success factors that can be further separated into the categories of performance potentials and management potentials. Therefore, it is the **central conclusion** that a company is successful, i.e. it is competitive, and exhibits strengths if it is able to meet the requirements to consequently orientate themselves to the customer needs and, secondly, to have an advance in comparison with competitors so that

[s]trategic success factors are strengths and weaknesses of a company responsible for the success at the competition (Bea & Haas, 2005, p. 115).

The **contributions** of the strategic success factors can be summarised in a way of providing an analytical framework because if an improvement of performance can be connected with one of these areas, e.g. through the concentration on core competencies, outsourcing or advantages of cooperation, then it can be assumed that the competitiveness is achieved. Furthermore, the performance potentials shown in Table 1 will work as a framework when it comes down to the function of ISN in Section 2.3. Hence, **limitations** exist because the strategic success factors are used from the perspective of a single company so that the question for competing ISN remains unanswered. Additionally, a comprehensive view is needed because “[t]he optimum value-added depth of a co-producer in a logistics network is not necessarily optimal for the total logistics network. However, a balanced win-win situation for all companies involved is prerequisite to long-term or intensive cooperation in a logistics network.” Furthermore, the companies participating in such an ISN through forms of cooperation have to evaluate the costs and usages for the fulfilment of tasks within the ISN because it is the objective for everyone of these free market economy oriented companies to maximise the profit in the long run (Staehle, Conrad, & Sydow, 1999, p. 440; Wöhe, 2000, p. 119). This advantage of participating in an ISN through cooperation because of a higher usage than costs is called the **networking effect**. Hereby, it can be assumed that the networking effect shall contribute or at least do not contradict to the company performance. As a result, (Bach et al., 2010, p. 9) point out that in general the evaluation of the “networking advantage” for companies to participate in an International Supply Network by measuring all costs and benefits for the fulfilment of tasks has not been made. Therefore, an **adequate explanation approach for the performance of logistics from a company-wide perspective to the business objectives is needed** (Roth & Miller, 1990; Tracey, Vonderembse, & Lim, 1999).

Performance potentials	Strategic success factors
Procurement	Relative prices of the input factors, quality of the pre-products, attunement with supplier (e.g. realisation of Just-in-Time), degree of dependency from the suppliers...
Production	Capacity of the production line, level of proficiency of the production lines, flexibility of the production lines, in-house production depth, structure of costs
Distribution	Quality of the products, brand name, life span of property rights, age structure of the products, quality of the distribution systems and after-sales-services, price range, complaints management, market share, customer loyalty
Staff	Qualification, level of education, age, ability to learn, identification with the company, entrepreneurship
Finance	Access to the capital market, level of debts, stock development, financial resources, ...
Research & Development	Innovativeness, degree of research and development, research efficiency, patents, ...

Table 3: Strategic success factors of the performance potentials (Bea & Haas, 2005, pp. 116–117).

Conclusions for
the effects-
perspective

Nevertheless, with regard to the course of research the strategic success factors allow a framework for explaining the creation of competitiveness. Therefore, the effects of the ISN on the competitiveness – on the individual and the network level – can be analysed.

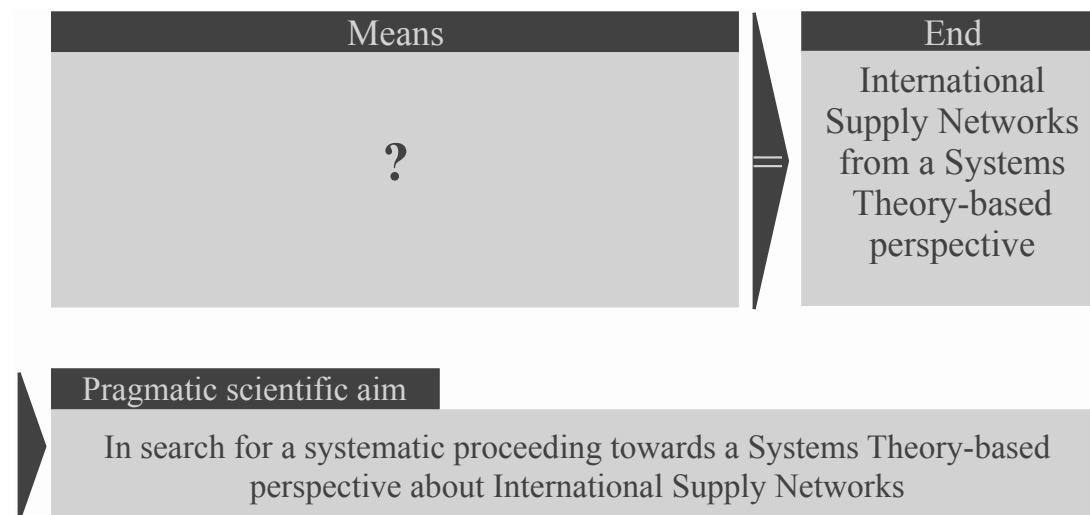
The question about how to integrate the results of the descriptive and analytic research task with regard to the development of a research model shall be outlined in the next subsection because the pragmatic scientific aim is targeted towards end-means combinations so that a systematic proceeding is searched for.

2.1.3 Pragmatic research task: How to proceed from a Systems Theory-based perspective?

It is the **pragmatic scientific aim** of this subsection to outline a systematic proceeding for the development of a research model. This systematic proceeding has to integrate the result of the descriptive and analytic research task. Additionally, it has to be in accordance with Systems Theory because it has been introduced as the underlying theoretical framework that determines about how to look on or perceive the subject of scientific consideration. Therefore, means towards the end of considering International Supply Networks from a Systems Theory-based perspective are searched for (cf. Figure 2-10).

Pragmatic
research task of
Subsection 2.1.3

Figure 2-10: In search for a systematic proceeding



Source: Own illustration.

The modelling has been introduced as a key characteristic of Systems Theory in Section 1.5. In this regard, the ontological scientific position according to (Chmielewicz, 1979) – focussing on elements, relations, characteristics and functions – as well as the network approach help to derive a first **modelling approach** from a System Theory-based perspective because they help to represent ISN in a stylised or abstract way. In order to do so, the definition of ISN as a result of the descriptive research task shall be considered through the raster or pattern of the ontological scientific position. Thus, parts of the definition can be assigned to the category of the elements, the relations and the functions as shown in Table 4. As a result, it can be assumed that the **elements of ISN** constitute companies that are specialised on different activities in the value creation processes through the concentration on their

Modelling
approach

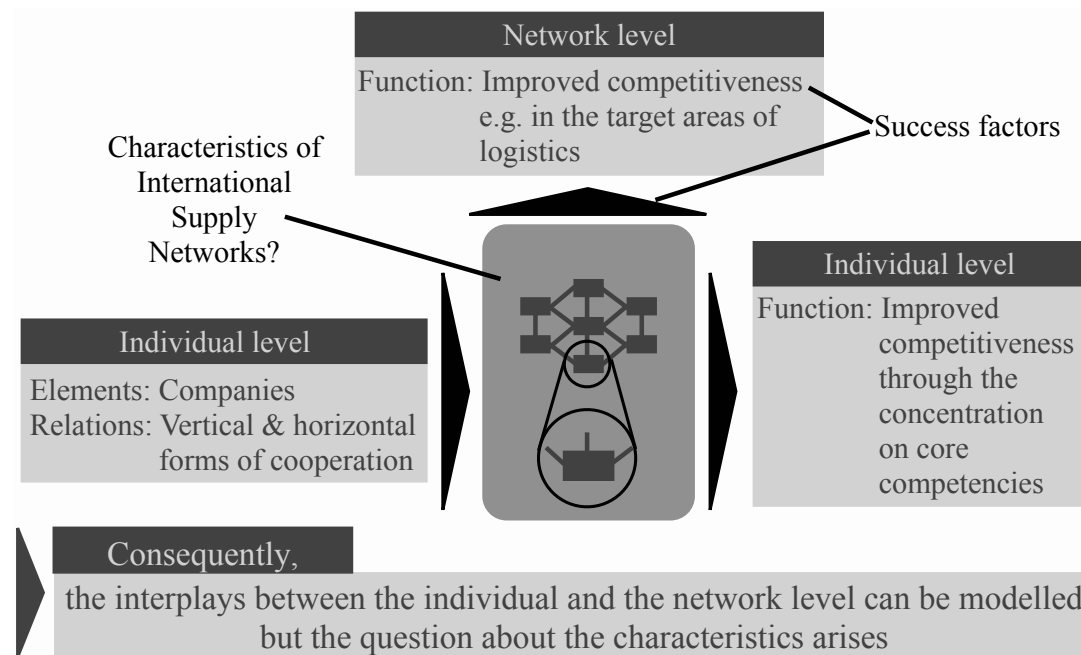
core competencies and an international division of labour. These companies are **related** with each other through vertical and horizontal forms of cooperation because it will be shown in Section 2.3 that the collaboration and the coordinated exchange e.g. of information or material can be understood as a form of cooperation. The function of ISN consists of an improved competitiveness that can be achieved e.g. through the logistic target areas (LTA) or an improvement of the 6 R's of logistics.

Definition of International Supply Networks with the help of the preliminary research in the working group of (Hülsmann & Lohmann, 2009, p. 37)		
Elements	Relations	Functions
“...international active companies... [that] ... have specialised on different activities in the value creation processes through the concentration on their core competencies and an international division of labour.”	• Flow of information • Flow of material • Vertical & horizontal ... • cooperation • collaboration • coordinated exchange	• “...competitiveness of the whole network shall be improved...” competitiveness • “...targeted towards a safety of supply, a reduction of costs, flexibility and improvement in performance...” (LTA) • “...to offer the right amount, in the right state, at right time, at the right place and to the right costs...” (6 R of Logistics)
→ Companies	→ Cooperation	→ Competitiveness

Table 4: International Supply Networks from a Systems Theory-based perspective

This consideration can be further specified with the help of the results of the analytic research task. The cause-perspective explained that International Supply Networks arise because companies concentrate on their core competencies in order to improve their own competitiveness. Therefore, the elements and relations create an International Supply Network that has to improve the competitiveness on the individual and the network level (cf. Figure 2-11). Therewith, the question about the characteristics of International Supply Networks arises because the elements, relations and functions can be outlined and arranged in a logical order with the help of the cause-and-effects perspectives. Characteristics as a further essential category for specifying every subject of scientific consideration of the ontological scientific position according to (Chmielewicz, 1979) have not been addressed in the descriptive and the analytic considerations. Consequently, the characteristics of the ISN have to be considered from a Systems Theory-based perspective so that the underlying theoretical framework as well as the ontological scientific position is fulfilled.

Figure 2-11: Systems Theory-based consideration



Source: Own illustration.

Consequently, with regard to the pragmatic scientific aim a systematic proceeding could be derived because the characteristics of International Supply Networks have to be considered in order to connect the elements and relations as well as the function to improve the competitiveness on the individual and the network level. As a result, a first implication towards the second research question can be drawn because the characteristics of ISN seem to be the starting point to answer the question about the causal relation between ISN and the company success.

Conclusions for
the pragmatic
scientific aim

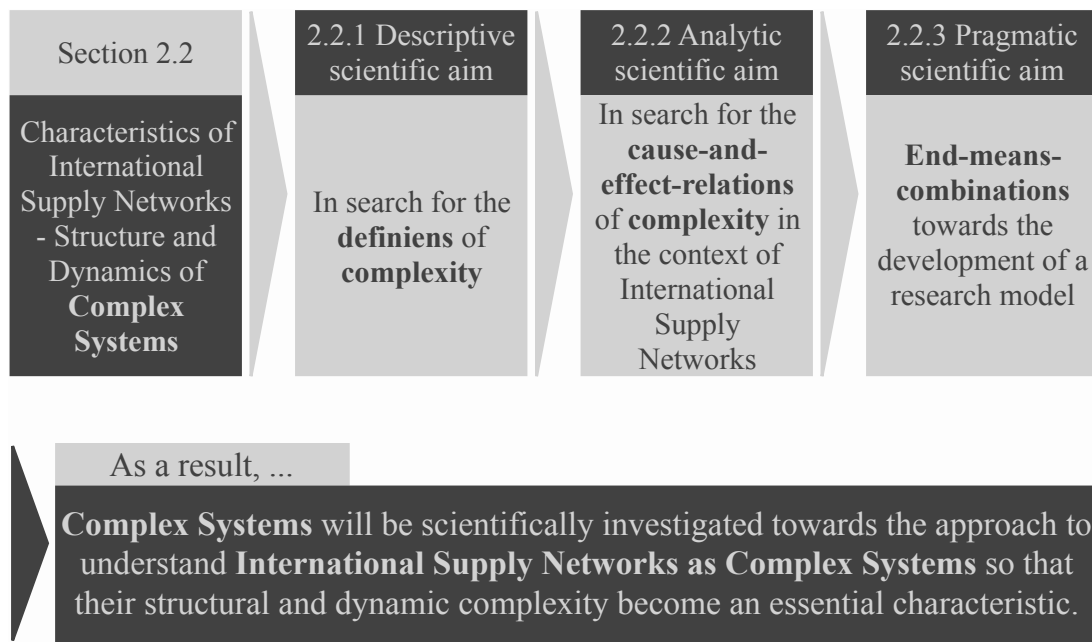
2.2 Characteristics of International Supply Networks: Structure and Dynamics of Complex Systems

Overview over
Section 2.2

It is the **aim of Section 2.2** to consider the **characteristics** of International Supply Networks because after having clarified its elements and relations in the previous section the ontological scientific position according to (Chmielewicz, 1979, pp. 43–44) recommends to consider the characteristics as a further essential category of every subject of consideration. This consideration of the characteristics of ISN should be in accordance with the underlying framework of Systems Theory that was selected because of the interplay between the individual and the network level as well as the interdisciplinary approach. Therefore, a strong limitation about how to possibly consider the characteristics of ISN exists because other aspects of other theoretical approaches are neglected. For example, insights from a behavioral science-based decision theory (cf. e.g. (Kirsch, 1976) or from the Neo Institutional Organisational Theory (cf. e.g. (Greenwood, Oliver, Suddaby, & Sahlin, 2008)) are not taken into account so that the consideration of the characteristics of ISN will be strongly simplified.⁴² In order to balance this limitation, the characteristics of ISN will be considered with the help of the **interdisciplinary framework of complexity** that is also able to address the causal interplay between the individual and the network level. Therefore, the concept of complexity will be disambiguated (Subsection 2.2.1) before the cause-and-effect relations for their existence (Subsection 2.2.2) and the end-means combinations of the complexity management (Subsection 2.2.3) with regard to the course of research will be given. As a result, the structural and dynamic complexity will be identified as an essential characteristic of ISN (cf. Figure 2-12).

⁴² An introduction into different theoretical approaches about how to consider the organisation of networks and their characteristics can be found e.g. in (Kieser & Walgenbach, 2010; Sanders & Kianty, 2006).

Figure 2-12: Overview over Section 2.2



Source: Own illustration.

2.2.1 Descriptive research task: What is the nature of Complexity?

Descriptive
research task of
Subsection 2.2.1

The **descriptive scientific aim** of this subsection consists of the descriptive scientific research task comprising a disambiguation of complexity so that with reference to the course of research according to (Chmielewicz, 1979) the **definiens of the definiendum of complexity is searched for** (cf. Figure 2-13).

In search for the
definiens of
complexity

Figure 2-13: In search for the definiens of complexity



Source: Own illustration.

Definiendum of
complexity

Despite of the fact that **complexity** has become a buzzword, the famous physicist Stephen Hawking has named the 21st Century as the century of complexity in order to underline its importance.⁴³ With the help of this reference, the **definiendum of complexity can be assigned into the field of physics** in particular and **into the field of Systems Theory** in general because on the one side it found its way into common usage in the field of Chaos Theory to express the unexpected ways of behaviors (Gell-Mann, 1995, p. 63; Greschik, 1998, p. 9 et sqq.) and on the other side it can be subsumed into the general fields of research of the underlying theoretical framework of Systems Theory – i.e. the study of the non-linear dynamics of Complex Adaptive Systems (Bar-Yam, 1997, p. xi; Holland, 2006, p. 1; Schuster, 2001, p. foreword) – that has been introduced in Section 1.5. With regard to the study of the non-linear dynamic of different systems, the **idea** of the **definiendum of complexity** can be depicted in a way as to define or understand complexity as a characteristic of a system (Schlange, 1994, p. 3; Steger & Schwandt, 2010, p. 8). For example, according to (Axelrod & Cohen, 2000) a system is considered to be complex when “there are strong interactions among its elements, so that current events heavily influence the probabilities of many kinds of later events”.⁴⁴ Against the background

⁴³ Cited according to (Erdi, 2008, pp. preface, 1). „I think the next century will be the century of complexity.“ Stephen Hawking (Complexity Digest 2001/10, 5 March 2001.).

⁴⁴ Cited according to (Steger & Schwandt, 2010, p. 8).

of its **etymological original** in the Latin word *complexus* meaning “interweaved, networked and connected (Duden, 1997, p. 431), it is the **aim** of the **definiendum of complexity** to trace back the behaviour of a system to its characteristics as being complex, i.e. the way it is structured (Bar-Yam, 1997, p. xi; Mainzer, 2008, p. 1 et sqq.). This is grounded on the **basic assumption** outlined in the field of Systems Theory that different systems comprising the same features do behave in the same way (Bar-Yam, 1997, p. 1) and that the behaviour on the system level cannot be simply reduced from the behaviour on the individual level so that a more holistic approach is needed (Gharajedaghi, 2006, p. 9). Therewith, it is the **central conclusion** that a high number and diversity of elements and their connections with each other that change over time (the elements & connections) lead to an unexpected or unpredictable system behaviour that cannot be easily explained so that new qualities arise. Therewith, it is also essential to separate an individual level of the elements and their relations from a network level covering the system behaviour. Against this background, the definition of complexity according to (Meyer, 2007, p. 25) shall be used as a reference because it comprises a literature review, it is developed in the context of logistics and it is based on the underlying theoretical framework of Systems Theory⁴⁵:

The concept of complexity refers to the characteristics of a system that is determined through the number and diversity of its elements, their relationships with each other and the change of these elements and their relationships over time (Meyer, 2007, p. 25).

Despite of its **main limitation** that no universally accepted definition about **complexity** exists and that it is used in different disciplines in different ways, it is the **main contribution** of the **definiendum of complexity** that it points to an universal characteristic of all ISN from a System Theory-based perspective. This **definiendum of complexity** does not claim to provide a definition based on extensive literature review because with regard to Systems Theory and the ontological scientific position a definition is needed for deriving a stylised model.

Consequently, the definiendum of complexity refers to the **characteristic of a system** that is determined through the number and diversity of its elements and their relationships with each other and the change of these elements and their relationships over time.

Conclusions for
the definiens

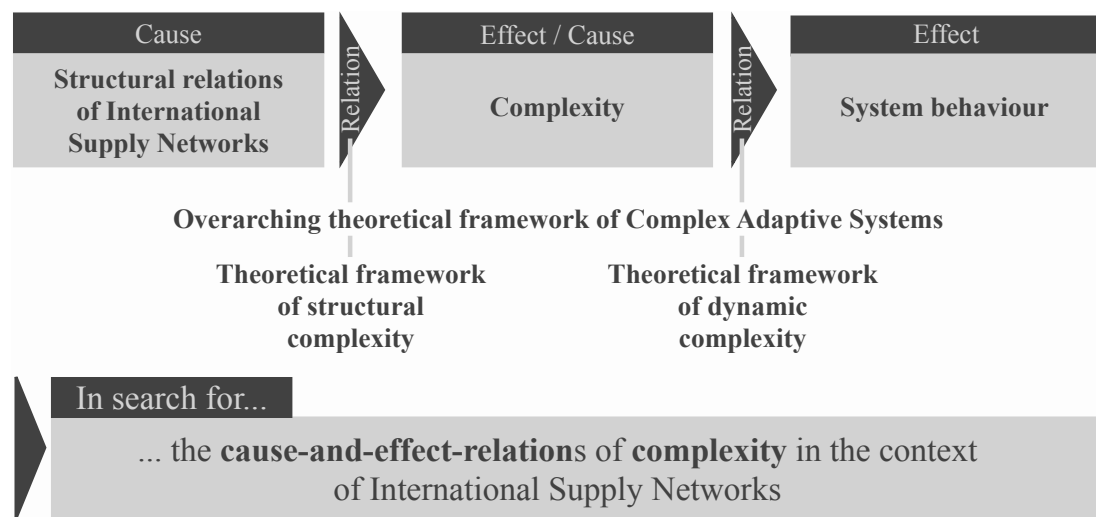
⁴⁵ For deriving a definition about complexity for the application in the field of logistics, (Meyer, 2007, p. 25) separates suitable approaches into different segments of systemtheory in general with reference to Luhmann (1980) that constitutes the basis for many other definitorial approaches. Hereby, the complexity of a system is defined as the amount of elements, the amount of potential relations as well as the diversity of these relations and elements. In this conjunction, the diversity of the elements is also labelled variety while the diversity of the relations is called connectivity that is extended by the changes of the system behavior over time, i.e. the dynamic.

2.2.2 Analytic research task: Why to consider International Supply Networks as Complex Systems?

Analytic research
task of
Subsection 2.2.2

The cause-and-effect relations are subject of consideration of the **analytic scientific aim**. To do so, **structural relations** will be firstly examined in the field of **managerial economics** before the **theoretical framework of Complex Systems** will be introduced that is able to deal with an identified **gap of knowledge**. Based on this, with the help of the **structural** and the **dynamic complexity**, it becomes able to render evidence why to consider International Supply Networks as Complex Systems.

Figure 2-14: In search for the cause-and-effect relations of complexity



Source: Own illustration.

ISN as Complex
Adaptive
Systems

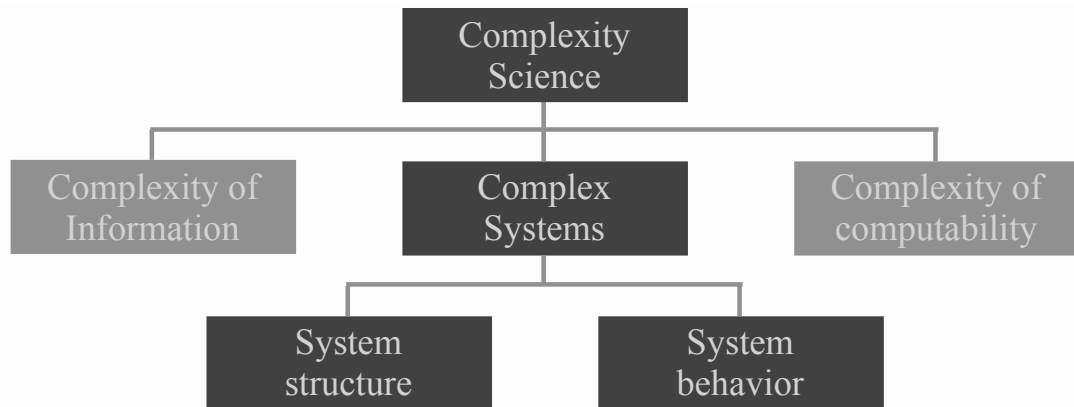
(Choi et al., 2001; Grapp & Hülsmann, 2005; Hülsmann et al., 2011; Pathak, Day, Nair, Sawaya, & Kristal, 2007; Surana, Kumara, Greaves, & Raghavan, 2005; Wycisk et al., 2008) argue to consider **International Supply Networks as Complex Adaptive Systems** (or even Complex Adaptive Logistics Systems) because they constitute systems of high numbers and varieties of different elements and relationships that evolve over the time. Due to the fact that with reference to (Bar-Yam, 1997, pp. 4–5; Gell-Mann, 1995, pp. 120–125) all Complex Systems would be in some sense purposive by adapting to the systems environment, the concept of Complex Systems shall be introduced so that a more general perspective about Complex Adaptive Systems can be taken. The **origin** of the **theoretical framework of Complex Systems** goes back to the “work in cybernetics in the 1940s, to work on general systems theory in the 50s, chaos and catastrophe theory in dynamical systems in the 1960s and 70s, to work on complex systems spearheaded in the 80s by

groups like the Santa Fe Institute ... focussed on abstract mathematical systems and simple physical systems.⁴⁶ In this conjunction, the **theoretical framework of Complex Systems cannot be assigned** directly into a scientific discipline such as e.g. physics – although it is very connected with it – because of the usage of different methodologies from different disciplines. Therefore, according to (Bar-Yam, 1997) the study of complex systems is “the ultimate of interdisciplinary fields” because the advances that have been made “are strongly rooted with this new scientific discipline” so that it can be **classified** as an interdisciplinary scientific framework (Bar-Yam, 1997, p. 1). This interdisciplinary scientific framework has been addressed to one of the main research areas of the underlying theoretical framework of Systems Theory in Section 1.5 so that it can be concluded that the study of **Complex Systems** is part of Systems Theory whose latest development is the extension to the research of **Complex Adaptive Systems**. For this reason and as a point of clarification, the following considerations will position themselves to a physics-related perspective of the overarching underlying framework of Systems Theory because the physicists (Gell-Mann, 1995; Holland, 2006) initiated the study of Complex Adaptive Systems in the 1990s at the Santa Fe Institute. Hence, the understandings of the concept of complexity differ from each other because of the different objectives of the investigations and interpretations this concept has been used for so that the concept of complexity is very subjective and the “process of consideration” is very important (Bar-Yam, 1997, p. 1). An approach for the **classification of complexity** is provided by (Mainzer, 2008, pp. 110–111) who distinguishes complexity of information, dynamic complexity and complexity of computability (cf. Figure 2-15). Hereby, **complexity of computability** refers in general to the size and extension of computer programs and algorithms while the **complexity of information** broaches the issue of patterns of signals that are lying between random noise and total regularity. Finally, closed, i.e. isolated, systems have to be distinguished from open, i.e. dissipative, ones so that an interrelation of the system with its environment occurs. This interrelation leads to the category of **complex systems** respectively the dynamic complexity. Due to the fact that a system⁴⁷ is thinkable without complexity but complexity is not thinkable without a system so that the concept of a system should be considered as a superordinate concept. Additionally, the definiens of complexity has shown that the concept of complexity is closely tied to the concept of a system (Ludwig, 2001, p. 14).

⁴⁶ (University of Southampton, 2013). “... but more recently, interest has increased in complex adaptive systems, such as social systems, biological systems, and technological systems where the parts actively change the way they interact. The increased use of computer simulation and interest in biological questions created research in artificial life and the simulation of adaptive behaviour in the 1990s.”

⁴⁷ The etymological origin of the concept of a system can derived from the Grecian word *systema* that had the meaning of a “whole compounded of several parts or members” (Duden, 1997, p. 792; Ludwig, 2001, p. 12)).

Figure 2-15: Classification of complexity



Consequently, ...

with the help of this classification approach of Complexity Science, the considerations will focus on Complex Systems.

Source: Own illustration. (Cf. (Mainzer, 2008, pp. 110–111))

For getting a better understanding of the theoretical framework of complex systems in this context, the publisher Springer is used as a reference point because it is the biggest scientific publisher in the world that has edited a “Springer series in Complexity” comprising individual books, a Book Series and different Journals. Therewith, even without knowing the detailed information about the amount of publication it can be assumed that the understanding of Springer that proceeds or is the headline of all these publications has a certain range or importance in the scientific world because of four book series⁴⁸ and thirty journals⁴⁹.

“Complex Systems are systems that comprise many interacting parts with the ability to generate a new quality of macroscopic behavior through self-organization, e.g., the spontaneous formation of temporal, spatial or functional structures. This recognition, that the collective behavior of the whole system cannot be simply referred from the understanding of the behavior of the individual components, has led to various new concepts and sophisticated tools of complexity. The main concepts and tools – with sometimes overlapping contents and methodologies – are the theories of self-organization, complex systems,

⁴⁸ Springer Series in Synergetics, Institute of Nonlinear Science, Physics of Neural Networks, Understanding Complex Systems.

⁴⁹ Acta Applicandae Mathematica, Annals of Mathematics and Artificial Intelligence, Archive for Rational Mechanis and Analysis, Biological Cybernetics, Central European Journal of Physics, CHANCE, Communications in Mathematical Physics, EPJ Data Science, The European Physical Journal E, The European Physical Journal D, The European Physical Journal B, The European Physical Journal Plus, Evolutionary Intelligence, Evolving Systems, Foundations of Physics, International Journal of Machine Learning and Cybernetics, Journal of Biological Physics, Journal of Engineering Physics and Thermophysics, Journal of Statistical Physics, Journal of Systems Science and Complexity, Journal of Systems Science and Systems Engineering, Letters in Mathematical Physics, Memetic Computing, Natural Computing, Network Modeling Analysis in Health Informatics and Bioinformatics, Neural Processing Letters, Open Systems and Information Dynamics, Optical Memory and Neural Networks, Social Network Analysis and Mining, Theory in Biosciences.

synergetics, dynamical systems, turbulence, catastrophes, instabilities, nonlinearity, stochastic processes, chaos, neural networks, cellular automata, adaptive systems, and genetic algorithms.”

Hence, despite of its wide range this understanding given by Springer can work as an orientation because it refers inter alia to the separation of the “behaviour of the whole system” and “a new quality of macroscopic behaviour” from “many interacting particles” and “individual components”. For clarifying this issue, it seems insightful to investigate what **complexity researchers** think about complexity because they are experts on this field so that an implicit as well as explicit knowledge about complex systems can be imputed to them. Therewith, a **review** seems promising. For this reason, the book *Complexity: 5 Questions* edited by (Gershenson, 2008) will be introduced because this volume “consists of short ... contributions by leading figures in the field of complexity” with the aim “to bring together the opinions of researchers with different backgrounds on the emerging study of complex systems ... (to) see similarities and differences, agreements and debates among the approaches of different schools” (Gershenson 2008, p. 139). In order to reach this aim, (Gershenson, 2008) asked 24 complexity researchers the following five questions: “Why did you begin working with complex systems?”, “How would you define complexity?”, “What is your favourite aspect / concept of complexity?”, „In your opinion, what is the most problematic aspect / concept of complexity?“ and „How do you see the future of complexity? (including obstacles, dangers, promises, and relations with other areas).“ Consequently, as a result of the review of the statements of these 24 complexity researchers that is shown in Table 5, the following conclusions can be drawn:

- It can be assumed that the theoretical framework of Complex Systems deals with the characteristics of a system because 20 of 24 complexity researchers mentioned this aspect.
- It can be assumed that the theoretical framework of Complex Systems deals with an individual or micro- and a network or macro-level because 15/16 of 24 complexity researchers referred to this differentiation.

Therewith, a starting point for **characteristing** the **theoretical framework of Complex Systems** is given.

Researcher	Statements	Characteristic of systems	Individual- / Microlevel	Network- / Macrolevel
Peter M. Allen, Professor: Complex Systems Management Centre, School of Management, Cranfield University, UK.	“I think that it is what characterizes all evolved, open systems , where the structure and organization has emerged over time through processes of self-organization. It therefore applies to all natural, multilevel systems (molecules, cells, organs, organisms, groups, populations, ecosystems, etc.). ... Complexity emerges and evolves as a result of heterogeneity which is created by underdetermined processes, and undergoes differential dynamics in which some elements are amplified and some are suppressed. This continuous process leads therefore to successive dynamical systems which call structural attractors (sets of phenomena that together have ways of getting resources from the environment. This process of qualitative evolution and which can be temporarily stable, until some new micor-heterogeneity is amplified, changing the boundary of the previous system, and giving rise to emergent properties and features)”	✓	✓	✓
Philip W. Anderson, Professor Emeritus: Physics Department, Princeton University, USA. The Nobel Prize in Physics 1977	“I’m happy to define emergence , as the appearance as the scale is increased of properties unrelated to those of the substrate How about – the search for generalizable features in the behavior of large or complex aggregates of simpler systems .”	✓	✓	✓
W. Brian Arthur, External Professor: Santa Fe Institute, USA. Schumpeter Price in Economics 1990.	“It is really movement to look at how multiple elements reacting to the patterns that those elements together create , as opposed to the reductionist approach which looks at the things from the top down in finer and finer detail. ... But they are always multiple elements reacting to the patterns that those elements create. ... as people look more and more systems unfolding and evolving over time .”	✓	✓	✓
Yaneer Bar-Yam, President, New England Systems Institute	„ Complex systems and complexity refer to the existence of system behaviors that cannot be described from the behavior of parts , and must be described through the understanding of their interdependence. ... I realized that the key issue is that complexity depends on the scale of observation . By considering the complexity as a function of the scale of observation, and not trying to consider a single scale, ...”	✓	✓	✓
Eric Bonabeau, Chief Scientist, Icosystem Corporation, USA and France	“... it is a system comprising multiple, sometimes many, constituent units that interact in such a way that the system’s aggregate behaviour cannot be inferred from the behavior of one constituent unit in isolation. ... it applies to many, many different systems from different disciplines and it suggests that a method borrowed from one discipline can be used to understand a completely different system in a completely different discipline operating at completely different scales.”	✓	✓	✓
Paul Cilliers, Professor of Philosophy, University of Stellenbosch, South Africa	“The most important characteristic of a complex system is probably the fact that it has emergent properties a complex system has properties which result from the non-linear interaction between the components of the system, properties which cannot be reduced to some property of the components themselves .”	✓	✓	✓
Jim Crutchfield, Director, Complexity Sciences Center, University of California, Davis, USA	“Definition 2 is “sophisticated”, “intricate”, “consisting of related parts”, “structured”, and the like. ... Instead, I use “complexity” to describe the properties of a system captured by definition 2. ... Without recounting the technical results, the upshot is that there is a deep connection between how a system stores and process information – how it “intrinsically computes” – and how the system is structured .”	✓	✓	
Bruce Edmonds, Director, Centre for Policy Modelling, Manchester Metropolitan University Business School, UK	“Complexity is that property of a model which makes it difficult to formulate its overall behaviour in a given language/framework, even when given reasonably complete information about its atomic components and their interrelations .”		✓	✓
Nigel Gilbert, Professor of Sociology, University of Surrey, UK	“Complexity provides a vocabulary of emergence, attractors and dynamics that helps to dissolve these conceptual problems by showing how behaviour can lead to structure and structure can constrain behaviour the so-called ‘ micro-macro-link .’”		✓	✓
Hermann Haken, Professor Emeritus, Institut für Theoretische Physik, Universität	“Complexity may be the borderline, where the transition from simple to nearly (or completely) unsolvable problems happens.”			

Stuttgart, Germany				
Francis Heylighen, Professor, Vrije Universiteit Brussel, Belgium	“... authors trying to characterize complex systems just provide extensive lists or tables of properties that complex systems have and that distinguish them from simple systems. These include item suchs as: many components or agents , local interactions, non-linear dynamics, emergent properties , self-organization , multiple feedback loops, multiple levels , adapting to its environment, etc. ... self-organizing processes normally produce emergent properties, and include feedback loops which themselves entail non-linearity. ... it is the relations weaving the parts together that turn the system into a complex , producing emergent properties. ... Aspects can can be related to each other across space, across time or across levels systems “fitting” or adapting to each other.”	✓	✓	✓
Bernardo A. Huberman, Senior HP Fellow and Director, Social Computing Laboratory, HP Labs, USA	“That positivity leads to chaotic behaviour out of very simple deterministic equations and the ensuing complex behaviors one observes when studying their evolution. But in systems composed of many interacting parts that happen to be intentional (social, economic, ecological) and not necessarily decomposable, complexity arises from the behavior of the whole from the plans of individuals , and thus the panoply of fascinating patterns and apparent regularities we are constantly surprised with.”	✓	✓	✓
Stuart A. Kauffman, Director, Institute for Biocomplexity and Informatics, University of Calgary, Canada	“It allows us to look at systems with a very large number of parts , where the parts may be different from one another and may influence one another in different ways. As we allow them to influence one another, we can ask what is the collective behaviour of the resulting system and whether there are emergent collective features that we can find. My own passion is to hope that those emergent collective features will allow us to find laws that describe the behaviour of such systems, that are relatively insensitive to the details of the structure of the system.”	✓	✓	✓
Seth Lloyd, Professor, Massachusetts Institute of Technology, USA	“... complexity arises out of a combination of the difficulty of describing or characterising a system (measured, e.g., in bits), and the difficulty of doing something with the system (measured, e.g., in energy applied/dissipated or in dollars spent).”	✓		
Gottfried Mayer-Kress, Adjunct Associate Professor, Department of Kinesiology, Pennsylvania State University, USA, Editor Complexity Digest	“On a technical level I would say that complexity is a measure that describes the amount of information needed to describe a complex system.”	✓		
Melanie Mitchell, Professor of Computer Science, Portland State University, USA	“A more useful approach, I think, is to ask what concepts are most appropriate to employ in characterizing the behaviour of these so-called complex systems .”	✓		✓
Edgar Morin, Emeritus Research Director, Centre National de la Recherche Scientifique, France	“My definition of complexity gives privileges to: Systemic relations.”	✓		
Mark Newman, Professor of Physics, University of Michigan, USA	“If I have to describe what I do I say that I work on “complex systems”. ... Commonly a complex system is defined to be a system composed of many components or “agents” which interact with one another so that system as a whole is more than just the sum of its parts.” We say the system shows “emergent behaviors”, collective responses of all the parts that make it up.”	✓	✓	✓
Grégoire Nicolis, Professor, Interdisciplinary Center for Nonlinear Phenomena and Complex Systems, Université Libre de Bruxelles, Belgium	“Although algorithmic complexity accounts for certain features of natural complex systems in its basic philosophy it is fundamentally different from the complexity one is concerned with in nature, where one seeks to identify emergent properties , concerted behavior and evolution.”	✓		✓
Jordan B. Pollack, Professor of Computer Science, Brandeis University, USA	“The elegance and beauty of the complexity hierarchy of generative formal languages consumed many early careers in computer science ...”			
Peter Schuster, Head Institute of Theoretical Chemistry, University of Vienna, Austria, President Austrian Academy of Sciences	“Complexity is defined by negotiation: Simple systems are characterized by simple causality that manifests itself in easily recognized input-output relations, e.g. ‘more input leads to more output’ or ‘more input leads to less output’, simple systems have no inherent limits of predictability in the sense that only uncontrollable inputs lead to unpredictable outputs, and simple systems are commonly low-dimensional in the sense that a few independent parameters are sufficient to describe the exhaustively. In other words, complex systems have sophisticated input-output relations, are inherently unpredictable and high-dimensional.”	✓		
Ricard V. Solé, Research Professor, Complex Systems Lab, Universitat Pompeu Fabra, Spain, External Professor Santa Fe Institute, USA	“I think there is a more or less robust consensus in relation to what makes a complex system : some set of elements interacting in such a way that higher-order, system properties emerge . These properties cannot be reduced to the properties displayed by individual parts and thus some kind of “ irreducible order ” is at work. I would add to this tentative definition that complexity is strongly tied to an unbreakable dialog between system and parts : the global	✓	✓	✓

	pattern is generated by individuals, who also receive feedback from the system. Moreover, it seems clear that the global pattern can be explained (at least in most cases) by completely ignoring most of the individual details, and that seems also inextricably linked to complex behaviour.”			
Tamás Vicsek, Professor of Physics, Department of Biological Physics, Eötvös Loránd University, Budapest, Hungary	“The world is made of many highly interconnected parts over many scales , whose interactions result in a complex behaviour needing separate interpretation for each level . This realization forces us to appreciate that new features emerge as one goes from one scale to another, so it follows that the science of complexity is about revealing the principles governing the ways by which these new properties appear. ... In complex systems, we accept that processes occurring simultaneously on different scales or levels matter, and the intricate behaviour of the whole system depends on its units in a non-trivial way. ”	✓	✓	✓
Stephen Wolfram, Founder & CEO, Wolfram Research, Inc., USA	“I might say that sometimes our notions of complexity end up being very close to randomness, and sometimes not. ... It tends to be more about different models of the observer – or different characterization of what one is measuring about about a system – than about the fundamental capabilities of the system itself.”	✓		
24 Complexity researchers with different definitions for complexity		20	15	16
→ Conclusion				

Table 5: Review of the statements of complexity researchers

For **characterising the theoretical framework of Complex Adaptive Systems**, the work of (Meyer, 2007) shall be used as a reference point because it comprises a literature review and it deals with the field of logistics. Therewith, as outlined in Table 6 the characteristics of complexity deal with the system structure comprising the amount and diversity of the elements and relations while the system behaviour deals with the amount and diversity of patterns of behaviour over time.

	Luhmann (1980)	Bohne (1998)	Ulrich/Probst (1991)	Bronner (1992)	Beer (1973)	Tang/Salminen (2001)	Schwaninger (1994)	Hub (1994)	Malik (1996)	Gell-Mann (1996)	v. Forrester (1977)	Ashby (1985)	Gomez/Probst (1997)	Kirchhof (2003)	Bohne (1993)
System structure															
Diversity of the elements		x	x										x	x	x
Amount of the elements	x	x	x	x	x	x									
Diversity of relations	x	x	x	x											
Amount of relations	x			x	x	x							x	x	x
Spectrum of relations						x									
System behavior															
Timely behaviour (Dynamic)							x	x					x	x	x
Diversity of potential system states or configurations							x	x	x						x
Amount of separable system states												x			
Reequred computation for the system description										x	x		x		
Subjective complexity										x				x	

Table 6: Characteristics of complexity according to (Meyer, 2007, p. 25).

In this conjunction, (Bar-Yam, 1997, p. 7 et sqq.) mentions the following **essential properties** of Complex Systems that might be assigned in the following way.

- Elements (and their number), interactions (and their strength) and diversity/variability. → System structure.
- Formation/operation (and their time scales), environment (and their demands) and activities (and their objectives) because all complex systems “are in some sense purposive” so that their “dynamics has a defineable objective or function”. → System behaviour.

With the help of these **characteristics** and **essential properties** the **idea** of the **overarching theoretical framework of Complex Systems** to differentiate between a system structure and a system behaviour because of the **aim** to scientifically study these complex systems with many interacting elements that produce a global behaviour that “cannot easily be explained in terms of interactions between the individual constituent elements” (University of Southampton, 2013). This approach is **based on the assumptions** that “there exist simple and therefore comprehensible laws” and that these laws “are founded on universal principles that may be used to describe disparate problems ranging from particle physics to the economics of societies. A corollary is that transferring ideas and results from investigations in hitherto disparate areas will cross-fertilize and lead to important new results” (Bar-Yam, 1997, p. xi). Thus, it is the **central conclusion** of the **theoretical framework of Complex Systems** that different systems can be analysed and better understood because with the study of the elements and relations on the individual or micro-level and of the phenomena or behaviour of the system on the macro-level similar patterns or laws can be recognized leading to the same results whether it is a biological, economic or mechanical one (Bar-Yam, 1997, p. xi). Therewith, “mathematical developments and modelling approaches from physics can be used to better understand these systems” and new approaches from e.g. systems biology can be used for inspiring new results (University of Southampton, 2013). It is the **main contribution** of the **theoretical framework of Complex Systems** that it can be used for bridging the gap of knowledge in the field of managerial economics about the causal interplay between the individual and the network level because, firstly, it can be used for the cause- and the effects-perspective by using the frameworks of the **structural complexity** and the **dynamic complexity**.

Structural
complexity for
the cause-
perspective

It is the **aim** of the **cause-perspective** to explain the **causal relation between the structural relations of International Supply Networks and the complexity** because a framework is needed that overbears the gap of knowledge in the field of managerial economics. Therefore, it is the **idea** of the **cause-perspective** to use the **framework of the structural complexity** – as part of the **theoretical framework of Complex Systems** – for the aspect of the system structure. This is **based** on the **assumption** that the **structural complexity** is reflected in the amount and diversity of the elements and relations because the structure of a system is usually understood as the pattern of elements of a system and how they are connected with each other (Duden, 1997, p. 777). Therewith, it is the **central conclusion** that if the structural relations of the considered International Supply Network comprise a high amount and diversity of elements and relations, then it has to be concluded that the characteristic of the system is of high forming of complexity. The **framework of the structural complexity contributes** to the research because with the help of the concept of a network that is “a set of items, called vertices or sometimes nodes, with connections between them, called edges” (Newman, 2003, p. 1) it becomes possible to typologize different patterns of structures in a system. Furthermore, due to the measurable approaches such as e.g. Complex Network Science (cf. Section 3.1.3), it becomes possible to operationalise the structural complexity. Additionally, with the help of **previous studies in the working group**, it has already been stated that International Supply Networks comprise a high amount and diversity of elements and relations (Grapp & Hülsmann, 2005; Hülsmann et al., 2008). Therewith, it is the **main contribution** to overcome a gap of knowledge in the field of managerial economics. This is **limited** through the fact that an isolated consideration of such ratios for the structural complexity lack a power of explanation so that they have to be connected with theoretical approaches e.g. from the field of Strategic Management (cf. Section 2.3.3 and 2.4.3).

Dynamic
complexity for
the effects-
perspective

The **effects-perspective aims** to explain the **causal relation between the complexity and the system behavior** because after having selected the structural complexity on the individual level the effects of this structural complexity have to be picked out as a central theme. For this, it is the **idea** of the **effects-perspective** to use the **framework of the dynamic complexity** – as part of the **theoretical framework of Complex Systems** – for the aspect of the system behaviour. By considering the **origin** of the **theoretical framework of the dynamic complexity** that can be traced back to the field of Thermo Dynamics in physics through the Austrian physicist Ludwig Boltzmann (1844 – 1909) (Mainzer, 2008, p. 39) its **basic assumptions** can be outlined. Firstly, the dynamic of a system, i.e. the timely evolution of change of the system states, is connected with causality because according to (Mainzer, 2008)

[t]he dynamic, i.e. the timely sequence of system states, is considered/understood in the field of philosophy as the causality of cause and effect. Linear dynamic systems commensurate to a strong causality in which causes and effects are proportional to each other. A weak causality in which causes and effects are only distinctly determined, also includes (deterministic chaos). Therewith, we are in the field of nonlinear systems whose dynamic equations describe feedback loops of manifold causes and effects (Mainzer, 2008, p. 110).

Secondly, an observable state of the whole system on the macro-level is determined through the amount W of micro states on the individual level that determine the current state of the whole system so that this system state is also called to be a thermodynamic probability because in the general the field of statistical mechanics explains a macro state such as e.g. density, pressure or temperature through microstates. Therefore, it is the **central conclusion** that the dynamic complexity is the result of the structural complexity of a system because the microstates determine the macro states so that a causal relation between these two levels can be derived (Bozarth, Warsing, Flynn, & Flynn, 2009). As a result, chaos and disorder but also new structures (on the system level) and order through self-organisation arise (Fynes, Voss, & Burca, 2005). Therewith, the **framework of the dynamic complexity contributes** to the research because it allows understanding the effects of the structural complexity, i.e. the structure of the International Supply Networks, through the dynamic, i.e. the system behaviour. Furthermore, the connection of phenomena of the dynamic complexity with the application area of International Supply Networks is accepted in the scientific literature because by considering the **preliminary studies** in the working group of Prof. Dr. Hülsmann International Supply Networks have been characterised as Complex Adaptive Logistics Systems (Hülsmann et al., 2011; Wycisk et al., 2008) (cf. (Choi et al., 2001; Pathak et al., 2007)). For this reason, this special characteristic of an International Supply Network can be understood within the framework of Complex System because by combining time and the environment”complex systems get the ability to adapt so that the **concept of Complex Adaptive Systems (CAS)** arises. According to (Schuster, 2001) “all CAS have a basic common structure” and they “are made up of elements or agents ... which interact with each other and with their environment in a nonlinear fashion”. Furthermore, they “generate from input information – from the environment... - and an output action which changes the environment” so that all CAS perform computations which can be described within the framework of nonlinear dynamics (Markose, 2003; Schuster, 2001, p. 7). In this conjunction, thirdly, further frameworks for understanding the characteristic behaviour of International Supply Networks becomes available because the concept

of **emergent complexity** and of **chaotic complexity** are essential aspects for the understanding of Complex Systems. Hereby, the **concept of emergent complexity** refers to the consideration of scales, e.g. the consideration of an individual element and the consideration of the behaviour of the total system because according to (Bar-Yam, 1997) “elements are those parts of a complex system that may be considered simple when describing the behavior of the whole” (Bar-Yam, 1997, p. 5). The concept of chaotic complexity usually points to unexpected or totally random forms of behaviour because they are analysed within the framework of nonlinear dynamics stating that the development of the system behaviour cannot be exactly predicted (Greschik, 1998; Malik, 2008).

As a result, with regard to question about the characteristics of ISN it can be assumed that the nature of the **system behaviour is ambivalent**. On the one side, it has been outlined that Complex Adaptive Systems are in some sense purposive by adapting to the external requirements from the environment. This points to the concept of the emergent complexity because of its feature to address to a new quality on the level of the system that cannot be simply reduced to the elements of the system. For example, the population of ants in Section 1.1 was used to illustrate the intelligent behaviour of the whole population. On the other side, Complex Adaptive Systems comprise unexpected ways of behaviour because of e.g. self-organising effects. The field of Chaos Theory deals with this aspect of non-linear feedback loops and the attractors towards a system can tend so that the behaviour of a system can turn into totally different directions as a result of small changes in one of the system states (Jetschke, 1989; Meschede, 2004; Sornette, 2006). This **ambivalent behaviour of Complex Adaptive Systems** that is covered through the study of its dynamics is also reflected in the **strategies of the complexity management**. Therefore, an introduction into the complexity management shall be given that does not claim to provide an extensive overview of different strategies of the complexity management. Instead, it shall just give indications towards the ambivalent behaviour.⁵⁰ An introduction that takes the discipline of logistics as well as a systemtheoretic perspective explicitly into account is given by (Meyer, 2007). Besides this **assignment of the complexity management into the field of logistics respectively Supply Chain Management** the **complexity management** can be further **classified** as a new class of management strategies because

[T]he complexity management comprises the application of insights of complexity science for the goal-oriented design and control of complexity in

⁵⁰ An introduction into the complexity management can be found e.g. in (Kaluza et al., 2006; Malik, 2008).

*consideration of economic objectives.*⁵¹

With the help of literature review (Meyer, 2007) **differentiates** strategies of the complexity management into three basic types of strategies, i.e. the **reduction of complexity**, the **control of complexity** and the **prevention of complexity**.

With reference to (Meyer, 2007, p. 33) it is the **aim** of the **strategy of the reduction of complexity** to reduce the complexity of the considered system, here the ISN, by reducing already existing amount of parts, variants and processes comprising the **idea** to simplify the system, i.e. the amount and diversity of the elements and relations. This is **based** on the **assumption** that some parts and connections can be identified as reducible or redundant, i.e. that these parts and connections can be removed without infecting the functioning of the – logistic – system. The reason for this is that the complexity is connected with additional cost for the management of the system and for dealing with unexpected disturbances that can lead e.g. to a breakdown of the system (cf. e.g. the practical relevance in Section 1.3). Therewith, it can be **concluded** that the **reduction of complexity** refers to an abatement of redundant variants to the point of a portfolio-management of e.g. products or suppliers. Therewith, it is a **main contribution** of this strategy of highlighting redundancies that can generally make a system less efficient because the input-output-ratio is shifted. Therefore, the **strategy of the reduction of complexity** can be interpreted as strategies for improving the efficiency. Hence, with regard to the **main limitation** it has to be stated that such a precise analytic determination is in its infancy because positive long-term effects of such a pretended redundancy is neglected and a measurable calculation of for example co-evolutionary effects that a pretended redundant part makes a system even more efficient lacks research. Consequently, it can be assumed that reduction of complexity refers to the chaotic complexity.

Reduction of
complexity

According to (Meyer, 2007, p. 34) the **strategy of the prevention of complexity** **aims** at preemptively avoiding complexities before they occur by following the **idea** to consider current or actual processes and structures that might effect future complexities and their requirements. Obviously, this is **based** on the **assumption** that such processes and structures are recognizable in advance. Therefore, it is the **conclusion** that a modular design of products, organisational structures or processes can avoid the rise of complexities. The **main contribution** consists of referring to modular strategies because of synergetic effects so that this strategy is in accordance with modern management strategies, but a **main limitation** can be explained with

Prevention of
complexity

⁵¹ (Meyer, 2007, p. 26). According to Schwenk-Willi (2001, p. 22) complexity is defined by assigning the configuration, the control and development of the diversity of business activities in form of products, resources and resources. He defines the goal a maximum contribution to the customer benefits/value under gleichzeitig high economic feasibility.

regard to the uncertainty of the development or evolvement of a system. Because of the fact that the causal interplay between the structural and dynamic complexity lacks a precise theoretical foundation, measurable strategies cannot be provided. As a result, it can also be assumed that the prevention of complexities also tries to deal with the chaotic complexity by acknowledging the aspect of the emergent complexity because the different aspects of the complexity are hard to distinguish from each other and the evolvement of the system behaviour is hard to predict.

Control of
complexity

According to (Meyer, 2007, pp. 33–34) it is the **aim** of the **control of complexity** to efficiently handle the internal complexities that are the result of the external requirements, e.g. from the market, because it follows the **idea** that some complexities cannot be avoided. This is **based** on the **assumption** that the internal complexity of a system, e.g. an ISN or an individual company, is the result of the interplay with the complexity of the system's environment, e.g. the market because the increasing customer requirements require an increasing solution. Therefore, it is the **conclusion** of the **control of complexity** for example to optimise the value creation processes, to adapt the organisational processes or to make them more flexible. As a **result**, the **strategies of the control of complexity** seem to be in accordance with the approach because the complexity is considered to be a necessary characteristic of every system as a result of the external requirements a system has to fulfil (Meyer, 2007, pp. 33–34).

Conclusions for
the analytic
scientific aim

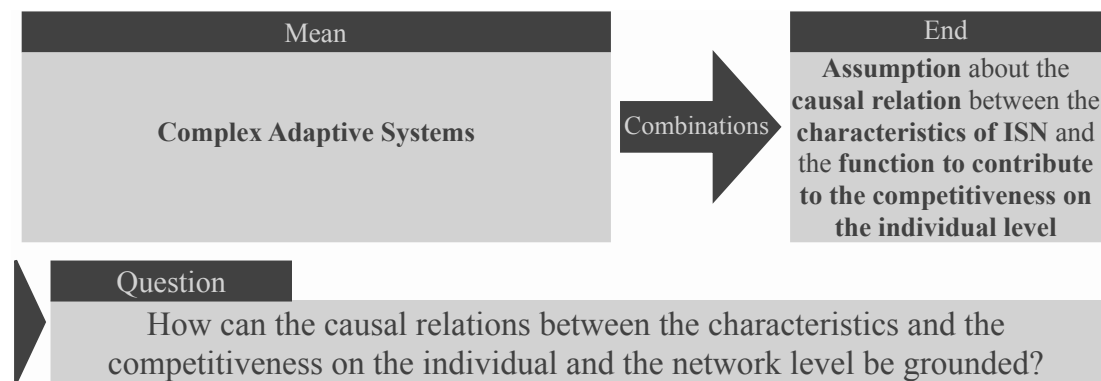
Consequently, the theoretical framework of Complex Adaptive Systems can be used for covering the characteristics of International Supply Networks. The reason for this is that the frameworks of the structural complexity and the dynamic complexity seem to be promising for covering the characteristics on the individual and the system level. Furthermore, the dynamic complexity for covering the behaviour of the system includes the concepts of the emergent and the chaotic complexity so that the ambivalent nature of the characteristics of complexity is represented. As a result, it has to be investigated, if the system behaviour of the International Supply Networks can be somehow connected with the emergent and the chaotic complexity for developing a research model.

2.2.3 Pragmatic research task: How to use Complex Adaptive Systems for developing a research model?

How to use **the framework of Complex Adaptive Systems for developing a research model**? This question points to the **pragmatic scientific aim** because end-means combinations are searched for (cf. Figure 2-16).

Pragmatic research task of Subsection 2.2.3

Figure 2-16: In search for end-means combinations towards the research model



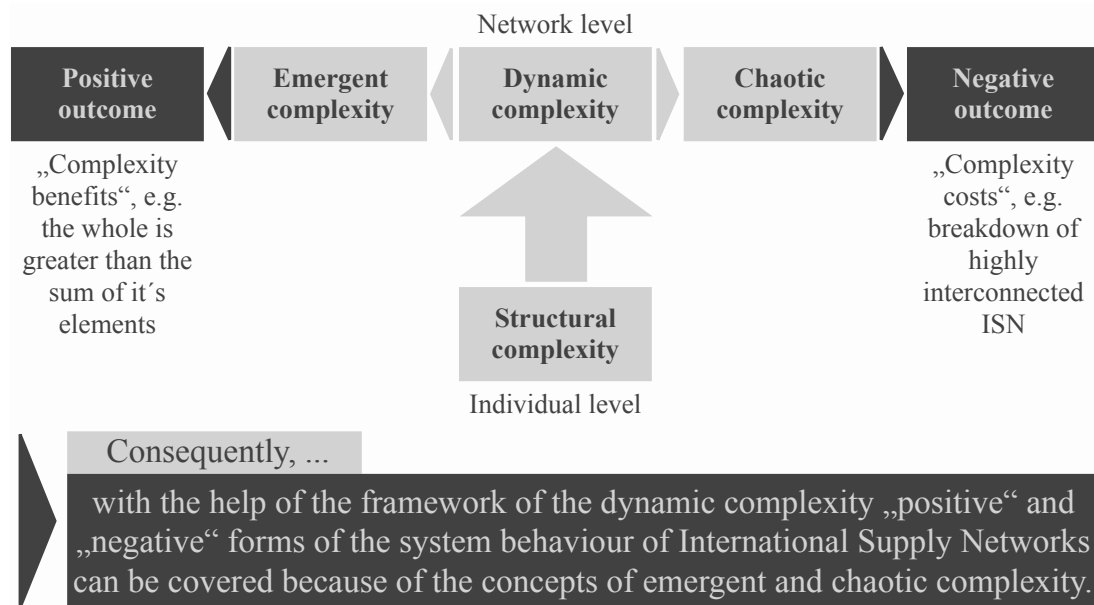
Source: Own illustration.

Despite of the fact that the scientific community has made impressive progress about the “characterisation and modelling of network structures”, insights of the “**effects of the structure**” on the “**system behaviour**” are still in their “infancy” so that it “remains to be seen what the crucial theoretical developments will be in this area” (Newman, 2003, p. 2 et sqq.). Therefore, the **causal interplay between the levels** of ISN **is still unclear** (Hülsmann & Lohmann, 2009, p. 34 et sqq.) and especially the question about how the **cooperative interplay** in the network **depends on the structure** of the system cannot be theoretically explained with the help of the framework of **Complex Adaptive Systems** directly. Nevertheless, for the sake of deriving a research model the insights from **Complex Adaptive Systems** shall be used indirectly. It has been outlined in the cause-perspectives that the structural complexity can help to cover the structural relations on the individual level. The effects-perspective included the dynamic complexity for covering the behaviour of the system. Hereby, the chaotic complexity pointing to unpredictable forms of behaviour was distinguished from the emergent complexity referring to new qualities on system level. With regard to the development of a research model it shall be assumed that the emergent complexity can be connected with positive aspects because it has been outlined that it refers to the purpose or function of a Complex Adaptive System. The chaotic complexity shall refer to negative aspects because the higher interconnectivity can lead to unpredicted forms of behaviour in dependence

A complexity-based framework

on small changes in the microstates of the elements or its relations. Therewith, the emergent complexity mostly refers to a positive aspect because the whole is considered to be greater than the sum of the elements (cf. the example of a collection of ants) so that the reasons why International Supply Networks occur could be connected with this concept. Therefore, with regard to the development of a research model a concept with the help of the framework of the dynamic complexity can be derived as illustrated in Figure 2-17.

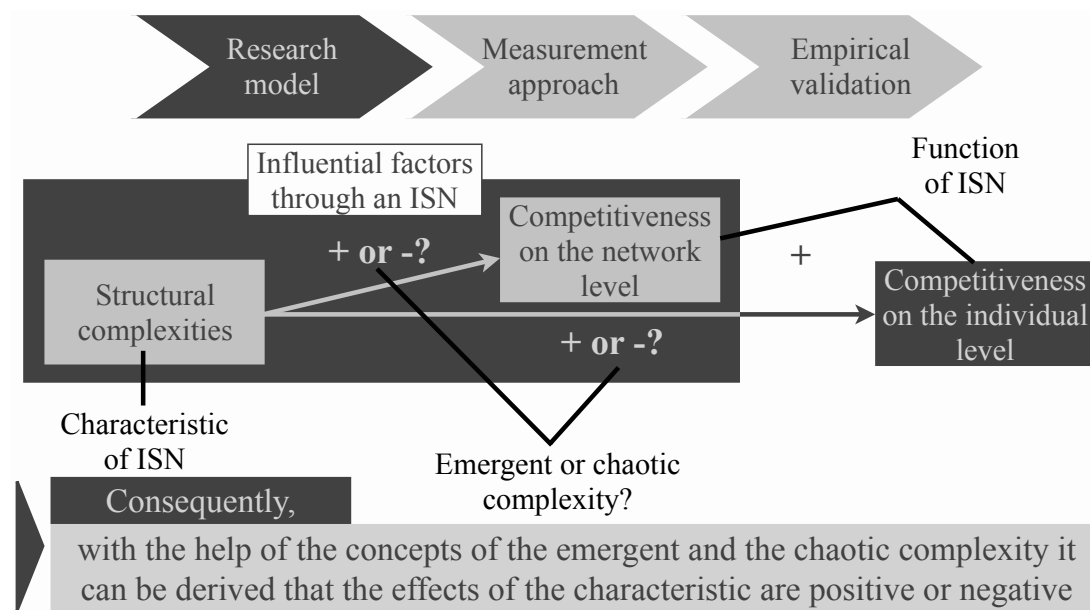
Figure 2-17: Concept with the help of the framework of the dynamic complexity



Source: Own illustration.

How can this concept be used for deriving implications towards the research model? Complexity has been identified as an essential characteristic of International Supply Network that was the result of the consideration from a Systems Theory-based perspective. Due to the fact that the functions have been identified in the ontological scientific position as an inferior form of a characteristic, it was also assumed that the functions to contribute to the competitiveness on the individual and the network level are the result or influence of the characteristic of an ISN. Therefore, by identifying the characteristic of ISN as the complexity it can be, firstly, derived that the research model will be complexity-based because of its superior position. Secondly, with the help of the framework of the dynamic complexity it can be derived that the causal relations between the characteristics of an ISN and the competitiveness on the individual and the network level should be either positive or negative depending on the emergent or chaotic complexity as illustrated in Figure 2-18.

Figure 2-18: Implications towards the research model



Source: Own illustration.

What are the **main limitations** of these implications? Firstly, the power of explanation is limited because despite of the fact that methodological approaches for both the structural complexity and the dynamic complexity exist, a commonly accepted theoretical framework for connecting these two aspects of Complex Adaptive Systems is still missing (Lumsden, Hulten, & Waidringer, 1998, p. 1). Secondly, the level of precision should be deepend because of the methodological problems of formalising the effects of the structural complexities in an abstract and therefore stylised way. Finally, the above-mentioned conclusions and contributions depend on the understanding of complexity one is willing to take because currently “no universally accepted definition of complexity” so that different phenonema are understood differently in different disciplines (Schwandt, 2010, p. 8). Nevertheless, these stylised implications **help** to develop a research model towards the overarching objective because the research model can be grounded on the framework of Complexity Science and first indications towards the positive or negative nature of the causal relations can be derived.

Consequently, the research model can be identified as a complexity-based one because the characteristics of the ISN can be covered through the framework of the structural complexity while its causal relations with its function can be grounded with the emergent or chaotic complexity so that positive or negative directions are thinkable.

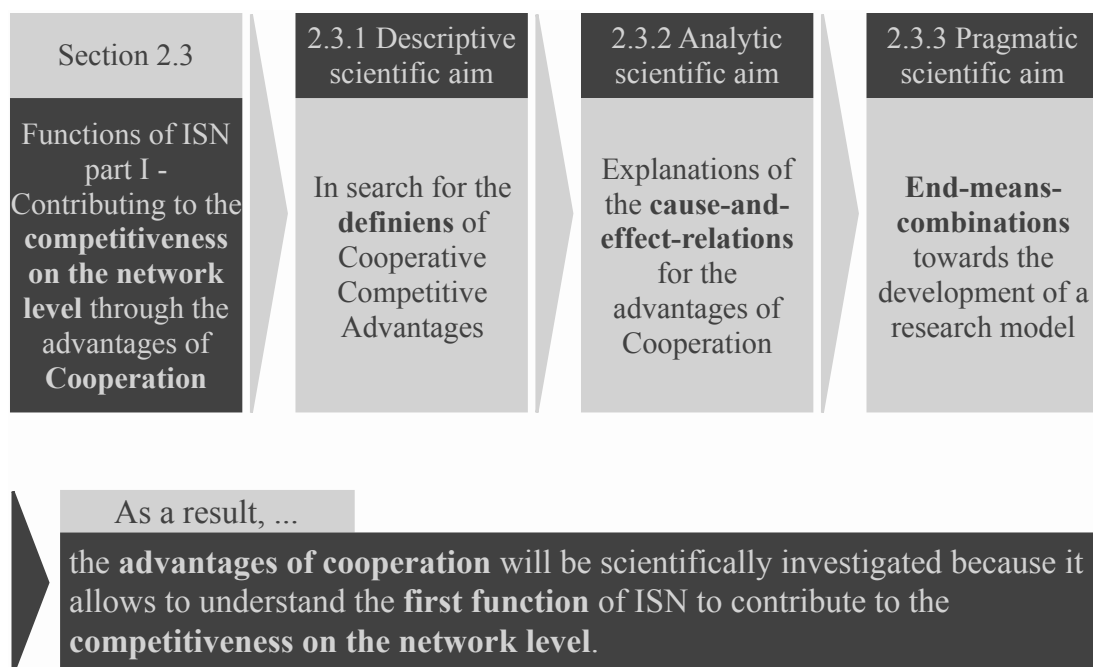
Conclusions for
the end-means
combinations

2.3 Functions of International Supply Networks part I: Contributing to the competitiveness on the network level through the advantages of cooperation

Overview over
Section 2.3

It is the **aim of Section 2.3** to clarify the first function of International Supply Networks to create and sustain competitiveness on the network level. For this, the concept of **Cooperative Competitive Advantages (CCA)** will be disambiguated (Subsection 2.3.1) before they will be arranged into a logical order through the considerations of the cause-and-effect relations (Subsection 2.3.2) implying that cooperation and synergies can lead to Cooperative Competitive Advantages. Finally, the end-means combinations towards the development of the complexity-based research model will be given (Subsection 2.3.3, cf. Figure 2-19).

Figure 2-19: Overview of Section 2.3



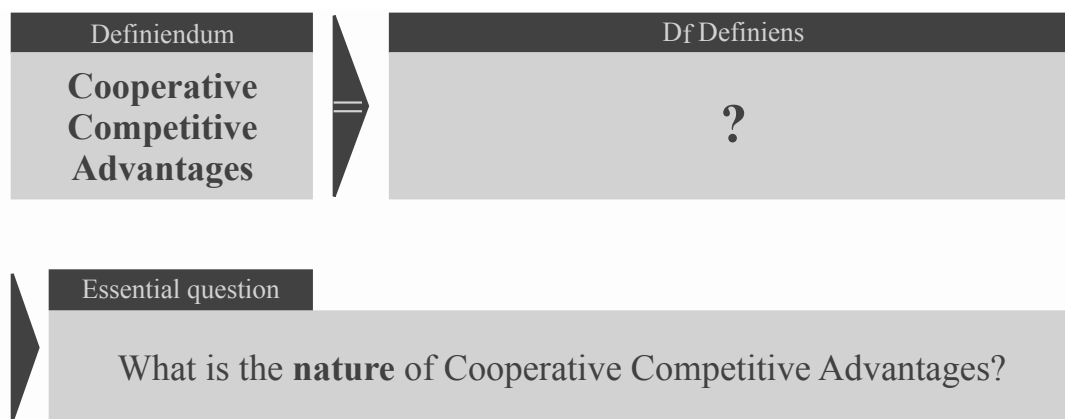
Source: Own illustration.

2.3.1 Descriptive research task: In search for the definiens of Cooperative Competitive Advantages

The **descriptive scientific aim** of this subsection consists in the descriptive scientific research task comprising a disambiguation of Cooperative Competitive Advantages because it will stand in the core of the analytic considerations of the next subsection. Therefore, with the help of the course of research according to (Chmielewicz, 1979), the **definiens of CCA is searched for** (cf. Figure 2-20).

Descriptive
research task of
Subsection 2.3.1

Figure 2-20: In search for the definiens of Cooperative Competitive Advantages



In search for the
definiens of
Cooperative
Competitive
Advantages

Source: Own illustration.

The **definiendum of Cooperative Competitive Advantages (CCA)** comprises the **idea** that an International Supply Network reaches a Competitive Advantage due to the advantages of cooperation while the **origin** of the approach that an International Supply Network tries to gain and maintain a competitive advantage, too, goes back to the **preliminary study in the working group**⁵², this **idea** to reason such a competitive advantage of an International Supply Network as a **Cooperative Competitive Advantage** one can be identified as an **original approach of this thesis** because of the **aim** to go for an explanation approach for the competitiveness on the network level by explicitly tracing it back to the advantages of cooperation of and within an ISN. Against this background, the **definiendum of CCA** is grounded on the **basic assumptions** of an **increasing network competition** as introduced in Section 1.1, the **characteristics of a Competitive Advantage according to** (Simon, 1988) because of the preliminary studies of (Hülsmann & Cordes, 2009)⁵³ and on the concept of **cooperation**.

Definiendum of
CCA

⁵² Cf. (Hülsmann & Cordes, 2009): Wettbewerbsvorteile von und in internationalen Wertschöpfungsnetzwerken.

⁵³ An import characteristic of a product or service is superior to those of a competitor it is recognized by the end-customer and this advantage can be adhered long-lasting (cf. Section 1.1).

Cooperation

The word **cooperation** has its **etymological origin** in the Latin word *cooperatio* meaning the collaboration or coactivation of two or more partners (Duden, 1997, p. 447). In the context of managerial economics, it points to an organisational concept of collaboration because ISN constitute an organisational form between market and hierarchy that is based on trust through cooperation so that the autonomy is set-aside in some areas (Hülsmann & Lohmann, 2009, p. 5). With regard to this degree of autonomy, according to (Thiemann, 2004, pp. 4–5) **different forms of cooperation** can be distinguished that are normally typologised in the following way with respect to e.g. time- or content-related aspects while a contractual cooperation refers to a legal system of rules between two or more companies without founding a new, legally independent company and without a capital participation, a Joint Venture refers to a contractually agreed long-term intercompany collaboration based on a capital participation and share of the business management and risk so that a legally independent enterprise arises. Finally, a merger and/or acquisition means that both – the legal and the economic – autonomy is repealed so that two or more companies are consolidated with each other. Against this background, the following considerations will be **contained** to the contractual form of cooperation because it best fits to the definiendum of ISN (cf. Subsection 2.1.1) so that according to (Thiemann, 2004) a contractual form of cooperation is **defined** as

the formalised and long-range collaboration between economically and legally autonomous companies for the sake of a common realisation of different aims that could not be achieved by the partners on their own. Hereby, the legal autonomy stays the same while economic autonomy is constricted in the partial area of the cooperation (Thiemann, 2004, p. 4).

In the context of the automotive industry, (Wallentowitz et al., 2009) highlights these **characteristics** that a cooperation consists of economically and lawfully independent companies, is characterised through a reciprocal coordination of the tasks, is based on decision of the partners by choice, aim at realising common or intercompatible goals of the partner and promises to achieve a higher achievement of goals in comparison with a single proceeding (U. Arnold & Eßig, 2005; Bieg & Krämer, 2005; Hülsmann & Lohmann, 2009; Scherm, 2005; V. Stein, 2005; Sydow & Möllering, 2009; Wallentowitz et al., 2009, 2010; Woratschek & Roth, 2005; Zahn, 2011). These **advantages of cooperation** refer to better performances because of having access to the resources of the cooperating partners (through the cooperation and the resulting relations) (Hülsmann & Lohmann, 2009, p. 5) so that goods and services can be brought together and offered based on the division of labor that could not be offered by a single company because restrictions regarding

capital, time, competencies or size of a single company can be overborne (Rösler, 2003, p. 35).

As a **result**, it can be **concluded** that a **Cooperative Competitive Advantage** exists, if the typical features of a Competitive Advantage according to Simon, i.e. an important characteristic of a product or a service is superior to those of a competitor, it is recognized by the end-customer and this advantage can be adhered long-lasting, can be traced back to the advantages of cooperation (interplays) in and of the ISN. Therewith, a **main contribution** exists with regard to combining cooperation with competitive advantages for explaining the competitiveness on the network level while it is **limited** to the fact that a theoretical reasoning is needed.

Consequently, a Cooperative Competitive Advantage is assumed to exist, if the typical features of a Competitive Advantage – an important characteristics of a product or a service is superior to those of a competitor, it is recognized by the end-customer and this advantage can be adhered long-lasting – can be traced back to the **advantages of cooperation in and of the ISN**.

Conclusions for
the definiens

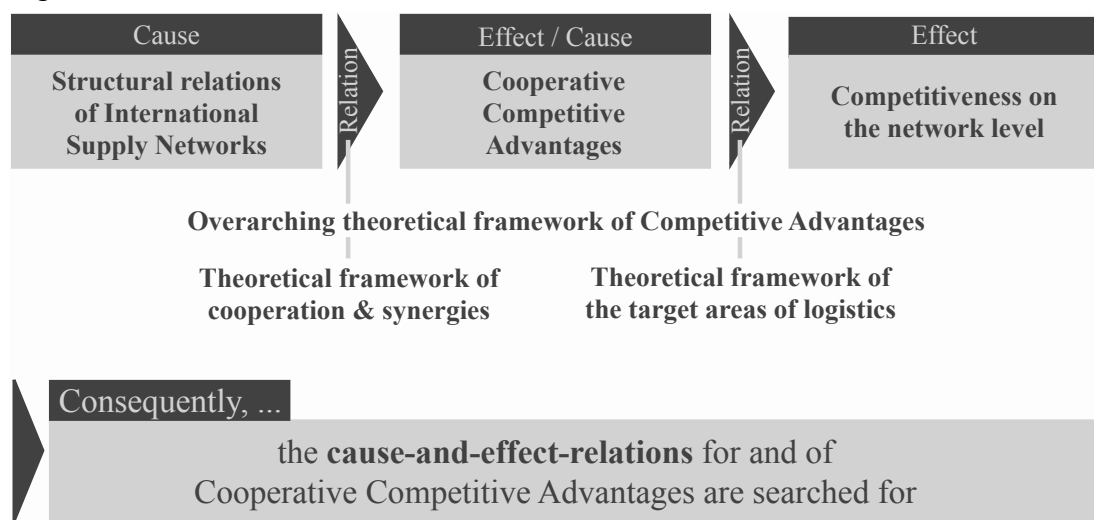
2.3.2 Analytic research task: Why Cooperative Competitive Advantages?

Analytic research
task of
Subsection 2.3.2

It is the **analytic scientific aim** of this subsection to **search for the cause-and-effect relations of Cooperative Competitive Advantages** because they will be used as an explanation approach between the structural relations and the competitiveness on the network level of International Supply Networks. In order to do so, Cooperative Competitive Advantages are considered from a cause- and an effect-perspective with the help of the **overarching theoretical framework of Competitive Advantages** from the field of Strategic Management (Figure 2-21).

In search for the
cause-and-effect
relations of CCA

Figure 2-21: In search for the cause-and-effect relations of CCA



Source: Own illustration.

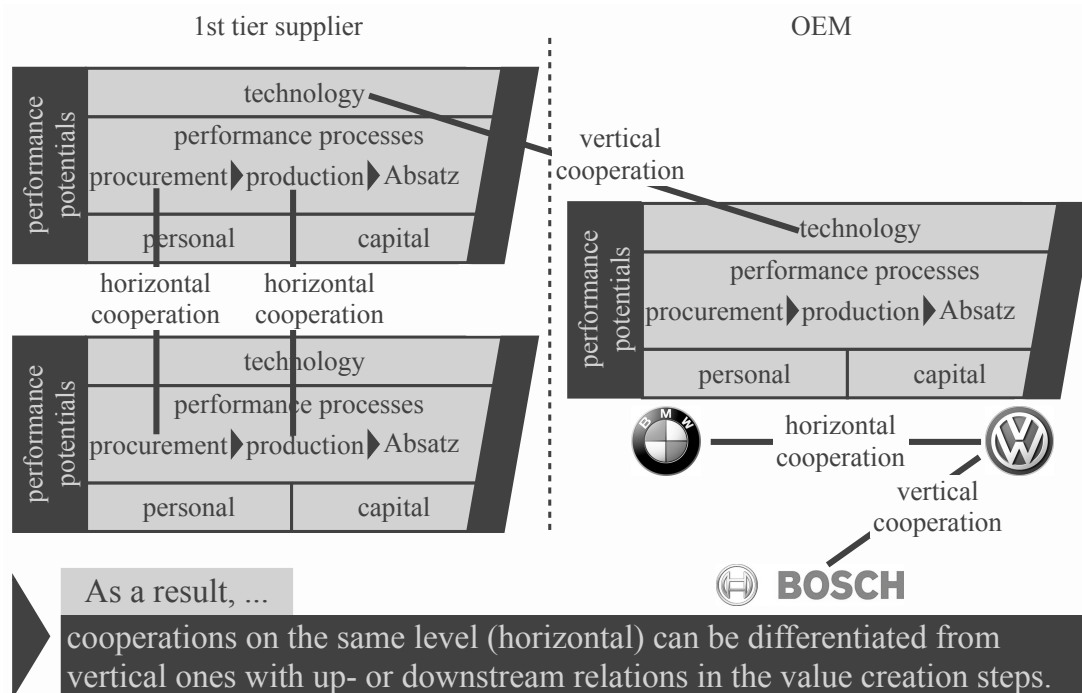
Overarching
theoretical
framework of
Competitive
Advantages

Section 1.2 introduced the **Market-based view**, the **Resource-based view**, the **Competence-based view**, the **Relational view**, the **Dynamic capabilities approach** and the **Resource-Dependence-Approach** as theoretical frameworks from the field of Strategic Management for explaining the creation of competitive advantages. With regard to the theoretical relevance of the two research questions it was concluded that the **Resource-Dependence-Approach (RDA)** and the **Relational View (RV)** can be characterised as **Resource-based and Network-oriented approaches** because they trace the origin of a competitive advantage back to the origin or in dependence from a network. While the RDA seems to be promising to explain the causal relation between the structural complexity and the company success in the next section, the RV shall be used for explaining the competitiveness on the network level. Due to the fact that it shall be the result of the advantages of cooperation, the framework of cooperation shall be introduced first.

The **cause-perspective** broaches the issue of the **causal relation between the structural relations of International Supply Networks and Cooperative Competitive Advantages** because the disambiguation of CCA in the previous subsection has pointed to the creation and sustain of competitive advantages from a resource-based perspective through cooperation. Therefore, in the context of the overarching theoretical framework of Competitive Advantages for the cause- AND effect-perspectives the **theoretical framework of cooperation** is introduced. The **theoretical framework of cooperation** is assigned to the field of **Strategic Management** because it has been identified as one key strategy on the corporate level so that it refers to the strategic goal-settings as a strategy of growth according to the degree of autonomy. By considering the **original framework of Porter's Value Chain**, two different forms are usually distinguished, i.e. horizontal and vertical forms of cooperation (cf. Figure 2-22).

Theoretical
framework of
cooperation for
the cause-
perspective

Figure 2-22: Horizontal and vertical cooperation



Source: With reference to (Thiemann, 2004).

Within the field of Strategic Management, **different theoretical frameworks** exist for analysing cooperation⁵⁴. For example, with regard to the application area of the automotive industry (Wallentowitz et al., 2009) points out that a diversity of

⁵⁴ Several authors argue to consider cooperation as a coordination mechanism for organisations (Bach et al., 2010, pp. 2–3; Hungenberg, 2001, pp. 414–415). An overview about selected theories and approaches of the research about (strategic alliances and) networks is presented by (Zentes, Swoboda, & Morschett, 2005) who mention the theory of competition, the theoretical approach of industrial economics, the theory of game theory, approaches of new industrial economics, traditional analytical framework of strategic management research, Resource-based View, Network theory and research, interaction-theoretical approaches and social scientific approaches of the process research.

economic and social theoretical approaches would exist for explaining cooperation but the **Game Theory**, the **Principal-Agent-Theory**, the **Transaction-Costs-approach** and the **theory of organisational learning** would be the most important or mostly used ones that are shortly depicted with reference to (Wallentowitz et al., 2009, pp. 44–45) in Table 7. While the Game and Principal-Agent-Theory would primarily focus on the behaviour of the cooperating partner and therefore the stability of the cooperation, the Transaction-Costs-Approach and the theory of organisational learning would focus on the reasons respectively the exchange of knowledge between the partners (Wallentowitz et al., 2009, p. 44). Because of the overarching theoretical framework, the **theoretical framework of cooperation** is considered from a competitive advantages-based perspective that constitutes one of different theoretical approaches within the field of Strategic Management. Therefore, cooperation has to be connected with one of the above-mentioned approaches to find out the success factors for and the effects of cooperation.

	Central question	Central statement
Transaction-Costs-approach	What are the reasons for the existence of cooperation?	Cooperation are agreed upon, if the market and hierarchical forms of transaction are disadvantages.
Game theory	What is the behaviour of the cooperatin partner? On what does the stability depend upon?	When is opportunistic behaviour neglected for gaining a “Win-Win-Situation”?
Principal-Agent-Theory	What is the behaviour of the cooperatin partner? On what does the stability depend upon?	Agents in charge do have space for decision through an Informationsvorsprung that can be used for one one’s advantages.
Theory of organisational learning	How can the company save its own Know How against diffusion and gaining the know how of the partner?	Cooperation are considered as an instrument with which the company has access to the Know How of the partner. The success of cooperation depends on the equilibrium with regard to the willingness to learn and transparency.

Table 7: Main theoretical approaches for explaining cooperation

In this conjunction, it is the **basic idea** of the **theoretical framework of cooperation** to analyse cooperation with regard to the outlined approaches from the overarching theoretical framework of Competitive Advantages because it is needed to focus on the effects on the competitiveness on the network level. Hereby, a focus on Resource-based approaches is used because of the reference of having access to the resources so that based on the division of labour products and services can be offered that could not be offered by a single company and by considering the **preliminary studies** that (Hülsmann, 2008) has edited a volume about a *continuously-oriented coordination of dynamic cooperation* (German original: *Kontinuitätsorientierte Koordination dynamischer Kooperation*) it is the **aim** of the **theoretical framework of cooperation** to address the concentration on core

competencies, the access to new knowledge and the generation of synergetic effects because according to (Wallentowitz et al., 2009, pp. 44–45) these would be the most important aspects for cooperation in the automotive industry which was mentioned by the majority of companies in a survey. Therewith, with the help of a SWOT-analysis that can be used for evaluating the strengths, weaknesses, opportunities and threads of cooperation, it can be derived that the opportunities of cooperation are usually higher evaluated than the potential threads (Wallentowitz et al., 2009, p. 46). It is the **basic assumption** that nowadays forms of collaboration/cooperation between companies lead to the creation of International Supply Networks because of the advantages of cooperation. These advantages of cooperation are based on synergies so that a deeper look into synergies is needed.

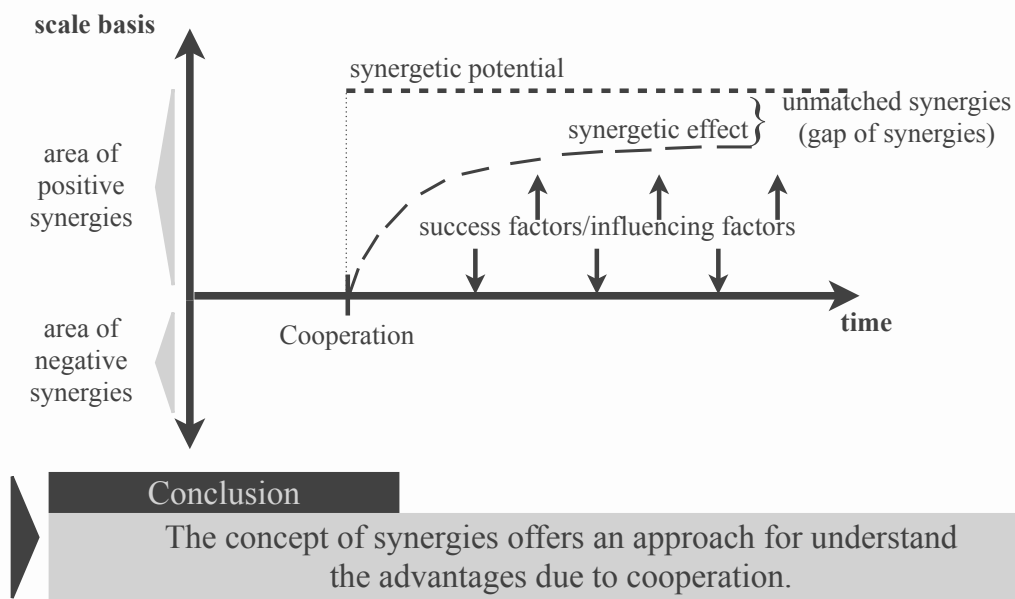
Opportunities	Threads
• Access to new markets • Gain of new knowledge • Realisation of economies of scale • Lower investment costs • Concentration on core competencies • Reduction of costs • Increase of productivity • Increased innovation capability • Decreased competition	• High complexities through cross-functions • Gaining trust needs longer than some forms of cooperation • Transactionscosts • Loose of Know How • Loose of qualified employees • Arise of dependencies

Table 8: Opportunitis and threads of cooperation in the automotive industry (According to (Wallentowitz et al., 2009, p. 46)).

Synergies are identified as **subject of consideration of the theoretical framework of cooperation** because **synergies** are approaches for explaining the improvement of the core competencies and the resource base so that the advantages of cooperation can be explained from a Competitive Advantage-based perspective. By considering the **origin** of the word synergy that can be traced back to the Greek word *synergia* (συνεργία) meaning collaboration in the sense of mutually benefits respectively a resulting common benefit (Duden, 1997, p. 790), the **idea** of **synergies** to distinguish between **influencing factors**, **synergetic effects** and **synergetic potentials** (cf. Figure 2-23.) targeted towards the **aim** of providing an explanation for the advantages of cooperation while Based on (M. Ebert, 1998) the synergetic potential comprises the total sum of all planned and potentially realised synergetic effects within an pre-defined space of time so that once a cooperation to reach synergies has been installed the synergetic effect is the in fact realised synergetic potential. Therefore, synergetic potentials constitute the maximum of synergetic effects that can be realised depending on influencing factors.

Synergies

Figure 2-23: Illustration of synergies



Source: With reference to (Thiemann, 2004, p. 77).

Influencing factors on synergies

The **idea of influencing factors** consists of identifying factors that influence the synergetic effect because they determine the degree of the adjustment or whether it becomes even a negative synergy. The reason for this can be seen by considering that according to (Thiemann, 2004, p. 85) an adjustment of the synergetic effect with the synergetic potential is **aimed for** because the knowledge about the synergetic potential constitutes the motivation for agreeing upon a cooperation. (Thiemann, 2004, p. 85) **differentiates** these **influencing factors** to that effect whether they constitute **internal success or influencing factors** that can be influenced by the management of the company or **external success of influencing factors**, that are non-influencable. These external or influencing factors constitute the frame for the internal ones such as e.g. political, economic, social, technological, ecological or legal one as outlined in the so-called PESTEL-framework (Thiemann, 2004, pp. 91–92). Hence, these external success of influencing factors will be neglected because they can be hardly influenced by the economic subjects that is determined by the economic power of a cooperation respectively company (Thiemann, 2004, p. 91). Therewith, the following only focuses on – ceteris paribus – internal success or influencing factors because of the underlying assumption of Systems Theory to focus on the system so that the system environment is neglected. With regard to the **internal success or influencing factors** different categories can be distinguished such as, for example, the compatibility of the goal-setting, the congruency of resources, the cultural compatibility, the information and knowledge management, the management, the quantification of synergies, the relations of sizes, the form of contract, the performance structure and the endurance of synergies would be of high

importance as internal success or influencing factors (Thiemann, 2004, pp. 85–90). From these different categories of internal success or influencing factors only the **congruency of resources** and the **quantification of synergies** will be further considered because they can be connected with some of the approaches from Competitive Advantages.

- **Congruity of resources:** Basically, a synergy comprises a bundle of resources or the ability of the cooperating partners to do this (Thiemann, 2004, p. 86).
- **Quantification of synergies:** In contrast to soft factors, such as e.g. corporate culture, hard factors focus on measurable/quantifiable aspects because for the success of cooperation it is important to quantify the synergetic potentials (Thiemann, 2004, pp. 88–92).

As a result, by focussing on internal success or influencing factors the congruity of resources and the quantification of synergies seems to be promising to concentrate on because of the above-introduced Resource-based focus for gaining a competitive advantage and the focus of this thesis on quantitative approaches. But what are potential effects?

Different theoretical approaches for explaining **synergetic effects** exist. These theoretical approaches shall be examined with regard to the derived categories of the congruency of resources and quantification of synergies. Hereby, the following considerations will be based on (Thiemann, 2004) and (M. Ebert, 1998) as a reference work because it was also done against the background of contractual cooperation in the context of company networks (Thiemann, 2004, p. 77). Because of this, theoretical approaches for explaining synergies are classified with respect to **heuristic approaches** (Ansoff and Porter), **quantitative approaches** (Jahreabschluss- und Aktienmarktanalyse) and **further approaches** (Thiemann, 2004, p. 93). The **heuristic approach** goes back to Ansoff (Corporate Strategy and New Corporate Strategy) who had the **idea** to systematically cover and search synergies in the context of the Strategic Management by separating the effects of synergies into **factual effects** including the management synergy, investment synergy, sales synergy and operating synergy and **temporal effects** such as founding one leading to single competitive advantages and business synergies. It is the result of Ansoff's synergetic approach to structure and quantify synergetic potentials with the help of a matrix in which the synergetic effects are vertically structured with reference to their functional areas so that hidden synergetic potentials can be identified. In addition to that, it is the **aim** of the **heuristic approach according to Porter** to extend the heuristic approach of Ansoff for some aspects and to integrate it in his industrial-economic model of his value chain so that

Effects of
synergies

interconnections between the individual supply chains that can be understood as synergetic potentials are covered. As a result, synergetic effects can be differentiated with respect to their ability to transfer e.g. knowledge between similar value chains and to combine different value chains respectively to bundle their activities so that these interconnections can be separated into material and immaterial cooperation as well as interconnections between competitors for building the potentials for rising synergies. Quantitative approaches aim at quantifying synergies for better estimating the potential success of a cooperation, whereby approaches can be mainly differentiated with respect to results from the stock market or the annual report. Further approaches are hard to identify because of inconsistent approaches that are sometimes hardly transferable for the evaluation of cooperation.⁵⁵ Against this background, with regard to **synergetic effects**, it can be seen that all these theoretical approaches are **based** on the **assumptions** that basically cooperation are connected (or at least intended) with the synergetic effects of **economies of scale and/or scope** (besides e.g. market position/market success, optimization of the degree of integration). The aim of **economies of scope** comprises the idea to realise a synergetic effect in the form of acquiring of a resource or a competence that did not exist before. It is the main assumption that economies of scope exist if the production of two goods within a company or a business unit are cheaper as in comparison with a production of these goods in two separated companies or business units. As a result, the change of the unit costs is reflected in the shift of the curves of the average costs towards the zero point. Economies of scope can be separated into production, procurement and marketing-related economies of scope (Welge/Al-laham 2001, p. 397). The aim of **economies of scale** comprises the idea to realise a synergetic effect by decreasing costs as a result of cooperation because it is assumed that the fixed costs per units decrease because of an increasing output pro unit (Bea & Haas, 2005, p. 100). They can also be separated e.g. into financial, production, procurement or marketing related economies of scale. **Consequently**, it can be derived that the theoretical framework for explaining cooperation can be connected with the framework of competitive advantages because of their resource-based perspective and their focus on synergetic effects. Therefore, the arise of a Cooperative Competitive Advantage can be assumed in the case of synergetic effects – economies of scope and scale – as a result of cooperation through the structural relations of an International Supply Network.

Target areas of
logistics

The second **main contribution** of the **overarching theoretical framework of competitive advantages** consists of being able to analyse the **causal relation between Cooperative Competitive Advantages and the competitiveness on the**

⁵⁵ Summary of synergetic approaches according to (Thiemann, 2004, pp. 93–101).

network level. The reason for this is that the **theoretical framework of the target areas of logistics** can be used for this **effects-perspective**. The **theoretical framework of the target areas of logistics** can be **assigned** – as being part of the logistics and SCM – **to the field of Strategic Management** because of the following reason: According to (Schönsleben, 2004, p. 36) a

“company’s performance is comprised of the achievement of objectives in the areas of quality, costs, delivery, and flexibility” (Pfohl, 1972, p. 29).

Therewith, the **target areas of logistics** can be **classified** as a goal-system of the logistics respectively SCM in which **different approaches** for goal-systems exists, for the so-called 6 R’s of logistics – to deliver the right products and services in the right amount and right quality to the right place at the right time and the right price – or the so-called logistics ratio system (LKS) for catching the performance of logistics (Schulte, 2009, p. 640 et sqq.). As can be seen in Table 9, the **target areas of logistics** can be further specified, whereby the achievements in the areas of quality, costs, delivery time and flexibility become part of the strategic planning system because the outcomes or formings in these **target areas of logistics** have to be in accordance with the growth strategies on the corporate with the competitive strategies on the business and with the functional strategies on the functional level (Schönsleben, 2004, pp. 80, 82, 85; Schulte, 2009, p. 25 et sqq.).

Target area quality	• to meet high demands for product quality • to meet high demands for process quality • to meet high demands for organization quality
Target area costs	• low physical inventory and low work in process • high capacity utilization • low cost rates for administration
Target area delivery	• high fill rate (high customer service ratio or short delivery lead time) • high delivery reliability rate • short lead times in the flow of goods
Target area flexibility	• high degree of flexibility to enter as a partner in logistics networks • high degree of flexibility in achieving customer benefits • high degree of flexibility in the use of resources

Table 9: Target areas of logistics according to (Schönsleben, 2004, p. 37).

Because of the **preliminary studies in the working group** it is the **idea** that with reference to (Hülsmann & Cordes, 2009) these **target areas of logistics** can work as a competitive advantage because if an import characteristic in one **target area** is superior to those of the competitor, it is recognized by the customer and this advantage of the performance can be adhered long lasting, then the features of a

competitive advantage according to (Simon, 1988) are achieved.⁵⁶ Therefore, it is the **aim** to transfer these **target areas of logistics** to the ISN of the German automotive industry so that the **target areas of time, cost, flexibility and quality** become a theoretical framework for the network level with whom it becomes possible to determine the forming of a – Cooperative – Competitive Advantage. This approach is grounded on the **basic assumptions** that, firstly, the definition of the competitiveness of the – German – automotive industry based on (Diez, 2012) containing the two main aspects of a **superior product** and **profitability** can be separated as to address the features of a superior product with the competitiveness on the network level while the profitability refers to the competitiveness on the individual level. The reason for an assumed separation is that only the organisational units on the individual level can aim for profits while it has been outlined that the value creation of the car, i.e. the product, is increasingly shifted to the value creation system (cf. Subsection 2.1.1 and 2.1.2).⁵⁷ Therefore, the potential superior product of the car is assumed to be the result of the cooperative interplay in and of an ISN so that it is the second **basic assumption** that the formings in the **target areas of time, cost, flexibility and quality** can be transferred to the car as the product of the ISN because the **target areas of time, cost, flexibility and quality** were identified as being part of the SCM so that it can be logically connected with the cooperation in the ISN that is also characterised through the postulate of logistics of “putting the end-customer first” (Harrison & van Hoek, 2008, pp. 6–7). Therefore, it is the **central conclusion** that the **target areas of logistics** can be understood respectively transferred to the characteristics of the ISN because it is assumed that their formings are the result of the cooperative interplay of the value creation partners and because of their character as a “marketing instrument” (Schulte, 2009, p. 7) of every logistic activity the features of a competitive advantage according to (Simon, 1988) are mapped and connected with cooperation. What are the **contributions** of the **theoretical framework of the target areas of logistics**? Firstly, they offer a framework for considering the effects-perspective of Cooperative Competitive Advantages because a CCA is assumed to exist in at least one of the **target areas of time, cost, flexibility and/or quality**. In this conjunction, (Grant, 2010, p. 211) highlights the problem “that if we identify competitive advantage with superior profitability, why do we need the concept of competitive advantage at all” so that a

⁵⁶ (Hülsmann & Cordes, 2009, p. 89).

⁵⁷ While the aspect of an **appropriate profit** were assigned to the competitiveness on the individual level of the car manufacturer the ability to sell **products**, i.e. the cars and corresponding services, will be assigned to the competitiveness on the network level because of the following reasons. Firstly, several sources argue that the value creation is more and more distributed to the suppliers so that a **shift of the value creation** occurs. The value creation is the key ingredient for the product. Therefore, if the connections of the value creating suppliers with the car manufacturers can be linked to cooperation, then it can be assumed that the value creation of the product is the result of the whole network

separation with regard to the two levels seems valuable. Secondly, they allow ground for gaining and sustaining of a CCA on the cooperative interplay in an ISN. Thirdly, they allow to explain the construct of the competitiveness on the network level via enabling to connect the aspect about a superior product of the definiens about the competitiveness in and of the automotive industry with the marketing-oriented framework of Supply Chain Management by putting the end-customer first so that the features of the definition according to (Simon, 1988) are mapped. Nevertheless, some **major limitations** have to be mentioned. First of all, the competitiveness with regard to the superior product depends on much more factors because for example the categories of reliability, safety, price-benefit-ratios, overall costs, environmental-friendliness, design, service and prestige of the brand are typical customer requirements for purchasing a car (Wallentowitz et al., 2009, p. 22). Therefore, it remains to be analysed if and how the **theoretical framework of the target areas of logistics** can be used for covering e.g. the above-mentioned eight categories of customer requirements for purchasing a car. Additionally, the market success and therewith the competitiveness also strongly depends on for example the selection and configuration of business models because business models are considered as bridging the gap between the research about strategy and e.g. distribution (Kittl, 2009). Therefore, (Bach et al., 2010) points out that research about the development of business models for the management of whole International Supply Networks – including the design of competitive advantages – are missing. Finally, despite of the fact that ratios have been developed for measuring the logistics performance and logistics costs an operationalisation in the meaning of ratios for measuring the outcomes in the four target areas of the whole network is in its infancy, therefore a unique assignment is missing (Arndt, 2010, p. 122). In order to figure out whether these advantages of cooperation due to synergetic effects are of particular importance and applied in reality due to a lack of operationalisation, it shall be exemplary considered, if current management approaches are based on these considerations. Thus, the procurement strategies shall be introduced because of their focus on resources and synergetic effects.

From a descriptive scientific perspective, **procurement strategies** do not have to be mistaken with the strategic procurement because procurement strategies refer to the methods about how to goal-orientedly achieve the tasks in the area of the success potentials of the strategic procurement (Large, 2009, pp. 38–39). Therewith, the strategic procurement is one of the performance potentials **in the field of strategic management** besides the production, distribution, staff, finance, research and development so that they can be sources for competitive advantages as a strategic success factor (Bea & Haas, 2005, p. 509 et sqq.). The **origin** of the **strategic**

Procurement
strategies

procurement respectively procurement strategies started with (Sandig, 1935) who connected the tasks of procurement with the creation of the managerial requirements (Large, 2009, p. 17). According to (Schulte, 2009, pp. 268–269) **procurement strategies** are essentially influenced by the corresponding economic situation so that, e.g. the shortage of goods in the 1950s led to a supply at all costs to ambitious marketing concepts towards the needs of the end-customer in the 90s. For this reason, **procurement strategies** can be understood as measurements in the sense of end-means combinations for realizing and securing competitive advantages and to strengthen the success potentials of the company (D. Arnold et al., 2008; Bea & Haas, 2005, p. 512; Large, 2009, pp. 31–32). In this conjunction, it is their **aim** to achieve the four tasks of the strategic procurement, i.e. the safety of availability⁵⁸, the increase of flexibility⁵⁹, the decrease of procurement-relevant costs⁶⁰ and the safety of the environment⁶¹ so that in general the goal of the strategic procurement are in the conflict area of cost reduction, performance improvement and the sustainment of the autonomy (Bea & Haas, 2005, p. 514). How to **classify procurement strategies**? In his book *Strategic procurement* (Large, 2009) **classifies procurement strategies** to the effect whether they are targeted towards the opening of **external or internal potentials of success**. Against the background of the objective of this thesis, the following consideration will focus on **external procurement strategies** because by pointing to the supplier (supplier strategies) or other demander in the procurement markets (cooperative strategies) they take the ISN-based perspective into account (cf. Figure 2-24). Hereby, (Large, 2009) differentiates the **procurement strategies for the opening of external potentials for success** further with respect to **supplier** and **cooperative strategies**. Before the considerations will be responsive to this differentiation between **supplier** and **cooperative strategies**, sourcing-concepts will be picked out as the central theme at first because as can be seen in Figure 2-24 all their substrategies are labelled as sourcing-strategies so that a systematisation of sourcing-concepts is needed.

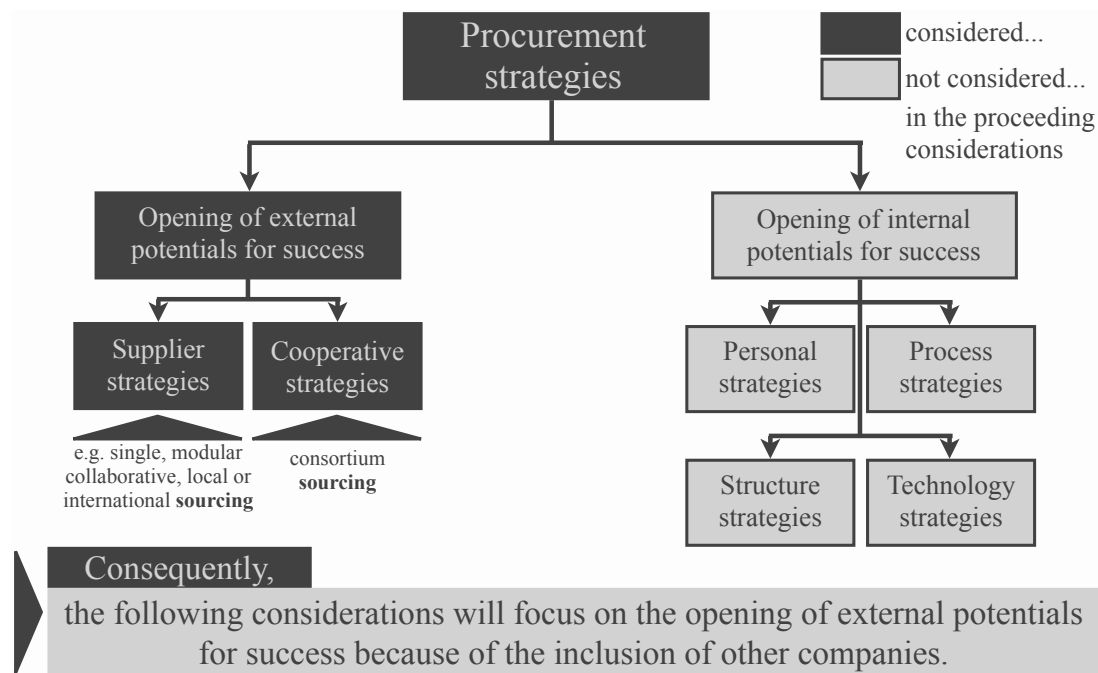
⁵⁸ **Safety of availability** points availability of required material for the production place at the right amount, at the right quality, at the right time to the right place.

⁵⁹ **Increase of the flexibility**: A high flexibility is needed for adapting to rapidly changing market requirements.

⁶⁰ **Decrease of procurement-relevant costs**: By considering that in the industry up to 50% are material costs, costs of transportation, storage, personal etc. have a tremendous importance.

⁶¹ **Safety of the environment**: Procurement strategies can have a significant influence on the environment so that ecological aspects have to be taken into account.

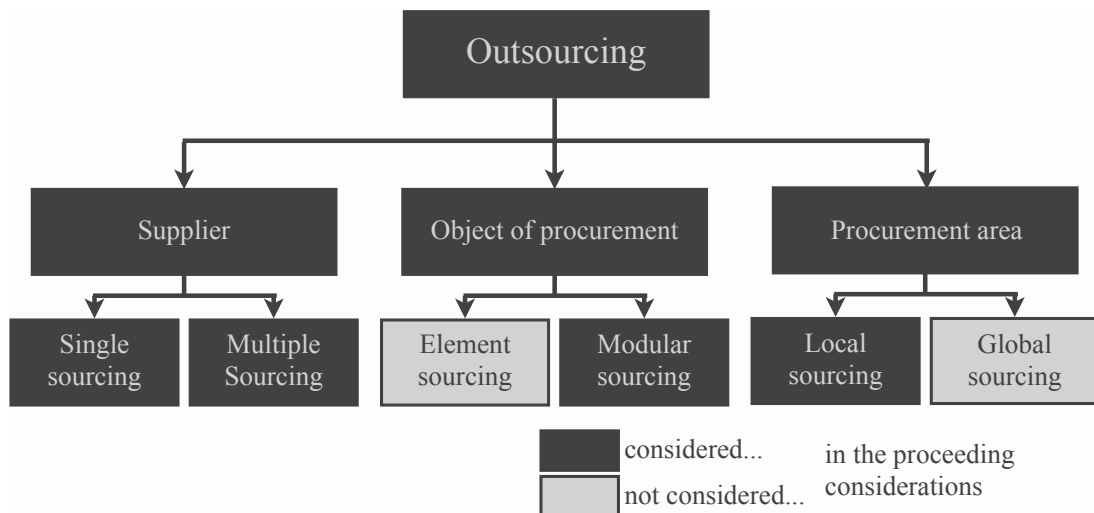
Figure 2-24: Classification of procurement strategies



Source: With reference to (Large, 2009, p. 40)

Such a **systematisation of the sourcing concepts** is given by (Schulte, 2009) with regard to the categories of supplier (sole, single, dual or multiple), object of procurement (unit, modular, system), subject of procurement (individual or collective) and area of procurement (local or global). Hence, (Schulte, 2009, p. 284) points out that concepts that are able to strikingly deal with the challenge (as outlined above) would be the concepts of global sourcing, single/multiple and modular/system sourcing because they would be able to reduce or handle the complexity in the area of the procurement (cf. Figure 2-25).

Figure 2-25: Overview sourcing concepts



Source: With reference to (Schulte, 2009, p. 284).

According to (Arndt, 2010, pp. 210–211) these concepts can be defined as it follows:

- Single/multiple sourcing refers to the restraint to one/choice of many supplier by choice for the benefit of a deepened/weakened collaboration.
- Modular sourcing means that single parts are not build up within a company to bigger units (modules) but instead purchased completely as a whole modul from a so-called modul supplier so that the amount of supplier and the complexities is significantly reduced.

Besides the different supplier strategies that are part of the supplier-customer-relationship in the field of Strategic Management and their derived sourcing concepts (**vertical form**), cooperative strategies for commonly procuring companies (**horizontal form**) can achieve a cooccurrence on the market for improving their position and to realise common potentials of success such as e.g. capacities for cost reduction through bundeling of the purchase volume, increase of the transparency on the market and the process of object of procurement initialisation. All of these considerations about the **procurement strategies** are **based** on the Resource-based View (and its derivates) from the field of Strategic Management because they follow the **assumption** that having access to the resources of the other companies with the help of the **procurement strategies** the success of the company can be critically influenced (Large, 2009, p. 39). Therefore, it can be **concluded** that e.g. the concentration on the modular/system sourcing and/or a corresponding supplier selection is of utmost importance because the raise of economies of scope and/or scale supports the competitiveness (Bea & Haas, 2005, p. 514; Large, 2009, p. 31 et sqq.; Wallentowitz et al., 2009, p. 45). This points to the **main contribution** of the

procurement strategies because an analysis about the contributions of the **procurement strategies** on the functional level to the competing strategies on the business level has been done in the field of Strategic Management so that for example a **supplier selection** with regard to the **cost leadership** and **differentiation** can be used. According to (Bea & Haas, 2005) the **selection of the supplier** is strongly determined through the competitive strategy that dominates on the delivery area. Therefore, two different consequences can be distinguished here: cost leadership and differentiation (Bea & Haas, 2005, p. 515).

The **idea** of the **supplier selection for supporting the cost leadership** comprises the **aim** to consequently manage the cost structures (Bea & Haas, 2005, p. 515). Therefore, it is the **main assumption** that the delivery price and delivery conditions would be more important criteria for selecting a supplier as in comparison with, e.g. the quality of delivery or the image of the supplier. Therewith, it is a **central conclusion** to favour the Just-In-Time-Principle by trend because the relatively easy to predict amount of the material requirements on a large scale-production allows reducing the warehouse stock, the minimization of the processing time as well as due time reliability for being the cheapest offerer on the market based on the reduction of costs. Furthermore, for the supplier selection price for delivery and their conditions are more important than the quality or the image of the supplier. It **contributes** to pragmatic scientific aim by supporting the shift of the strategy of the inhouse-value creation towards outsourcing so that the means connected with this approach become available for this course of research (Bea & Haas, 2005, p. 515). Hence, a **limitation** exists because of their focus on individual companies so that appropriate strategies for optimizing the whole International Supply Networks are missing.

Supplier
selection for
supporting the
cost leadership

The **idea** of the **supplier selection for supporting the differentiation** comprises the approach of the production and distribution of high quality products and service with a limited number of pieces with the help of suppliers (Bea & Haas, 2005, pp. 516–517). Therefore, it is the **aim** to evaluate, besides the reliability, especially quality-related criteria while price-related aspects are neglected (Bea & Haas, 2005, pp. 516–517). It is **based on the assumption** that intensified collaboration between the supplier and demander is required in the case of a reduced in-house value creation (outsourcing) so that the amount of suppliers should stay low (single sourcing in contrast to multiple sourcing) in order that the form of cooperation mostly concentrates of the areas of research and development as well as production agreements (Bea & Haas, 2005, pp. 516–517). It can be **concluded** that such a form of a Supply Chain Management enables a high level of quality and cost advantages because of the advantages of cooperation and specialisation. As a consequence, the value creation processes respectively the value chains are strongly interrelated. It

Supplier
selection for
supporting the
differentiation

contributes by highlighting the importance of the cooperative interrelations for the common success, but it is **limited** through the trend of reducing the amount of suppliers so the causal interplay between complexity effects and procurement strategies is still neglected.

Modular
Sourcing for
supporting cost
leadership/
differentiation

Especially in the automotive industry, **modular sourcing** constitutes a strategy with the **idea** to be supplied from so-called system suppliers because of being a strategy for the cost reduction so that the car manufacturers just want to be delivered from few suppliers supplying complete systems so that e.g. these modules can be used for different models (Bea & Haas, 2005, pp. 515–516). Therefore, it is the **aim** to be supplied from work- and cost-intensive component groups because of the **basic assumption** that due to the concentration of core competencies economies of scale and scope can be realised pointing to the **main contribution** of covering the trend of the shift of the value creation towards the supplier because of the advantages of cooperation and specialisation. Nevertheless, the question about how to achieve control in such a company-wide division of labour along the whole supply chains for the whole value creation processes remains of **limited** explanation.

As a result, it can be assumed that based on the RBV procurement strategies help to realise and secure competitiveness through the strategic potentials in the area of the strategic procurement. Therefore, it can be **concluded** that e.g. a combination of a horizontal form of cooperation through modular sourcing with a vertical form of cooperation of the supplier selection targeted towards a cost leadership can raise a Cooperative Competitive Advantage because of the economies of scale and scope. Therefore, the **main contributions** of procurement strategies of modular sourcing in combination with a cost leadership are leading to approaches that are based on the strategic procurement as a performance potential. This points to the **main limitation** of an isolated consideration because the **procurement strategies** often neglect the other areas of the production and distribution that are integrated through spatial and timely bypassing logistics activities as well as the areas of technology, finance and personal so that further factors – especially from an integrated and company-wide perspective – for realising a Cooperative Competitive Advantages are missing. In this conjunction, the transfer of these **procurement strategies** to the whole network is missing (Large, 2009, pp. 38–40).

Conclusions for
the analytic
scientific aim

Consequently, it can be derived that the theoretical framework for explaining cooperation can be connected with the framework of competitive advantages because of their resource-based perspective and their focus on synergetic effects. Therefore, the arise of a Cooperative Competitive Advantage can be assumed in the case of synergetic effects through economics of scope and scale as a result of cooperation

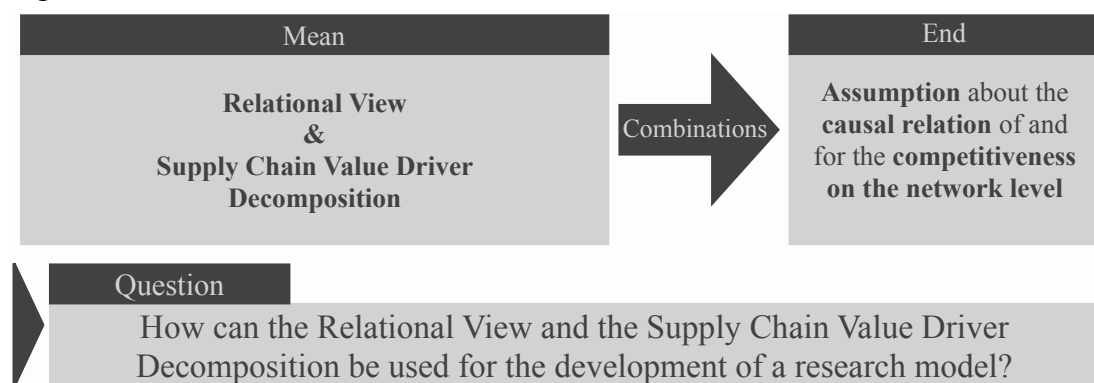
through the structural relations of an International Supply Network. These effects can be covered with the help of the framework of the target areas of logistics because they fit to the features of a competitive advantage and they can be considered as the outcome of a whole system, i.e. the ISN. Therefore, a potential explanation for the competitiveness on the network level has been introduced but how can it be used for the development of a research model?

2.3.3 Pragmatic research task: Procurement strategies for realizing Cooperative Competitive Advantages

Pragmatic
research task of
subsection 2.3.3

It is the **pragmatic scientific aim** of this subsection to derive implications for the development of a research model. Therefore, the **assumptions about the causal relation of and for the competitiveness on the network level are searched for** (cf. Figure 2-26). For doing so, the implications of the Relational View will be used because this framework was identified for taking the network-perspective explicitly into account in the context of explaining competitive advantages. Additionally, the Supply Chain Value Driver will be introduced because by anticipating the profit for the company success in the next section (cf. the second research question) the effects of the competitiveness on the network level on the individual level have to be considered.

Figure 2-26: In search for end-means combinations towards the research model



Source: Own illustration.

Causal relation
between the
structural
complexity and
the
competitiveness
on the network
level

It is the **aim** to analyse whether structural complexities of ISN can be theoretically connected with the Relational View because an assumption about the causal relation between the characteristics of ISN and the competitiveness on the network level has to be derived for the development of a research model. In Section 1.2 it was outlined that the RV enables the identification of four potential sources for competitive advantages (i.e. **relational rents**) of International Supply Networks, namely relation-specific assets, knowledge-sharing routines, complementary resources/capabilities and effective governance. Hereby, only the following two will be considered because they can easily be connected with the Resource-oriented view that was identified in the context of the resources of the cooperation.

- a. **Relational specific competencies** refer to the competencies that are created through common investment and shared knowledge during the cooperation.

b. Complementary resources or capabilities refer to the important aspect of the combination of valuable and hardly imitable competencies.

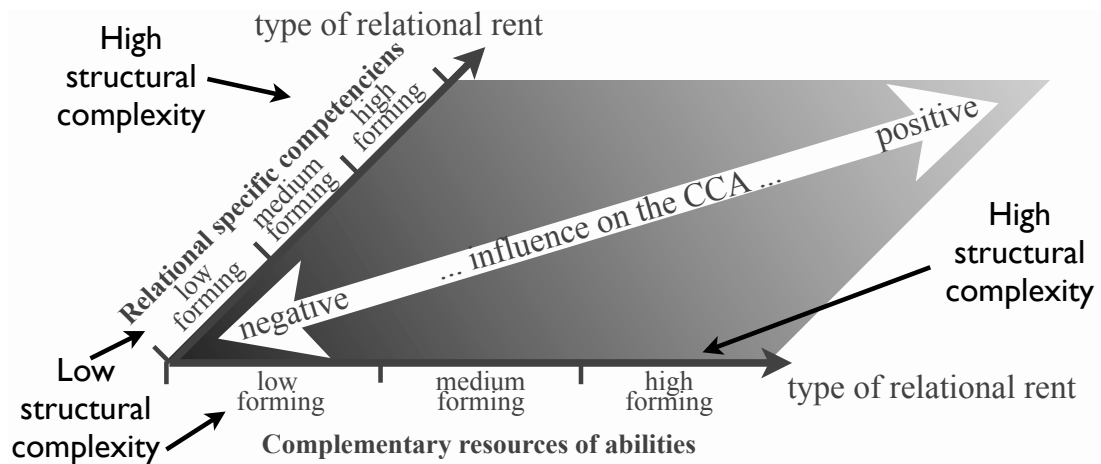
Therewith, by considering that an operationalisation of the categories of the RV has not taken place so far, it shall be **assumed** that the higher the forming of such a hypothetical measurement for the two categories, the higher the influence on the gain and sustain of a Cooperative Competitive Advantage would be. This can be reasoned by considering the explanations in Section 1.2 that relational rents were considered to be a supernormal benefit jointly generated in a mutual cooperative relationship with regard to the joint contributions of the specific partners. Furthermore, it focusses on the embedment of resources in cooperative relations as the essential source (and barrier) for competitive advantages so that company-wide relations originally create these relational rents. Finally, relational rents do not only base on interorganisational resources of individual partners but also on resources that can only be found in and through the structure of the network so that they can be attributed to the whole ISN. This attribution to the whole ISN enables a theoretical connection with the concept of the emergent complexity. Therefore, it has just to be discussed whether a low or high structural complexity might correlate positively or negatively with the forming of a relational specific competency and the complementary resources of abilities.

With regard to the complementary resources of abilities it shall be assumed that a high structural complexity would correlate with a high forming of this type of relational rent because the higher the amount and variety of the structural relations, the higher the combinations of valuable and hardly imitable competencies (and vice-versa).

With regard to the relational specific competencies it shall be assumed that a high structural complexity would correlate with a high forming of this type of relational rent because the higher the amount and variety of the structural relations, the higher the competencies that are created through common investments and shared knowledge as a result of the cooperation (and vice-versa).

These assumptions are the result of a logical reasoning based on the understanding of the structural complexity and the two categories that originate from the Relational View. Despite of the fact that these assumptions are not grounded through other references or empirical studies, they enable to derive an assumption about the pattern of correlation as illustrated in Figure 2-27 for the development of the research model.

Figure 2-27: Categories of the RV for studying the CCA.



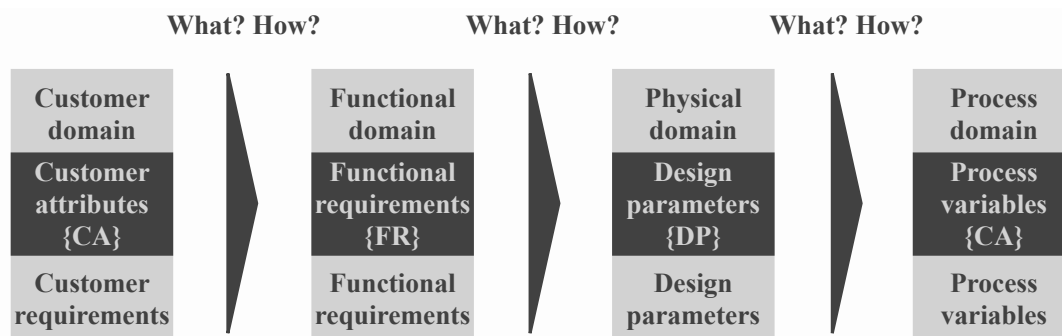
Source: Own illustration and inspired by (Colmorn & Hülsmann, 2012, p. B15).

Causal relation
between the
competitiveness
on the network
level and the
company success

By considering the company success as an essential part of the second research question and by anticipating the profit orientation of the next section, the **causal relation between the competitiveness on the network level and the company success** shall be considered with the help of the **Supply Chain Valuedriver Decomposition**. It is the **idea** of the **Supply Chain Valuedriver Decomposition (SCVD)** to systematically decompose the Supply Chain Management with the help of the methodological approach of the **Axiomatic Design (AD)** for deriving cause-and effect-relations between valuedrivers of an ISN and the contribution to the company success (Sennheiser & Schnetzler, 2008, pp. 19, 61, 83). The **origin** of the methodological approach of the **Axiomatic Design** for the design of products, systems and processes goes back to Nam P. Suh from the MIT, whose **idea** consists of fundamentally and consequently distinguish between goals (what) and means (how) because most of the time more means are available for reaching a goal that are qualified in different ways (Sennheiser & Schnetzler, 2008, pp. 46–47). Therewith, it is the **aim** of the **Axiomatic Design** to ground design as a discipline on a scientific basis and to support all the activities in relation with the design through the theoretical foundation of logical and rational processes and instruments (Sennheiser & Schnetzler, 2008, p. 47). According to (Sennheiser & Schnetzler, 2008, p. 49), this approach is based on two assumptions namely the axiom of independency and the axiom information. The axiom of independency assumes that functional requirements have to be independent from each other so that each functional requirement has to be fulfilled without influencing another one. The axiom of information assumes that the content of information of a design should be minimal so that a low content of information maximises the probability to fulfil a functional requirement. Therewith, it is postulated that these two axioms determine the resulting principles of a “good” design and how to achieve it. Against this

background, it is the **central conclusion** of the **Axiomatic Design** that differentiation of the goals and means can be concretized with the help of so-called domains, whereby each domain can be considered as a different perspective on the same problem as illustrated in Figure 2-28. Hereby, the customer requirements of the so-called “customer domain” are described as “customer attributes” {CA}, whereby each of the the customer attributes represents a customer requirement. Herefrom, the functional requirements {FR} can be derived for specifying what has to be achieved so that the FRs constitute requirements that are independent from each other and that have to achieved through so-called “design parameters” {DP} that are defined by means of technical or technological realisations. Finally, they are translated into process variables {PV} that deal with the concrete realisations with the help of processes, resources and methods.⁶² The **main advantage** of the **Axiomatic Design** consists of focusing on approaches so that a hierarchical and methodologically structured process arises towards an operationalisation, based on the differentiation between ends and means on different levels.

Figure 2-28: The “Domain-concept” of the Axiomatic Design



Source: With reference to (Sennheiser & Schnetzler, 2008, p. 62).

What are the **limitations**? Firstly, the used terms and definitions can be understood in different ways and are intuitively recognizable so that a deeper study of this methodology is required. Secondly, its application of objects with a high degree of abstraction, such as ISN and the SCM, lack a fundamental understanding because their design parameters are of conceptionally nature. As a **result**, the **Axiomatic Design** constitutes a structured approach for decomposing requirements on the operational level towards an operationalisation on the strategic level by following a strict separation between ends and means as well as causes and effects.

Therefore, with the help of the **methodological approach of the Axiomatic Design** it is **idea** of the **SCVD** to develop an explanation approach or causal model with cause-and-effect relations about the value contribution of the SCM as well as a

⁶² Translated and summarised from (Sennheiser & Schnetzler, 2008, p. 47).

goal-system for exploiting logistics potentials of success targeted towards the **aim** of identifying value driver in and of International Supply Networks (Sennheiser & Schnetzler, 2008, p. 62). Because of the **methodological approach of the Axiomatic Design**, the SCVD is per se **based** on the **assumptions** of the Axiomatic Design. Furthermore, it is also based on Porter's Value Added Chain.

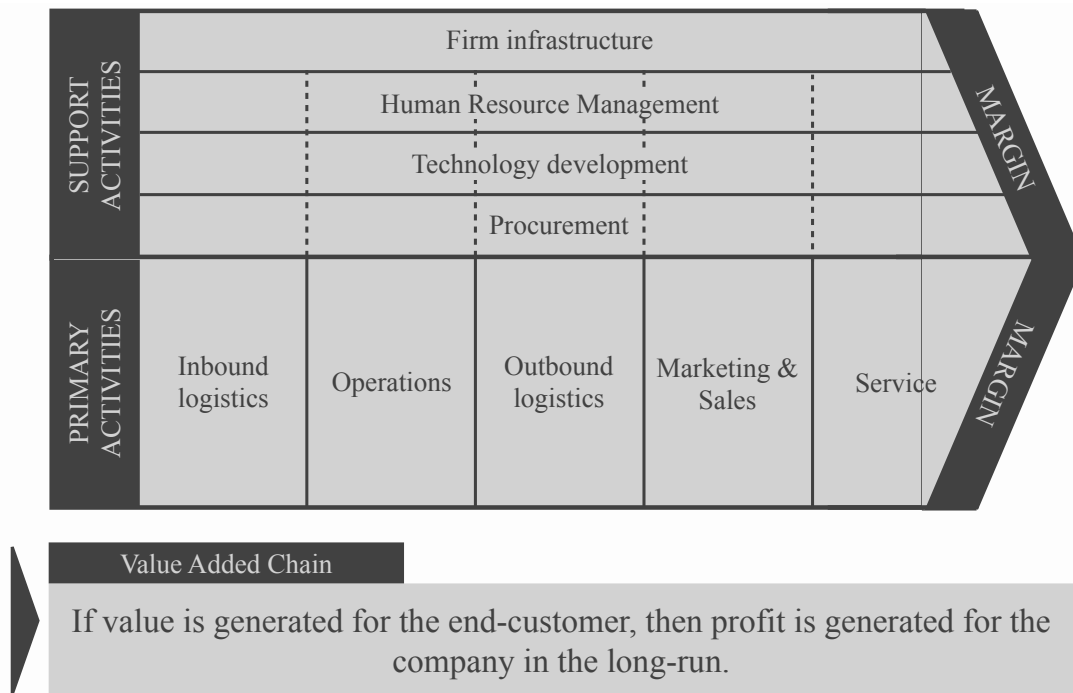
Porter's Value Added Chain

To start with, the **theoretical framework of Porter's Value Added Chain** is introduced that can be **assigned into the field of Strategic Management** because it can be **classified** as a theoretical framework for analysing the strengths and weaknesses of a company for the business analysis as part of the strategic planning (Bea & Haas, 2005, pp. XIII–XV, 111–114). Generally, it is the task of the strategic planning to adjust the potentials of a company with the requirements of the (market) environment so that strengths and weaknesses can be identified. In this connection, **Porter's Value Added Chain** is one of **different approaches** for the strategic planning, e.g. besides the competitor analysis and the performance measurement. Michael Porter **developed** the **theoretical framework** of the **Value Added Chain (VAC)** (also generic value chain, Value Chain) that comprises the **idea**⁶³ that every company has an individual value added chain that is embedded into a system of upstream and downstream value added chains of supplier and consumers (Bea & Haas, 2005, p. 112). Therewith, it follows the **aim** to strategically consider the value creation and to consider the processes as sources for cost and differentiation advantages (Bea & Haas, 2005, p. 113). It is the **main assumption** that “[i]n competitive terms, value is the amount buyers are willing to pay for what a firm provides them. Value is measured by total revenue, a reflection of the price a firm's product commands and the units it can sell” (Porter, 2004, p. 38). Against this background, it is the **central conclusion** that a “firm is profitable if the value it commands exceeds the costs involved in creating the product. Creating value for buyers that exceeds the cost of doing so is the goal of any generic strategic. Value, instead of cost, must be used in analysing competitive position since firms often deliberately raise their cost in order to command a premium price via differentiation” (Porter, 2004, p. 38). In this regard, it is the **main contribution** of being in accordance with the traditional configuration of managerial functions, such as procurement, production, distribution etc., that has also been used to cover cooperation and to identify these areas as source for competitive advantages (Bea & Haas, 2005, p. 113). Hence, it is **limited** because it is criticised that the composition of these single activities is hardly understandable and that it is too

⁶³ “Every firm is a collection of activities that are performed to design, produce, market, deliver, and support its product. All these activities can be represented using a value chain. A firm's value chain and the way it performs individual activities are a reflection of its history, its strategy, its approach to implementing its strategy, and the underlying economics of the activities themselves.” (Porter, 2004, p. 36)

strongly oriented to the classical managerial functions.

Figure 2-29: Porter's Value Added Chain

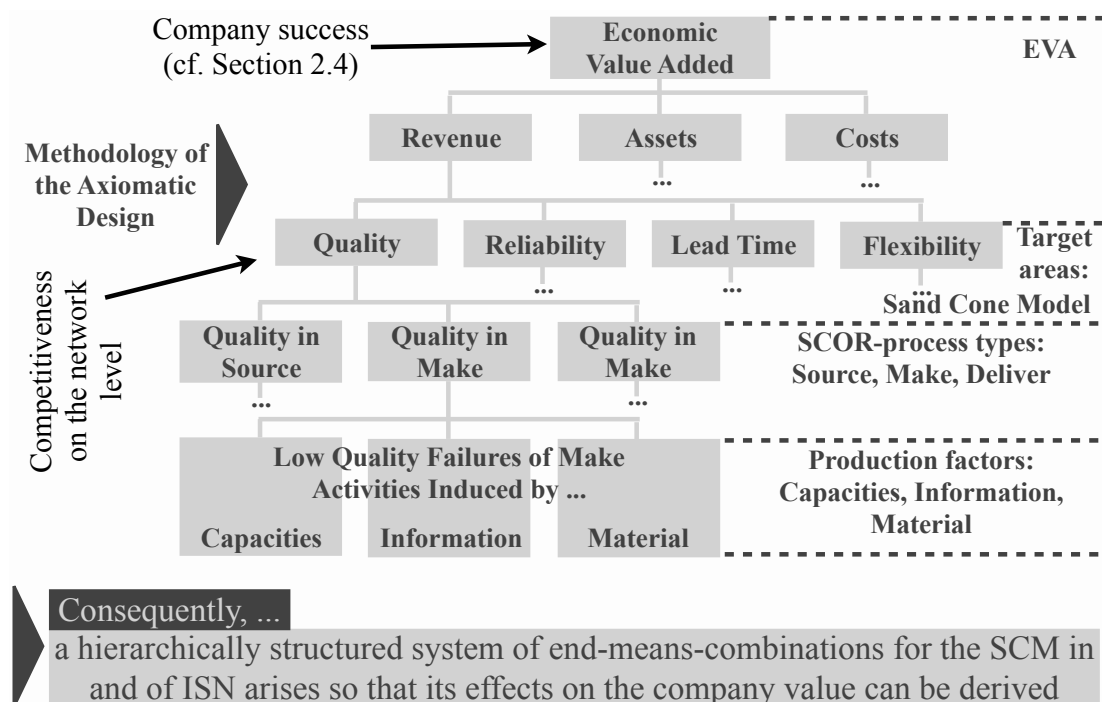


Source: With reference to (Bea & Haas, 2005, p. 113).

As a result of the **SCVD**, a generic and hierarchically structured end-means-system of the SCM can be **concluded** as illustrated Figure 2-30 pointing to the following **contributions**: Firstly, it becomes possible to identify valuedriver of the SCM in ISN for determining the value contribution of SCM concepts, methods and best practices. Secondly, an operationalisation of SCM objectives becomes possible because of potentially connecting them with ratios on the operational level. Thirdly, it is possible to connect the above-outlined target areas of logistics as potential sources for Cooperative Competitive Advantages on the network level with profit-based ratios on the individual level so that hints toward their potential causal relation can be derived. This is **limited** through the fact that a statistical analysis about e.g. the strengths of these valuedriver has not taken place so far.

Consequently, with regard to the causal relation between the competitiveness on the network level and the company success on the individual level the **SCVD** helps to assume a positive causal relation. The reason for this is that improvements in the target areas of logistics are assumed to e.g. increase the revenue that has e.g. positive effects on Economic Value Added as a measure for the company success. In combination with the assumption to consider the target areas of logistics to the outcome of the whole system, it can also be assumed to consider them as a potential Cooperative Competitive Advantage.

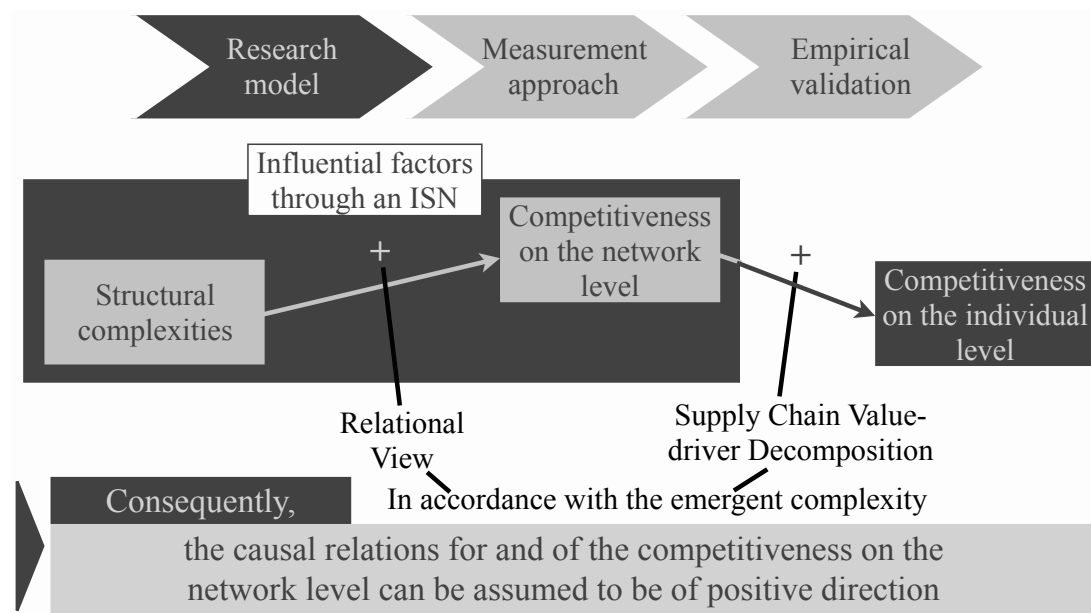
Figure 2-30: Illustration of the Supply Chain Valuedriver Decomposition



Source: With reference to (Sennheiser & Schnetzler, 2008, p. 62).

Which implications can be drawn towards the development of the research model? The assumptions that were grounded on the Relational View as well as the Supply Chain Value Driver Decomposition enables to finally derive a positive causal relation between the structural complexity and the competitiveness on the network level that should also have a positive causal relation with the competitiveness on the individual level (cf. Figure 2-31).

Figure 2-31: Implications towards the research model



Source: Own illustration.

Consequently, with regard to the development of the research model a positive causal relation between the structural complexity and competitiveness on the network level and between the competitiveness on the network level and the individual level can be assumed because of the – stylised – considerations with the help of the Relational View and the Supply Chain Valuedriver Decomposition.

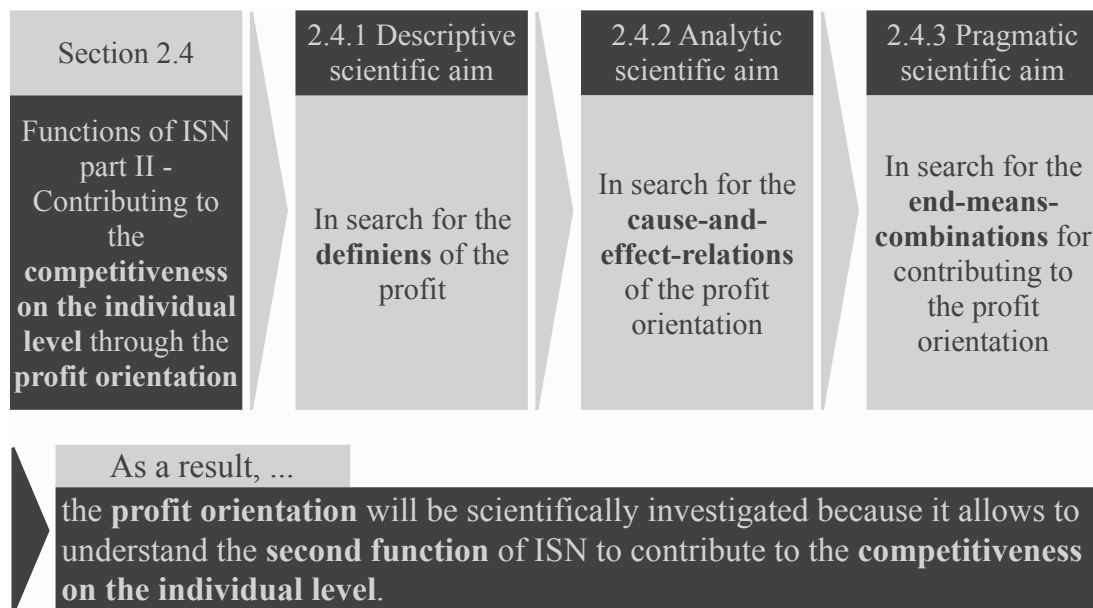
Conclusions for
the pragmatic
scientific aim

2.4 Functions of International Supply Networks part II – Contributing to the competitiveness on the individual level through the profit orientation

Overview over
Section 2.4

It is the **aim of Section 2.4** to clarify the second function of International Supply Networks to contribute to the competitiveness on the individual level as a result of the considerations in Section 2.1 because it was concluded that the competitiveness could be applied to the network and the individual level. Therefore, the concept of the **profit** will be disambiguated at first (Subsection 2.4.1) because it will be in the centre stage of the analytic scientific consideration (Subsection 2.4.2) for explaining the **competitiveness on the individual level**. Therewith, the end-means combinations towards the question about how to contribute to the profit orientation will be dealt with (Subsection 2.4.3). As a result of this section, the second function of ISN will have been scientifically investigated (cf. Figure 2-32).

Figure 2-32: Overview over Section 2.4



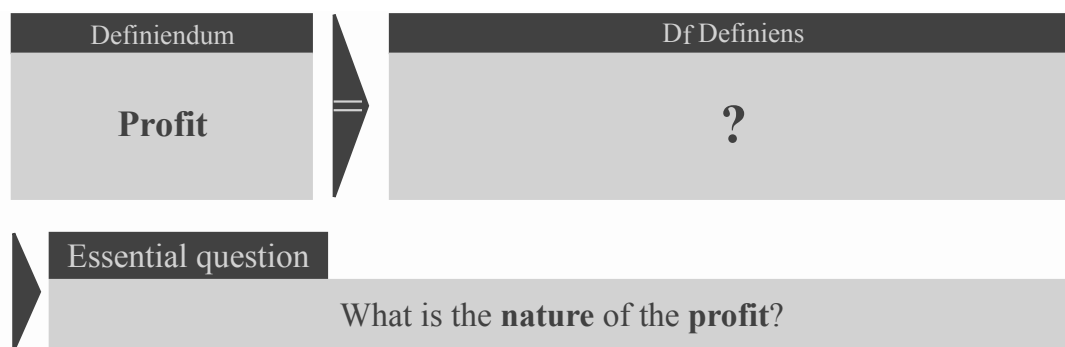
Source: Own illustration.

2.4.1 Descriptive research task: In search for the definiens of the profit

It is the **descriptive scientific aims** of this subsection to disambiguate the term of the **profit** because with reference to (Diez, 2012) the profitability was identified as a key element for the competitiveness of the (German) automotive industry so that it will help to explain the **competitiveness on the individual level**. Therefore, the corresponding definiens for the definiendum of the profit is searched for (cf. Figure 2-33).

Descriptive
research task of
Subsection 2.4.1

Figure 2-33: In search for the definiens of the profit



In search for the
definiens of the
profit

Source: Own illustration.

The **etymological origin** of the **definiendum of the profit** can be traced back to the Latin word *profectus* meaning progress, growth, advantage (Duden, 1997, p. 660) and it can be **assigned to the field of Strategic Management** because it is the objective for free economy market-oriented companies to maximise their profit in the long run (Bea & Haas, 2005, p. 15; Brealey, Myers, & Allen, 2006, p. 24; Staehle et al., 1999, p. 440; Wöhe, 2000, p. 119). Therewith, this objective to maximise the profit in the long run can be **classified** as one of **different approaches** for the strategic goal-settings because generally the overarching objectives companies are reliable to can be separated with regard to whether they concentrate on the fulfilment of demand or if they try to realise profits. Thus, a differentiation into profit versus non-profit oriented companies arises (Bea & Haas, 2005, p. 77).

Definiendum of
profit

By considering the economist Menger who wrote in his *principles of economics* in the year 1890, the **idea** of the **definiendum of the profit** to consider the entrepreneurial success as the overplus that is scored after the costs of the company for the value creation of the selling product (Berk & DeMarzo, 2007, p. 167; Brigham & Ehrhardt, 2005, p. 96; Menger, 2007). Therefore, it expresses the **aim** to determine the positive (profit) or negative (loss) outcome of an economic activity by comparing the costs in relation with the earnings. Its underlying **basic assumption**

can be explained with the help of the framework of financial economics. According to (Perridon & Steiner, 2007, pp. 2–3) the existence of markets is not optimal for organising the exchange of goods between the economic units because the market participants have to be able to quantify and compare their valuation with regard to the economic goods so that the monetary aspect becomes an essential instrument. As a result, it is further assumed that all economics units have to invest their available resources in a way so that they can optimally achieve their highest economic usage under technological, economic, social, legal, political and further basic conditions (Perridon & Steiner, 2007, p. 1). In this conjunction, it is the **central conclusion** that providing profit would be the primary goal of all financial activities of an economic unit (Perridon & Steiner, 2007, p. 3), whereby it is fixed in the internal legal structure of a company. **Main contributions** exist because of the following aspects: Firstly, the German car manufacturers have to be classified as profit-oriented companies because by considering the underlying basic assumption, their business reports and the fact that they are listed on the stock markets they are targeted towards gaining profit (cf. also next subsection) so that the profit orientation is a central framework for understanding the behaviour of the companies. Furthermore, the profit orientation will enable to select theoretical frameworks for explaining the competitiveness on the individual level because of the Supply Chain Valuedriver Decomposition and the company value that are both based on the profit-orientation. **Main limitations** can be recorded with regard to the Shareholder Vs. Stakeholder-discussion (cf. next subsection) because nowadays it is intensively discussed if companies would have to follow the interest of all the different stakeholders and not only the profit-orientation because of e.g. environmental, social or national economy oriented damages. Additionally while the idea of the profit is widely accepted, different techniques for measuring the profit exist so that their usage has to be evaluated dependent on the corresponding context.

Conclusions for
the descriptive
scientific aim

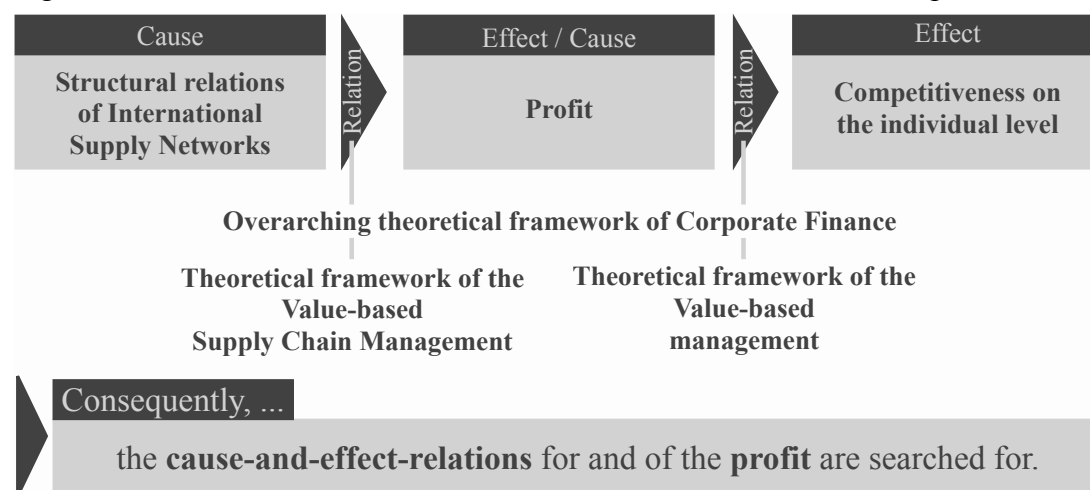
Consequently, the **profit** as a financial measure for the goal-achievement of the Strategic Management refers to the benefit which is scored after the costs of the company for the value creation of the product.

2.4.2 Analytic research task: In search for the cause-and-effect relations of the profit

It is the **analytic scientific aim** of this subsection to examine the **profit** because of standing in the centre stage of the analytic considerations between the structural relations of International Supply Networks and the competitiveness on the individual level as a second function of ISN (cf. in Figure 2-34). For this, the **overarching theoretical framework of the value-orientation** will be introduced because of enabling the **theoretical framework of the Supply Chain Valuedriver Decomposition** and the **value-based management** so that the cause-and-effect relations of the profit will have been analysed.

Analytic research
task of
Subsection 2.4.2

Figure 2-34: In search for the cause-and-effects-relations for and of the profit



In search for the
cause-effect-
relations of the
profit

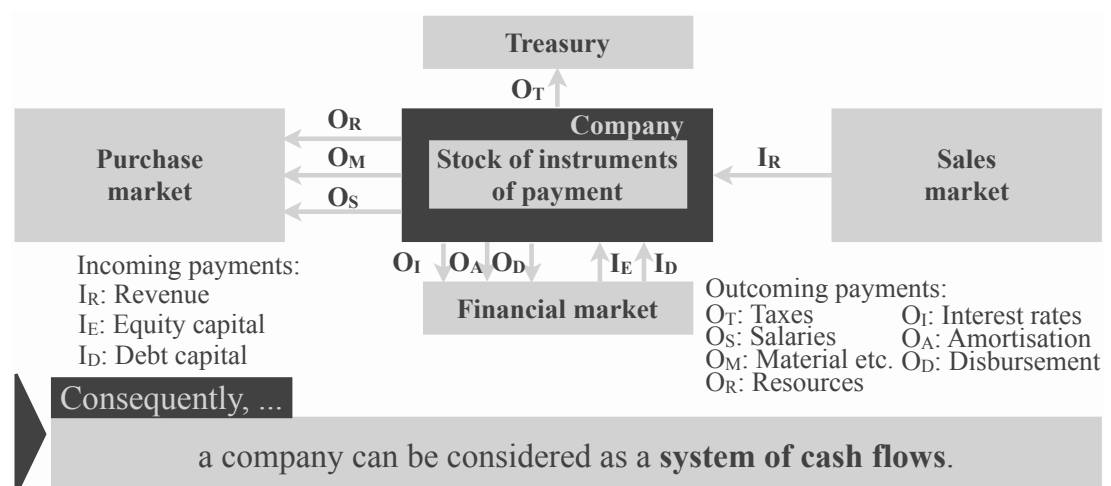
Source: Own illustration.

The **theoretical framework of Corporate Finance** is subject of consideration of the discipline of financial economics because the field of financial economics deals with the question about how and for which goals the financial activities of a company shall be organised (Bea & Haas, 2005, p. 531). Therefore, the **theoretical framework of Corporate Finance** can be **assigned into the field of strategic management** because it deals with the essential aspects of the survivability of a company (Bea & Haas, 2005, p. 531). In this regard, according to (Perridon & Steiner, 2007) a traditional perspective is distinguished from a modern or neoliberal one with regard to the **development of the discipline of financial economics**. The traditional perspective considered all the financial activities as supporting activities because for the performance areas of procurement, production and distribution capacities are needed for which different financial strategies such as e.g. to secure the liquidity are applied. The modern or neoliberal perspective has evolved to the

Corporate
finance

important area of the risk management, e.g. with the help of the Portfolio-theory or the Capital Asset Pricing Model, so that managerial decisions can be evaluated against the background of the overall financial goals (Perridon & Steiner, 2007, p. 15 et sqq.). A **classification** can be done with the help of the economic business processes that are usually distinguished into investment, finance and risk management but also with regard to the financial criteria such as independency, liquidity, rentability, unsecurity and the Shareholder Value, so that **different approaches** can be found in this framework (Perridon & Steiner, 2007, p. 9 et sqq.; Staroßom, 2006, p. 53 et sqq.). In this conjunction, the **theoretical framework of Corporate Finance** can be **characterised** as a special area in the field of financial economics because it deals with the question about the optimal capital structure (finance), policy of dividends (invesments) as well as the evaluation of the company value for investment decisions (risk management) by following the overarching objective of maximising the Shareholder Value (Perridon & Steiner, 2007, p. 9 et sqq.; Staroßom, 2006, p. 53 et sqq.). It is the **idea** of the **theoretical framework of Corporate Finance**⁶⁴ to consider a company – as illustrated in Figure 2-35 – as a system of cash flows because the activities of a company – such as the procurement, production and distribution – with its environment, e.g. the treasury, the sales market, purchase market or financial markets, are in a free market economy generally connected with incoming (e.g. revenue, equity capital or dept capital) or coutcoming payments (e.g. taxes, salaries, material, resources, interest rates, amortisation rates or disbursements) (Staroßom, 2006, pp. 17–18) cf. also (Bea & Haas, 2005, p. 531).

Figure 2-35: A company as a system of cash flows



Source: With reference to (Staroßom, 2006, p. 17).

⁶⁴ In German: "Finanzwirtschaft der Unternehmung" or "Unternehmensfinanzierung", "financial economics".

For this reason, the **framework of Corporate Finance** aim at dealing with all tasks for the development and security of the cash flows constituting the basis for the survival of the company and the selection and implementation of strategies by following the overarching goal to maximise the Shareholder Value (Bea & Haas, 2005, p. 531; Staroßom, 2006, p. 54 et sqq.). These tasks are **based** on the following **assumptions**: Firstly, the security of the liquidity constitutes a central condition for every activity of the company because of the free market economy (Staroßom, 2006, p. 20). Secondly, the financial management has to contribute to the overarching objective of the strategic management for profit-oriented companies because of its cross-divisional function (Bea & Haas, 2005, pp. 531–532; Perridon & Steiner, 2007, pp. 12–13). In this connection, it is a **central conclusion** of the **theoretical framework of Corporate Finance** that the risk management, the financial management and the investment decisions including the investment decisions of investors into the company have to be connected with an appropriate profit (e.g. an added value) in a medium or long term. This profit can only be achieved if the activities of a company can generate an added value for the end customer (e.g. the company is competitive) (Bea & Haas, 2005, p. 78 et sqq.; Bodie, Kane, & Marcus, 2009, p. 5, 636 et sqq.; Perridon & Steiner, 2007, p. 12; Staroßom, 2006, p. 63 et sqq., 77; Wöhe, 2000, p. 72 et sqq.). Therefore, the **main contribution** of the **theoretical framework of Corporate Finance** consists in providing the **theoretical framework of the value-based Supply Chain Management** for the cause- and the **value-based management for the effects-perspective**.

The **cause-perspective** broaches the issue of the **causal relation between the structural relations of International Supply Networks and the profit** because after having analysed the effects on competitiveness on the network level in the previous section an additional analysis about the effects of the structural relations on the competitiveness on the individual level is needed. For doing so, the profit-orientation will stand at the centre stage because it has been outlined that it is the objective for every free-market oriented companies to maximise their profits in the long run for surviving on the market (Wöhe, 2000, p. 119). In order to do so, the cause-perspective will be covered through the **theoretical framework of the value-based Supply Chain Management based** on (Sennheiser & Schnetzler, 2008) for analysing this causal relation because their introduction is one of few self-contained theoretical approaches that are also based on cause-effect-relations. What is the **idea** of the **value-based Supply Chain Management**? According to (Sennheiser & Schnetzler, 2008) it is the **idea** of the **value-based Supply Chain Management** to extent the Supply Chain Management with the questions about its value contribution because a company can draw an important part of its company success on the market

Value-based
SCM for the
cause-
perspective

from its SCM so that the Supply Chain respectively the SCM “represent[ing] a network of firms interacting to deliver a product or serve to the end customer” (Sennheiser & Schnetzler, 2008, p. 4) becomes a valuable resource for themselves (Sennheiser & Schnetzler, 2008, pp. IX,XI, 1, 8, 23 et sqq). Therefore, it is the **aim** of the **value-based Supply Chain Management** according to (Sennheiser & Schnetzler, 2008) to develop an integrative model for the SCM with which it is possible to arrange activities on a normative, strategic and operative level because they point out that investigations about the value-contribution through the SCM would be still in its infancy so that a theoretical framework can be created (Sennheiser & Schnetzler, 2008, pp. 1,19,40–46). This approach is **based** on the following **assumptions**: Firstly, the goals of the SCM have a significant contribution for achieving the goals of the profitability, whereat they refer to the survey of (Dehler & Weber, 2001) from the WHU Otto Beisheim School of Management in Vallendar who showed empirical evidence that companies with a high logistics performance have better revenues and ratios of profit of sales in trend (Sennheiser & Schnetzler, 2008, pp. 23–24). Therefore, SCM can lead to a competitive advantage. Secondly, the logistics has evolved over the time from 1960 to 2010 from a functional integration over an internal integration to an external integration include a focus on the company-wide management of supply chain, a focus on cooperation and a focus on networks (Sennheiser & Schnetzler, 2008, pp. 5–7). Thirdly, the logistics performance can be covered through the concepts of the so-called *order qualifiers* and *order winners* while the first concept refers to basic criteria/customer requirements that have to be fulfilled by the company to survive on the market, the second concept constitutes characteristics beyond that for turning the balance so that the end customer decides for this special products or services. If a company meets the requirements of an order winner in a special market segment, it can gain a competitive advantage (Sennheiser & Schnetzler, 2008, p. 8). In this regard, it is the **central conclusion** of the **value-based Supply Chain Management** according to (Sennheiser & Schnetzler, 2008) that with the help of the used methodological approach of the axiomatic design (cf. the next subsection) cause-and-effect relations of the Supply Chain Management on the company success can be analysed because of the decomposition of valuedriver in International Supply Networks (Sennheiser & Schnetzler, 2008, p. 23 et sqq.). Because of the SCM to take the company-wide or interorganisational perspective explicitly into account (cf. Subsection 2.1.3), it is the **main contribution** of the **value-based Supply Chain Management** to offer the **Supply Chain Valuedriver Decomposition** so that end-means combinations for the contributions of ISN to the market success and therewith to the profit can be derived (cf. next subsection). This contribution of valuedriver through a **value-based SCM** is **mainly limited** through the fact that a clear definition does not exist about what

a valuedriver (or potentials for a value generation (Wöhe, 2000, p. 658, 306 et sqq.)) actually is. Furthermore, valuedriver can be classified with regard to financial valuedriver such as revenue, rentability or taxes and operational valuedriver referring processes or essential characteristics of the product or service, e.g. quality or image (Bea & Haas, 2005, pp. 78–79; Perridon & Steiner, 2007, pp. 27, 209; Staroßom, 2006, p. 34). Consequently, with regard to the function of International Supply Networks to contribute to the competitiveness on the individual level it can be assumed that the profit-orientation is of essential importance.

The **effects-perspective** picks the **causal relation between the profit and the competitiveness on the individual level** out as a central theme because it is needed to examine the question about how the profit can lead to the competitiveness. For this, the **theoretical framework of the value-based management** is used because it enables a causal link between the profit and the competitiveness on the individual level. (Coenenberg & Salfeld, 2007) draw the conclusion in their summary that the **value-based management** is not a singular strategic concept but more of an integral management approach comprising all fields of the Strategic Management so that it works as a guideline for every single management decision (Coenenberg & Salfeld, 2007, p. 281). Therefore, the framework of the **value-based management** can be **assigned into the field of Strategic Management** (Coenenberg & Salfeld, 2007, pp. V, 3). Within the **field of Strategic Management** the **Shareholder Value** is subject of consideration of the strategic goal-settings and planning system because with regard to the internal legal structure of a company it determines that the interests of the Shareholder, i.e. the owner of the company, take precedence over the interests of e.g. the employees or the public (Bea & Haas, 2005, pp. 75–77). As was outlined in the previous subsection, **different approaches** as guidelines for management decisions can be **classified**. One classification can be done with the help of the different levels of the strategic goal-settings. These different levels of strategic goals are notably concretised through ratios – especially on the corporate, the business and the functional level because of having the advantage of clarity and precision so that distinct measurements to achieve the strategic goals can be achieved. In order to derive presettings for the different business levels based on the strategic goal-settings, the corporate goals have to be further subdivided and operationalised and timely separated.⁶⁵ In this conjunction, it can also be seen that the **value-based management** can be classified with regard to an operationalisation. As a technique for supporting such a deductive break-up of goals different ratio systems exist. The

Value-based
management for
the effects-
perspective

⁶⁵ A justification can also be done by considering the function of strategic goals. (The formulation of strategic goals is an important – and sometimes practically neglected – task of the Strategic Management). This becomes clearer by introducing their functions: Function of decision: Goals deliver criteria for an evaluation of alternatives. Therefore, the existence of a system of goals derived from the strategic goals is a precondition for the selection of strategies.

Du-Pont-ratio system was developed in 1919 by the American chemical company *Du Pont* as a consistent target system for controlling a decentrally organised organisation of business units by deducing sub-goals through break-ups. The **theoretical framework of the value-based management** is based on the **concept** of the **company value** comprising the **idea** that the value of a company should be in accordance with the benefits the owner of the company can profit from (Bea & Haas, 2005, p. 78; Coenenberg & Salfeld, 2007, p. V; Perridon & Steiner, 2007, p. 14). Due to the fact that the owners of a company are also called the Shareholder for publicly listed companies this idea is also called the **Shareholder Value-approach**. This **Shareholder Value-approach originates** to the American Professors of Rappaport, Copeland und Furhan because they are often called to be the first who transferred theories and ideas from financial and capital markets into the field of Strategic Management (Coenenberg & Salfeld, 2007, p. 3). In this conjunction, it is the **aim** of the value-based management to goal-orientedly and systematically influence/interfere the value of a company, i.e. the Shareholder Value, in the long run. This approach is **based on the assumption** of the **Economic Profit-model**.

Economic Profit Model

The **Economic Profit Model** comprises the **idea** that for determining the value of a company at a particular time (e.g. the economic profit) one has not only to consider the expenses covered in financial statements but also the opportunity costs of the capital that is invested in the company. Therefore, it is the **aim** of the economic profit to measure/capture the appreciation of value/value added of a company at a particular period and can be **defined** as the difference between the return on invested capital (ROIC) and weighted average costs of capital (WACC) multiplied with the invested capital (Berk & DeMarzo, 2007, p. 167; Brigham & Ehrhardt, 2005, p. 96; Menger, 2007).

$$\text{Formula 2-1: } \textit{Economic profit} = \textit{invested capital} \times (\textit{ROIC} - \textit{WACC})$$

In this regard, the economic profit can also be defined as the net operative income after taxes (NOPAT) less the burden of the capital costs whereby both modes of calculation lead to the same results (Bodie et al., 2009, p. 636 et sqq.).

$$\text{Formula 2-2: } \textit{Economic profit} = \textit{NOPAT} - (\textit{invested capital} \times \textit{WACC})$$

Therefore, it can be **concluded** that according to the economic profit model the value of the company is in accordance with the invested amount of capital less an extra charge or discontinuation of the prognosed economic profit.

In this regard, it is the **underlying assumption** of the **value-based management** that sooner or later the development of the average market value (stock exchange value) always follows the development of the average company value (Shareholder

Value) because of the informational role of the (financial) markets (Bodie et al., 2009, p. 5). Therewith, it is the **central conclusion** of the **value-based management** a value-orientated management philosophy can lead to the ability to compile successful strategies again and again in the long term so that it will differentiate from their competitors in the long run. Because of this, it is the **major contribution** of enabling a connection with the competitiveness on the individual level of a company through the profit-orientation. Furthermore, the Shareholder Value has been widely accepted in the field of Strategic Management because the German car manufacturers listed at the stock markets follow this idea. Hence, a **main limitation** exists with regard to the discussion of the Shareholder vs. the Stakeholder approach because it can be argued that companies should not only focus on the interest of the owners of a company but also to focus on a diversity set of interests such as e.g. the employees or the society, i.e. the Stakeholders.⁶⁶

Consequently, with regard to the overarching objective respectively the development of a research model the following conclusions can be drawn: For investigating the cause-and-effect relations between the characteristics of ISN and its function to contribute to the competitiveness on the individual level it can be assumed that the profit orientation stands at the centre stage. The reason for this is that the theoretical framework of **Corporate Finance** helps to explain the profit-orientation because the company value refers to the benefit the owner of the company can benefit from so that a sustainable increase of the company value in the long run is an indicator for company's competitiveness. The reason for this is that a maximisation of the profit secures the liquidity and therewith the company's survival on the market as well as it serves as an indicator in the financial markets in the competition of potential investments. Therewith, it can be assumed that the profit orientation is essential for the evaluation of a company to participate in an ISN. While the previous section has outlined that the value-based Supply Chain Management helps to identify valuedriver – i.e. if value is generated for the end customer, then profit is generated for the company in the long run so that its competitiveness is secured – the question remains about how to develop an assumption about the direction of the causal relation between the structural complexities and the profit.

Conclusions for
the analytic
scientific aim

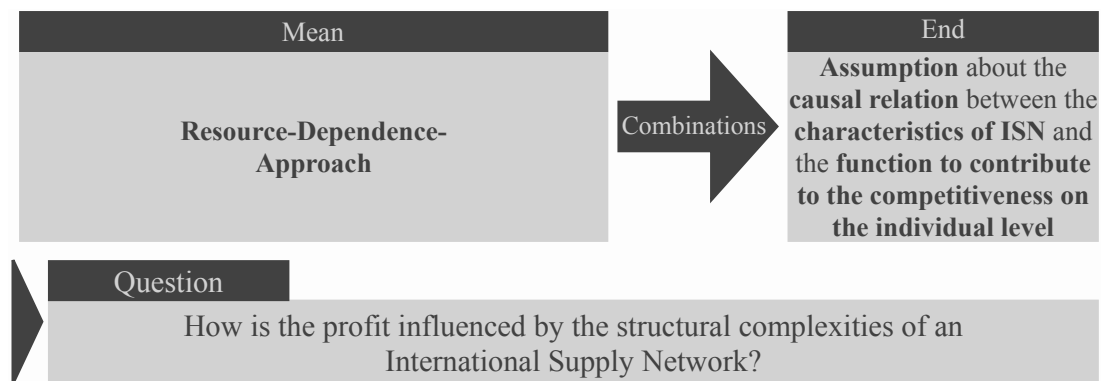
⁶⁶ An exemplary discussion of the Shareholder vs. Stakeholder approach can be found in (Starobom, 2006, pp. 54–63).

2.4.3 Pragmatic research task: How is the profit influenced by the structural complexities of the ISN?

Pragmatic
research task of
Subsection 2.4.3

It is the **pragmatic scientific aim** of this subsection to integrate the results of the previous two subsections because an **assumption about the causal relation between the characteristics of an ISN and the function of an ISN to contribute to the competitiveness on the individual level** is needed. This assumption about the causal relation can be understood as the **search for the end-means combinations towards the research model** as illustrated in Figure 2-36. In order to do so, a theoretical approach is needed that is able to deal with the causal relation between the structural complexities and the profit-orientation because these two concepts have been identified as the “placeholder” for the characteristics and the function of ISN. Such a theoretical approach is the **Resource-Dependence-Approach (RDA)** because it has been introduced in Section 1.2 as a theory for explaining the interorganisational behaviour and its dependency from its network environment.

Figure 2-36: In search for the end-means-combination towards the research model



Source: Own illustration.

Causal relation
between the
structural
complexity and
the profit-
orientation

For analysing whether the structural complexities in and of ISN can be theoretically connected with the profit-orientation, it is the **idea** to use the Resource-Dependence-Approach because by considering the **preliminary studies** in (Colmorn & Hülsmann, 2012) it has already been analysed about how the Economic Value Added as a measure for the performance of the focal firm can be connected with an introduced complexity-based approach from the field of Complex Network Science with the help of the Resource-Dependence-Approach. Therefore, due to the fact that the field of Network Science will be introduced as an approach for measuring the structural complexities in the next chapter, the following considerations will be closely related respectively **based** upon the explanations in (Colmorn & Hülsmann, 2012) because of the same underlying way of logical reasoning. Concerning theses

logical considerations, they are **based on the assumptions** of the Resource-Dependence-Approach that were outlined in Section 1.2.⁶⁷ In this conjunction, it is **assumed** that the network constitutes the organisational environment of the focal firm because it is connected with other companies through cooperative or logistic networks for getting access to material and immaterial resources which is also the reason why it is prudent of having a theoretical approach that is able to mirror the interdependencies of the focal firm from its network environment (Davis & Cobb, 2009, p. 3). Finally, the examinations are based on the value-driven consideration according to (Sennheiser & Schnetzler, 2008, p. 23 et sqq.) about the influences of logistics on such performance measurements like the Economic Value Added. Hereby, the authors gave reasons about causal relationships between the aims of logistics and the components of the EVA-concept. The derived causal relationships comprise both mathematically calculable relations as well as logical arguments that have to be proved or empirically validated. In order to answer the question about how logistics might strengthen the positive and weaken the negative aspects of the EVA, (Sennheiser & Schnetzler, 2008) distinguished between the three areas of revenue, costs and investments in current and noncurrent assets. Therefore, with the help of this framework the influences of the Supply Chain Management on the profit-orientation, here the Operating Income, can be seen (Christopher, 2005, pp. 94–95; Sennheiser & Schnetzler, 2008, pp. 32–37). Besides the fact that this picture is also highlighting the positive influence of the target areas of logistic on the profit (cf. above), the insights of the SCVD-decomposition can be also used for investigating the connection of the structural complexities with the Resource-Dependence-Approach. What are the **central conclusions** to be drawn?

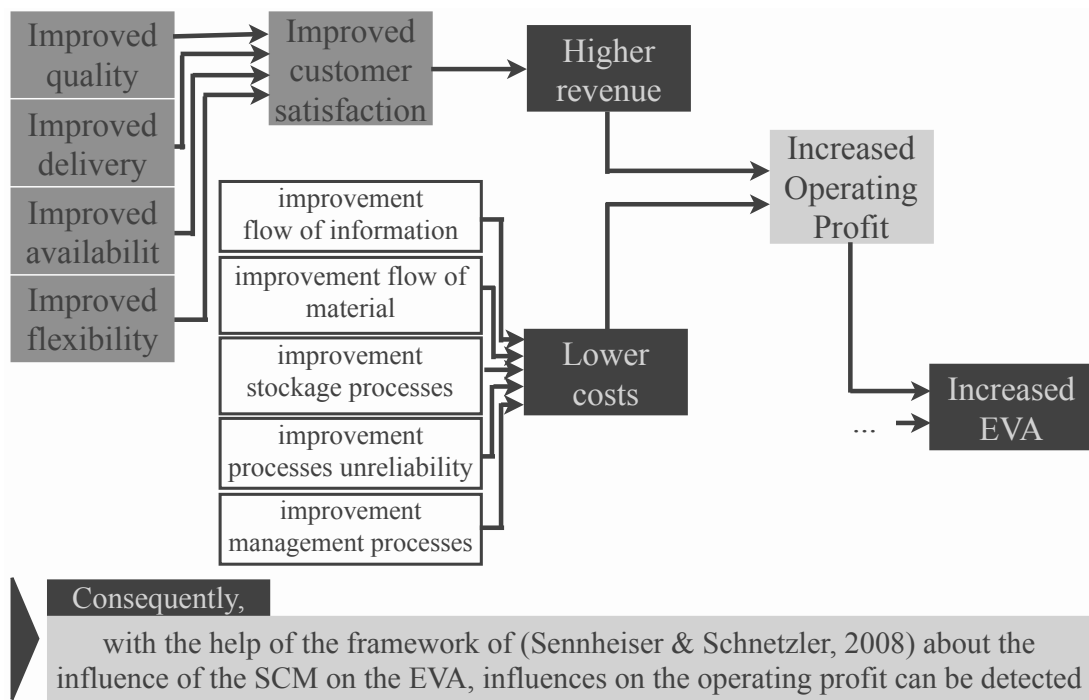
Firstly, the strength of a – vertical (i.e. transactional) or horizontal (i.e. competitive) – dependency is an essential driver/determinant for the behaviour of an organisation because it limits its autonomy. As a result, the relative share of the resource in the input and output relations of the organisation determines the (in)dependency of the resource-controlling organisation. Therewith, with reference to the examinations in (Colmorn & Hülsmann, 2012), the RDA highlights the importance of the – critical – resource so that it helps to classify the type of relationship because depending on the meaning of a considered resource for a company – and the corresponding tradeoffs – the relationships between the partners can be categorized as

- i. “dependent”, if the availability of the resource is critical and it has a high strategic meaning for the company,

⁶⁷ „It is the **central assumption** of the RDA that resources are essential for the company’s survival and functioning and that these resources are mainly obtained from the environment of the company through interactions leading to dependencies.”

- ii. “reciprocal”, if the offer from the suppliers and the demand from the company is in balance, or
- iii. “dominant”, if the company is the only customer of the supplier or the considered resource is easily to replace through other companies (cf. (Brunner, 2009, p. 33; Silver, 1993, p. 505)).

Figure 2-37: Influences on the operating profit



Source: Adapted from (Sennheiser & Schnetzler, 2008, p. 33).

Secondly, the resource-dependence-approach helps to classify the type of the organisational environment because the environment is ...

- a. “quiet & random”, if the critical resources are stable and homogeneously distributed within the environment across the organisations that do not have any connections between them,
- b. “quiet & clustered”, if the availability of the critical resources fluctuate over time (cf. (Brunner, 2009, p. 35)),
- c. “fluttered and reactive”, if interdependencies between the companies become relevant so that the actions of the others have to be taken into account so that the availability of the critical resources is unsecure and
- d. “turbulent”, if besides the previously mentioned interdependencies the interdependencies with other groups of stakeholders have also to be

considered that might also influence the availability of the critical resource (cf. (Brunner, 2009, p. 34; Davis & Cobb, 2009, p. 11)).”

Consequently, it can be **concluded** that the RDA is able to classify the dependency of the focal firm with respect to the type of relationship and to the type of the environment. Therefore, the question arises about how to use the RDA for investigating the influence of the structural complexity on the company profit?⁶⁸

With reference to the explanations in (Colmorn & Hülsmann, 2012, pp. B16–B17), the RDA “provides two nominal scales: The first one was defined as the type of environment with the nominal categories of “quiet & random”, “quiet & clustered”, “fluttered & reactive” and “turbulent”. This nominal scale that shall define the x-axis can be understood as an indicator for the “degree of fluctuation” because of their above-mentioned descriptions. It is the **first underlying assumption** ... that an increasing degree of fluctuation influences negatively the Economic Value Added. Reasons for this can be traced back to the concepts that a more fluctuating environment increases the probability of disruptions or that a higher dynamic of competition leading e.g. to delays.⁶⁹ Therefore, these delays caused by disruptions might negatively influence the revenue and/or the costs and/or investments because the companies tend to increase their stock as a backup (Joshi, 2011, pp. 684–689).” Against this background, it is assumed that the higher the degree of fluctuation is the more negative is the influence on the Economic Value Added or the profit. The second scale was defined as the type of relationship with the nominal categories of “dominant”, “reciprocal” and “dependent”. This nominal scale that shall define the y-axis can be understood as an indicator for the “degree of criticality” of the corresponding resource. Hereby, it is the **second underlying assumption** that a higher degree of criticality negatively influences the Economic Value Added [profit] because a dependent type of relationship indicates – by definition – an inferior situation for the focal firm. Therefore, it is assumed that because of this inferior situation the revenue, costs and investments are negatively influenced because of being in a worse situation to bargain so that the competitive behaviour of rivalries has to be taken into account (Schulte, 2009, p. 34). In this connection, it is assumed that the higher the degree of criticality the more negative the influence on the Economic Value Added [profit] (cf. (Schulte, 2009, p. 35)).”⁷⁰ As a result, it can be **concluded** that by integrating these two nominal scales and their assumed influence on the operating profit into a two-dimensional representation, a dependent type of relationship and a turbulent type of environment

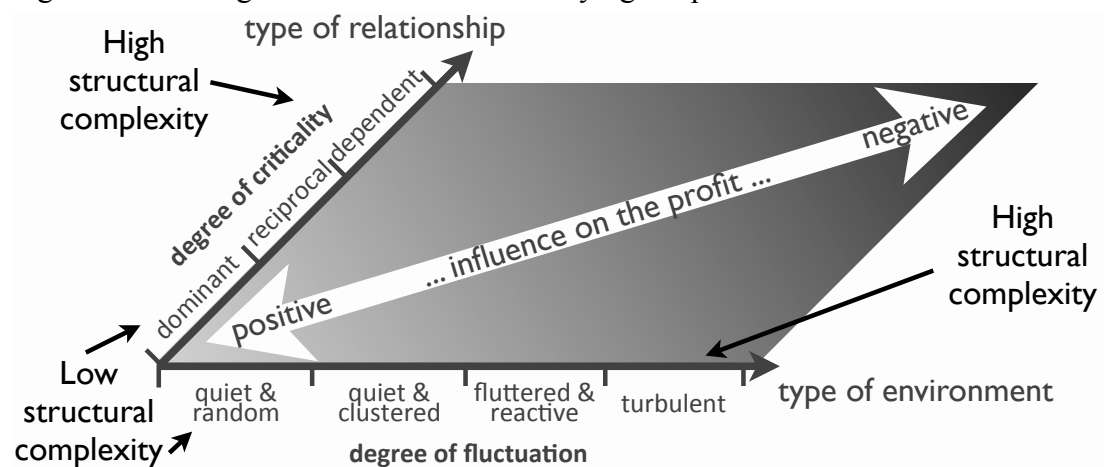
⁶⁸ The conclusions about the RDA are taken from the preliminary studies in (Colmorn & Hülsmann, 2012, pp. B14–B15).

⁶⁹ For example, the Five Forces of (Porter, 2004) are an approach to investigate the intensity of rivalry within an industry.

⁷⁰ Taken from the preliminary studies in (Colmorn & Hülsmann, 2012, p. B15).

should have the most negative influence on the operating profit while a dominant type of relationship in a quiet and random environment should lead to the most positive influence on the operating profit.⁷¹ Therewith, it is possible to derive assumptions about a positive or a negative influence on the operating profit depending on the characteristics in the categories of the “type of relationship” and the “type of environment” so that the Resource-Dependence-Approach as a framework for studying influences on the operating profit (cf. Figure 2-38).⁷² Hence, with respect to the outlined problem about connecting the structural complexities with the company performance, these two categories only constitute nominal scales⁷³ so that a direct measure is not possible. Nevertheless, with regard to the development of the research model a causal relation between the structural complexities and the profit-orientation can be derived because the categories of “dominant” and “quiet & random” can be understood as a low structural complexity while the categories of “dependent” and “turbulent” might be interpreted as a high structural complexity. The reason for this is that a higher number and varies of structural relations should indicate a higher exchange of resources leading to a higher dependency and turbulence and vice versa.

Figure 2-38: Categories of the RDA for studying the profit.



Source: Adapted from (Colmorn & Hülsmann, 2012, p. B15).

Conclusions for
the pragmatic
scientific aim

Consequently, with regard to the development of the research model a negative causal relation between the structural complexity and the profit can be assumed because of the considerations with the help of the Resource-Dependence-Approach.

⁷¹ For the sake of practical illustration, it shall be neglected that the two categories are not independent from each other so that e.g. a dominant relationship in a turbulent environment could be unlikely.

⁷² Adapted from (Colmorn & Hülsmann, 2012, pp. B16–B17).

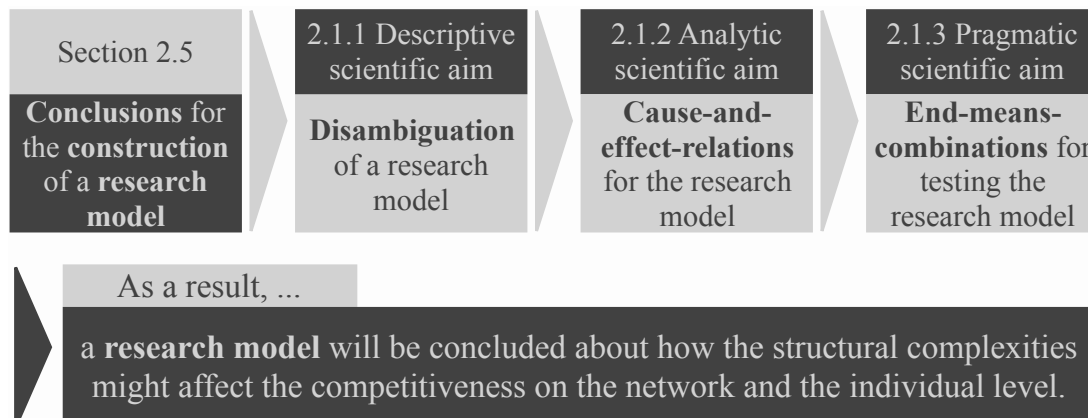
⁷³ A discussion about the impact of scales on the concept of research compare for example (Chmielewicz 1979).

2.5 Conclusions towards a research model about how the structural complexities might affect the competitiveness on the network and the individual level

Against the background of the research question, the overarching objective and the proposed scientific modus operandi that were outlined in the first chapter, this second chapter raised the issue of **specifying the underlying research problem**. For this reason, it is the **aim of this section** to summarise the insights of this chapter for deriving specific conclusions towards the research model. In order to do so, the definiendum of a research model will be firstly disambiguated (Subsection 2.5.1) because its corresponding cause-and-effect relations in the context of this thesis will be analysed (Subsection 2.5.2). Thereafter, the end-means combinations for handling the research model are outlined (Subsection 2.5.3) so that the underlying research problem of this thesis is specified for developing an appropriate solution approach in the next chapter (cf. Figure 2-39).

Overview over
Section 2.5

Figure 2-39: Overview over Section 2.5



Source: Own illustration.

2.5.1 Descriptive research task: Disambiguation of a research model

Descriptive
research task of
Subsection 2.5.1

The **descriptive scientific aim** of this subsection consists of the disambiguation of the **definiendum of a research model** because the underlying understanding of the definiendum of a research model determines the scientific proceeding (e.g. for developing a solution approach) so that the definiens of the definiendum of a research model – as illustrated in Figure 2-40 – is searched for.

In search for the
definiens of a
research model

Figure 2-40: In search for the definiens of a research model

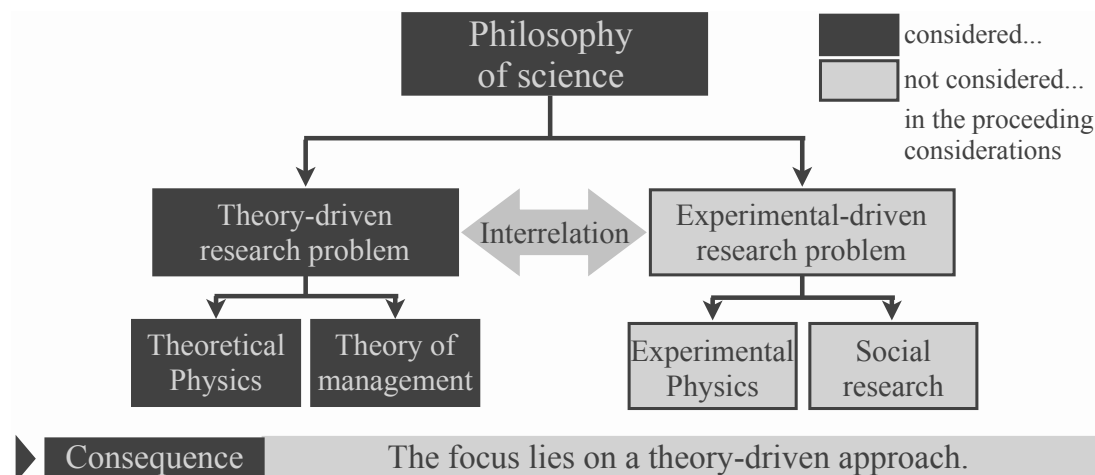


Source: Own illustration.

Definiendum of a
research model

The **definiendum of a research model** can be **assigned into the field of scientific theory** because it stands at the core about how create knowledge so that the **origin** of a research model can be traced back to the philosophy of science for itself or to the beginning of the scientific revolution in which the scientific method was developed (cf. section 1.5) (cf. (Chalmers, 2007, pp. 107, 113)). In this conjunction, **approaches** can be basically differentiated with respect to **theory-driven** and **experimental-driven approaches** (Chmielewicz, 1979). For example, in the field of physics the area of Theoretical Physics aims to develop hypotheses for new theories based on already existing ones that can be empirically tested while the area of Experimental Physics also tries to discover new regularities in nature through the development of experiments and empirical models (Meschede, 2004) (cf. Figure 2-41). Hence, both approaches are also interrelated with each other so that a theory- or experimental-driven research model should be considered as an idealised representation (Bossel, 2004, pp. 15, 25, 27). Against this background, the **idea** of a **theory-driven research model** can be summarised in the way that based on a construct of interest at the beginning, i.e. the research question or problem, potential relationships are derived through a review of literature and theories or rather logical reasoning against the background of a gap of knowledge (Raithel, 2009, p. 545).

Figure 2-41: Classification approaches for a research model



Source: Own illustration.

Therewith, it is the **aim** to develop so-called substantial hypotheses between the constructs of interest (Raithel, 2009, p. 545) because of the **basic assumption** that such substantial hypotheses about potential relations can be transferred into a model, i.e. a simplified representation of the reality in which the potential relations between the constructs (or variables) of interest can be represented through positive or negative relations (Backhaus, Erichson, & Weiber, 2011, pp. 78–79). Therefore, it is the **central conclusion** that a simplified and formal representation of the reality in the form of a model arises that can be falsified. This points to the **main contribution** of a **theory-driven research model** because it is in accordance with the epistemological scientific position according to Popper of falsifiable assumptions.⁷⁴ Hence, the **main limitation** can be summarised in the way that a model is always only an idealised representation of the reality whereby the researcher has to take care that no important factors are neglected for explaining the target phenomena because in this case the power of explanation would be limited (Raithel, 2009, p. 545).

Consequently, a **research model** can be defined as an **idealistic formal representation of the reality** where **potential causal relations** between the constructs of interest are represented through – **positive or negative** – **substantial hypotheses**. With regard to the overarching objective of this thesis the research model can therefore be identified as the first step of the explanation approach because assumption about the causal interrelations are derived that are based on theoretical reasonings.

Conclusions for
the descriptive
scientific aim

⁷⁴ This conclusion is determined by the selected scientific positions outlined in Section 1.5.

2.5.2 Analytic research task: Causal relations of the research model

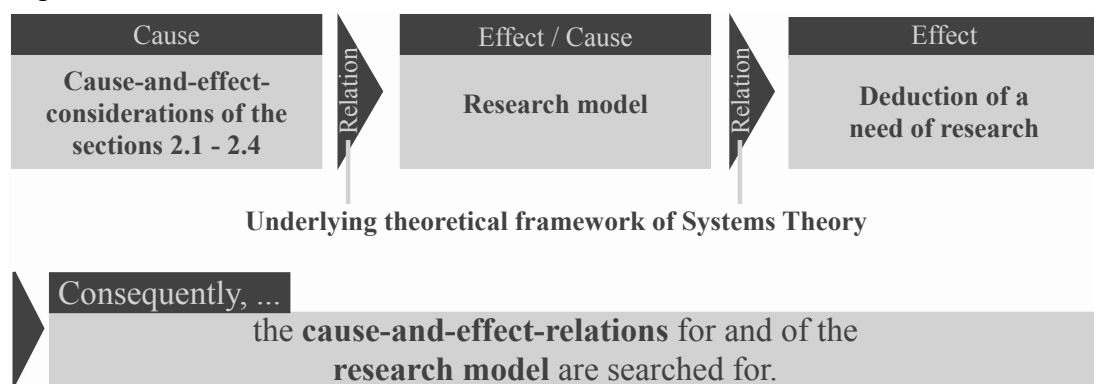
Analytic research
task of

Subsection 2.5.2

It is the **analytic scientific aim** of this subsection to integrate the cause-and-effect considerations of the previous subsections into a **research model** because it specifies the research problem so that the **cause-and-effect relations** for and of the research model **are searched for** (cf. Figure 2-42). To do so, the considerations are based on the theoretical framework of Systems Theory because it was the selected due to its interdisciplinary nature for combining the topics from the Strategic Management and Complexity Science.

In search for the
cause-and-effect
relations of the
research model

Figure 2-42: In search for the cause-and-effect relations of the research model



Source: Own illustration.

Cause-and-effect
relations for and
of the research
model

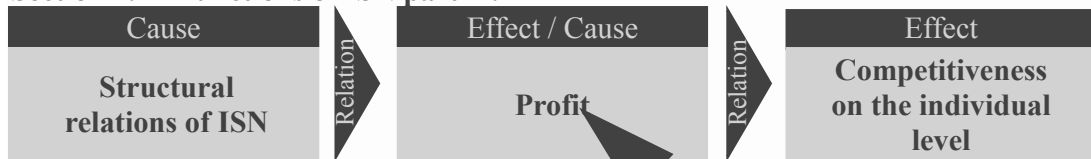
The following **considerations about the cause-and-effect relations for and of the research model** can be **assigned to the underlying theoretical framework of Systems Theory** because a stylised, i.e. abstract, research model about causal relationships will be developed from a complexity-based perspective that is applied to the context of an economic system. Therewith, the **cause-and-effect relations for and of the research model** can be **characterised** as being of interdisciplinary nature because the conclusions about the competitiveness on the network and individual level with the help of the discipline of the Strategic Management will be connected with the conclusions about the dynamic complexity from the discipline of Complexity Science.

Targeted towards the **aim** to build a research model that will determine the following procedures of developing a measurement approach, it is the **idea** to integrate the cause-and-effect relations of the previous Sections 2.1 – 2.4 of this second chapter because they dealt with the causal relations of the subjects of scientific consideration. Hereby, in Section 2.1 the consideration of elements and relations “led” to the existence of International Supply Networks because of – inter

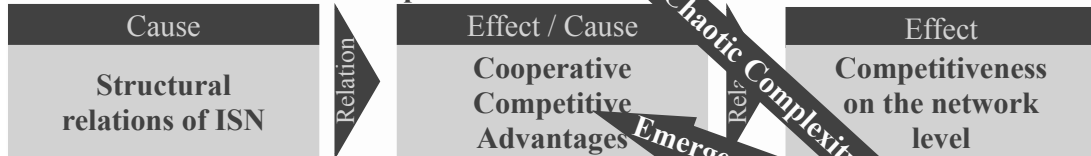
alia – the concentration on core competencies so that an ISN shall overall improve the competitiveness. With the help of Complexity Science in Section 2.2 it was concluded these structural relations of the ISN lead to a structural complexity determining a dynamic complexity as – inter alia – an essential characteristic of ISN. The first function of ISN that is generally considered to be a special (sub-)form of the characteristics consisted in contributing to the competitiveness on the network level through the existence of Cooperative Competitive Advantages (Section 2.3) while it is also the function of ISN to contribute to the competitiveness on the individual level through the profit-orientation (Section 2.4). Therewith, the **main idea** can be depicted as it follows: **If** the dynamic complexity, the competitiveness on the individual level and the competitiveness on the network level are all determined or the result of, i.e. they are effected by, the structural relations, i.e. the elements and relations of the ISN, **then** the dynamic complexity as a characteristic of an ISN should also effect the two functions towards the competitiveness of the ISN because with reference to (Chmielewicz, 1979) a function is generally considered to be a sub-form of a characteristic of a subject of consideration due to the interpretation that is needed. Therewith, it can be seen that the **considerations about the research model** are **based** on the introduced scientific *modus operandi* because of developing a stylised research model by connecting the two functions that were explained with the help of the framework from the Strategic Management with Complexity Science refers to the framework of Systems Theory including the methodological scientific position to make the causal relations quantifiable. Furthermore, this quantification of the causal relationships points to the epistemological scientific position of going for falsifiable assumptions. Finally, the approach of connecting these different aspects is based on the ontological scientific position according to (Chmielewicz, 1979) because of the outlined argumentation about how to connect the characteristics with the functions. As a result, the **main assumption** of the **considerations about the research model** consists of connecting the emergent complexity as a category of the dynamic complexity with Cooperative Competitive Advantages because it was introduced with “positive outcomes” while the chaotic complexity as a category of the dynamic complexity can be connected with the profit. Therewith, it is **assumed** that the two functions – the competitiveness on the network and the individual level that are explained with frameworks from the Strategic Management – can connected or even explained through the framework of the dynamic complexity from Complexity Science (cf. Figure 2-43).

Figure 2-43: Overview over the cause-and-effect relations of the Sections 2.1 – 2.4

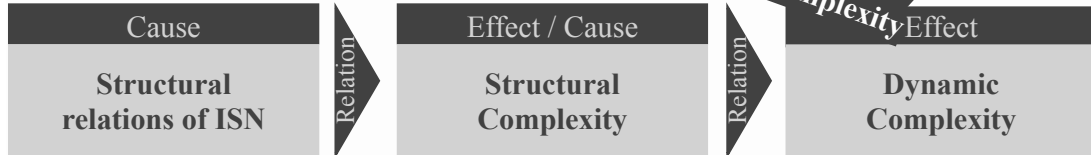
Section 2.4 - Functions of ISN part II:



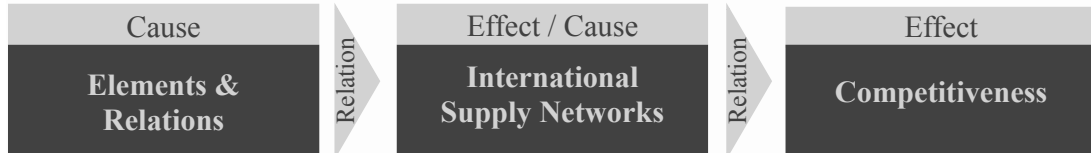
Section 2.3 - Functions of ISN part I:



Section 2.2 - Characteristics of ISN:



Section 2.1 - Elements & Relations of ISN:



Consequently, ...
If the structural relations effect the competitiveness on the individual and the network level, **then** the characteristic of the dynamic & emergent complexity should also effect the function on both levels.

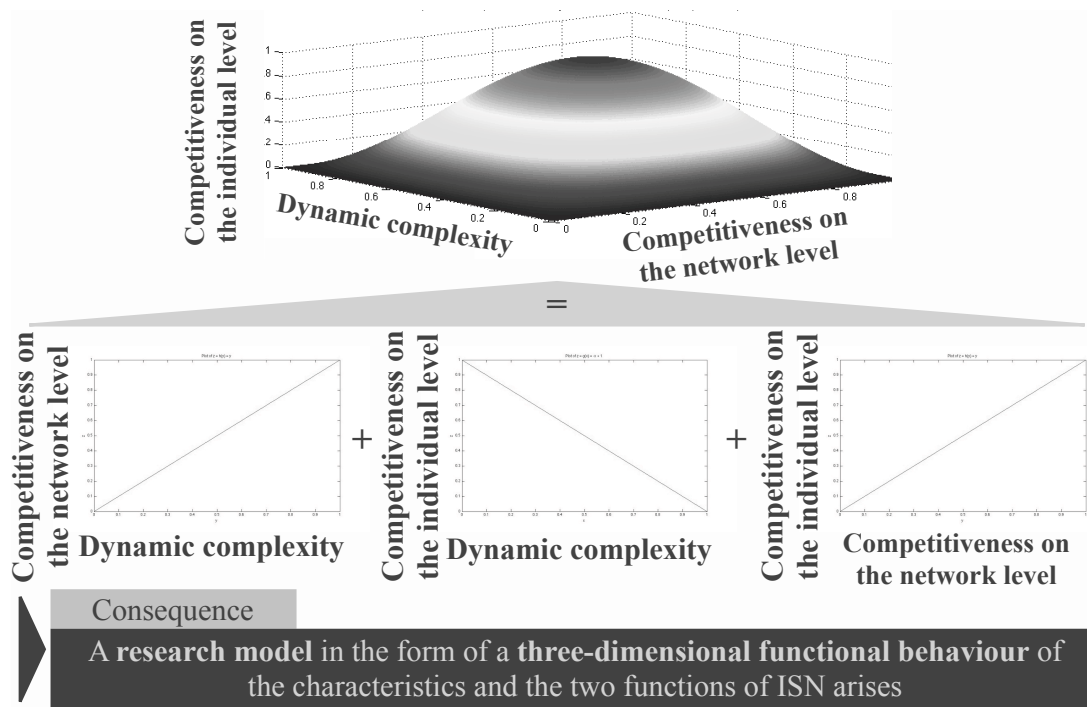
Source: Own illustration.

Against this background, it is the **central conclusion** of the **considerations about the research model** that a functional behaviour for the research model can be derived because three single pairs of relationships can be distinguished by considering an equivalence of the directions so that $3!/2 = 3$ combinations occur:

- Dynamic complexity & competitiveness on the individual level
- Dynamic complexity & competitiveness on the network level
- Competitiveness on the individual level & competitiveness on the network level

As a result, if these three pairs of combinations could be described through the three functional behaviours as it is shown in Figure 2-44 – these progressions of functional relations are just haphazardly selected for the sake of illustration! – then with the help of a superposition a three-dimensional functional behaviour arises (cf. Figure 2-44).

Figure 2-44: Exemplary illustration of the functional relations of the research model



Source: Own illustration.

The **contributions** of these **considerations about the research model** are mainly threefold: Besides the already discussed aspect that this research model is based on the scientific positions and the theoretical framework so that it is reliable to systematic scientific modus operandi, the research model allows, secondly, to derive – positive or negative – assumptions about their causal relationships. The relationship between the dynamic complexity and the competitiveness on the individual level is assumed to be negative because with reference to the basic assumption of connecting it with the chaotic complexity this relation should mainly deal with negative outcomes. The same argument goes for the relations between the dynamic complexity and the competitiveness on the network level and emergent complexity so that a positive relation is assumed. Finally because of the considerations in Section 2.1.2 the relation between the two functions should be of positive nature because in the long run they depend on each other. Finally, by anticipating the considerations of the next subsection, a measurability of the construct of interest becomes even more possible because of instead measuring the competitiveness on the network and individual level and the dynamic complexity, these latent, i.e. not directly observable, variables will be operationalised with the help of their factors that are placed upstream. Therefore, the construct of interest can also be translated into the structural complexity, Cooperative Competitive Advantages and the profit-orientation because it will be easier of finding manifest variables for these latent variables (cf. Chapter 3).

Nevertheless, besides the above-introduced main assumptions this research model is also **limited** because of neglecting many other factors that might also influence for example the competitiveness on the individual level respectively the profit. Furthermore, a deeper theoretical reasoning will be needed for arguing the shortly introduced functional behaviours. Therefore, these three – potential – causal relationships were theoretically grounded with the theoretical frameworks of the Relational View and the Resource-Dependence-Approach in Section 2.3.3 and 2.4.3. Finally, researchers with an educational background in physics are generally without inhibition in developing – sometimes intuitively – abstract models about their subject of interest and they are easily willing to reject their models, if the outcomes do not fit to the reality because this scientific method of a trial and error of theories and experiments was quite successful over the past three hundreds years (cf. section 1.5). On the other side, (Snow, 1968) has discussed in his book *The Two Cultures* the differences with the scientific approach in social sciences because hereby for example the preciseness due to an extensive literature review plays an important part. Therefore, due to the fact that the final conclusions about the assumed potential causal relations are based on some main assumptions, a social scientist might have problems with regard to the category of intersubjectivity while a physicist might be quite confident to just follow his or her insights and reject this approach, if the reality will not fit to the model.

Conclusions for
the research
problem

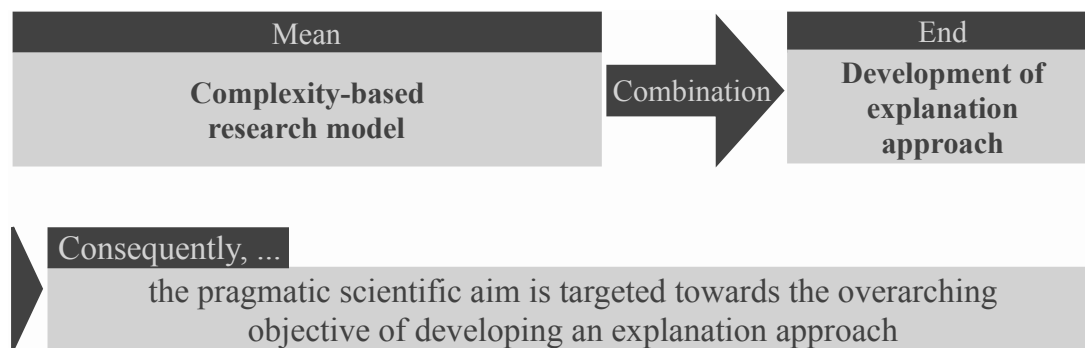
With regard to the overarching objective a **complexity-based research problem** has been developed about **how the structural complexities might affect the competitiveness on the network and the individual level**.

2.5.3 Pragmatic research task: Need of research to test the potential causal relations of the research model

Due to the fact that the **research model** is the **central subject of consideration** of this section, the **end-means combinations** are **targeted towards overarching objective of developing an explanation approach** (cf. Figure 2-45). Therewith, the **pragmatic scientific aim** of this subsection consists of identifying the complexity-based research model as the first step of the explanation approach towards the research questions.

Pragmatic
research task of
Subsection 2.5.3

Figure 2-45: In search for the end-mean-combination of handling the research model



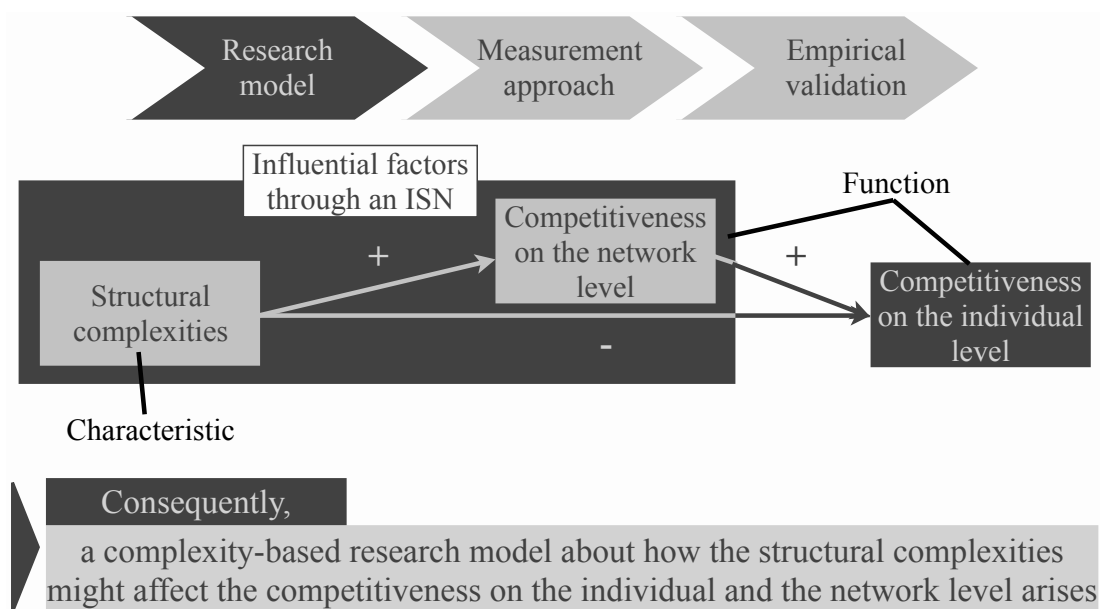
Source: Own illustration.

It has been outlined in Section 1.5 that the **development of an explanation approach that is able to explain Cooperative Competitive Advantages as well as the causal relations between an International Supply Network and the company success** would consist of a **research model**, a measurement approach and empirical validation. A complexity-based research model as a first step towards an explanation approach has been developed because of the following reasons: Firstly, the causal relations between an International Supply Network and the company success has been outlined because assumptions about the directions have been derived (cf. Section 2.3.3 and 2.4.3). Hereby, it was assumed that the company success that is represented through the profit does negatively depend on the structural complexity as a characteristic of an ISN. Additionally, the company success is positively influenced through the advantages of cooperation that represents the competitiveness on the network level. Therefore, an answer for the second research question occurs as illustrated in Figure 2-46. Secondly, an answer for the first research question can be derived, too. The reason for this is that this causal model about how the structural complexities might affect the competitiveness on the individual and the network level can be addressed as a Cooperative Competitive Advantage. This approach

A complexity-
based research
model towards
the overarching
objective

would take the ambivalent nature of the influences of an ISN on the company success into account. Thirdly, it comprises a multilevel consideration because the competitiveness on the network and the individual level are distinguished. Additionally, it bypasses the problem that a competitive advantage is still recognised by the customer through a company and not through the ISN. Finally, it explicitly takes the advantages of cooperation in an ISN into account and, indeed, from a RV-oriented perspective so that the characteristics of an ISN towards the realisation of a competitive advantages are considered. Finally, this complexity-based research model can be characterised as an interdisciplinary one because of the interdisciplinary nature of Systems Theory that enabled to connect topics from Complexity Science and Managerial Science. How to proceed with this approach?

Figure 2-46: Conclusions with regard to the overarching objective



Source: Own illustration.

Based on the **assumption** that the structural complexity, the company success and the advantages of cooperation are indicators that are logically placed upstream in front of the dynamic complexity, the competitiveness on the individual and the network level, it is the **idea** to place them as the essential latent variables of the research model because – most importantly – of the theoretical considerations. Additionally, they were in the core of the analytic considerations through cause-and-effect-perspectives. Therefore, it is the **aim** to express them through manifest variables for making them measurable.⁷⁵ The **main contribution** comprises the fact

⁷⁵ As outlined in Section the effects of the dynamic complexity, the competitiveness on the individual level and the competitiveness on the network level are latent variables, i.e. they are not observable. For these non-observable latent

that from an Systems Theory-based perspective the dynamic complexity can be expressed through the structural complexity because a gap of knowledge concerning the explanation between the structural and dynamic complexity was identified. Furthermore, the selection of these latent variables makes it easier to connect them with manifest variables because they are more specific. Hence, it is the **main limitation** that every representation or transfer leads to a loss of comprehensibility because essential features are neglected so that not all aspects of the phenomena of competitiveness are considered. Therewith, the **main contribution** consists of an approach that is in accordance with the outlined scientific positions in Section 1.5. Hence, this leads to the **main limitation** that – besides the outlined limitations of the falsificationism – a determination of functional relations as exemplary illustrated in Figure 2-44 is not possible because this would require an experimental-driven approach.

Consequently, with the help of the pragmatic scientific research task the complexity-based research model can be extended in the following way:

With regard to the **overarching objective** a **need of research** to **test the causal relations** between the **structural complexity** as a **characteristic of an International Supply Network** and its **functions** towards the **company success** and the **Cooperative Competitive Advantages** through falsifiable and therefore measurable hypotheses can be concluded.

Conclusions as a
result of the
pragmatic
scientific aim

3 The development of a Network Science-based Structural Equation Model

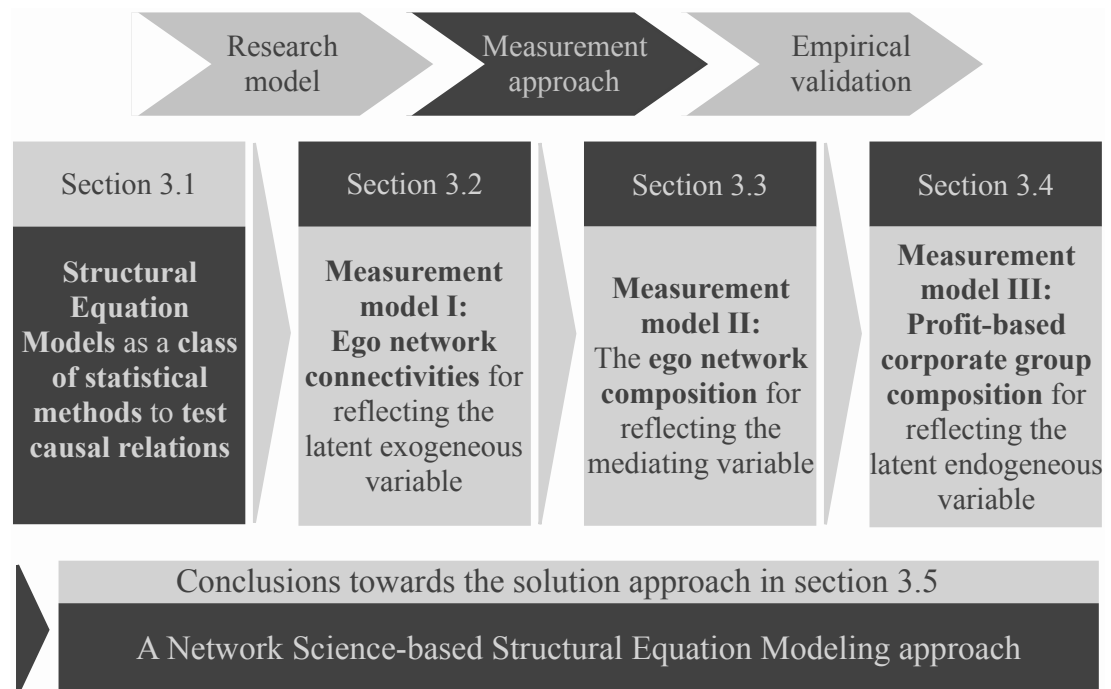
Overview over Chapter 3

The result of the previous chapter was the **theory-driven and complexity-based research model** about a need of research to test the causal relations between the structural complexity as a characteristic of an ISN and its functions towards the competitiveness on the individual and the network level through falsifiable and the therefore measurable hypotheses. Therefore, it is the **aim of this chapter** to introduce a **Structural Equation Model** as a **solution approach** in Section 3.1 because it comprises the features of being a statistical method for testing causal relations so that the following sections – as outlined in Figure 3-1 – are targeted towards the development of corresponding **measurement models** for

- the latent exogeneous variable (Section 3.2),
- for the latent mediating variable (Section 3.3) and
- for the latent endogeneous variable (Section 3.4.)

Therewith, the structural proceeding follows a systematic proceeding so that the result of Chapter 3 will be a Network Science-based Structural Equation Model as a solution approach for the outlined research model.

Figure 3-1: Overview over Chapter 3



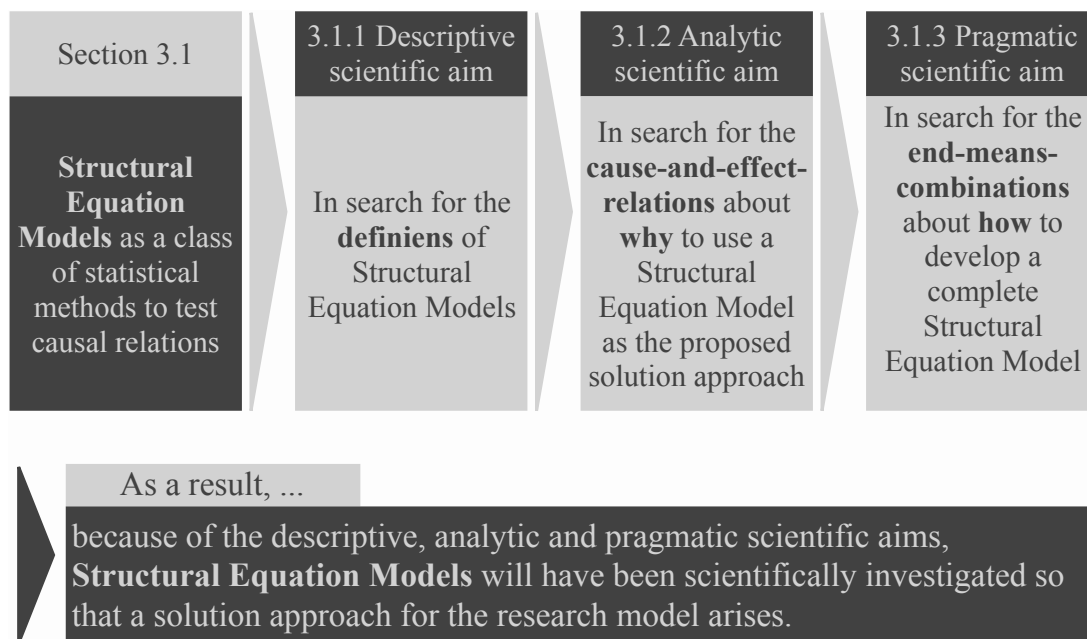
Source: Own illustration.

3.1 Structural Equation Models as a class of statistical methods to test causal relations

It is the **aim of Section 3.1** to clarify **Structural Equation Models as the solution approach for the outlined research model**. After the concept of SEM will have been disambiguated as a class of statistical methods to test causal relations (Subsection 3.1.1), the cause-and-effect relations about why to use SEM as the proposed solution approach will be given (Subsection 3.1.2). Based on this, the end-means combinations (Subsection 3.1.3) are targeted towards to introduce an established systematic framework for the development of a complete Structural Equation Modeling approach. Therewith, at the end of this section an approach will be clarified that is able to test causal relations and that meets the requirements with respect to the methodological perspective for quantitative methods as well as the ontological and epistemological scientific positions (cf. Figure 3-2).

Overview over
Section 3.1

Figure 3-2: Overview over Section 3.1



Source: Own illustration.

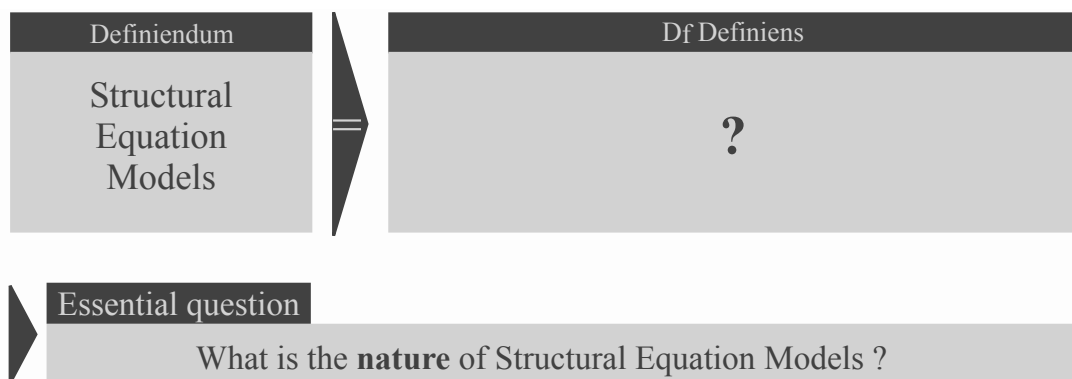
3.1.1 Descriptive research task: What are Structural Equation Models?

Descriptive
research task of
Subsection 3.1.1

It is the **descriptive scientific aim** of this subsection to **disambiguate the definiendum of Structural Equation Models** because – as will be shown below – with the help of the outlined nature of Structural Equation Models (cf. Figure 3-3) this class of statistical methods seems to be a promising approach for the outlined research problem. Therefore, an answer to the essential question about the nature of Structural Equation Models is needed. In order to do so, statistical methods have to be classified in general so that the SEM-approach can be appropriately assigned into the field of statistics. Therewith, it becomes possible to classify two main approaches of SEM specifically because Structural Equation Models are considered to be a class of statistical methods to test causal relations.

In search for the
definiens of
Structural
Equation Models

Figure 3-3: In search for the definiens of Structural Equation Models



Source: Own illustration.

The **definiendum of Structural Equation Models** can be **assigned into the field of statistics** that deals with the scientific method for the quantitative allocation, analysis and presentation of mass phenomena (Duden, 1997, pp. 769–770) whereby descriptive scientific methods are generally distinguished from inductive and explorative ones (Schwaiger & Zimmermann, 2009, p. 422) while a typologisation of statistical methods will be done in the next subsection because of its analytic aspect for the subject of consideration, a reason for considering **Structural Equation Models** as a statistical method can be seen by considering the origin. The **origin of Structural Equation Models** is closely related with the geneticist (Wright, 1921, 1934), who tried to investigate the influences of larger systems of variables with the help of linear equations from 1920 on (Reinecke, 2005, p. 45). His major aim was to specify directed relationships between variables and to determine the strength of the effect of the independent variable (cause) on the dependent variable (effect)

(Reinecke, 2005, p. 45). Based on this, the concept of a Structural Equation Model was **developed further** whereby two different approaches about how to **classify** Structural Equation Models can be distinguished because according to (Raithel, 2009) (Jöreskog, 1967, 1969, 1970, 1971) developed a covariance-based analysis leading to the LISREL-approach (Jöreskog, 1967, 1969, 1970, 1971) while a variance-based analysis can be traced back to Wold (Wold, 1966, 1975, 1982) also known as the Partial Least Squares-approach (Backhaus et al., 2011, p. 111; Raithel, 2009, p. 543). Furthermore, according to (Reinecke, 2005, pp. 14–18) it has been shown that the above-mentioned basic methods can be transformed into a Structural Equation Model so that e.g. the regression analysis etc. can be considered as a special subform and newer methodological advancements – e.g. models for several populations, longitudinal section model and the investigation of processes of development, models considering missing parameters as well as interaction models, bootstrap-methods, several layer models and the connection of traditional SEM-approaches with classificatory approaches – can all be considered as individual sub-classes of Structural Equation Models. Consequently, against this background of covariance-based and variance-based SEM and the development of methodological advancements, (Reinecke, 2005) points out that Structural Equation Models do not only refer to a single technique but also to a **whole group of models for a multivariate, statistical data analysis** (Reinecke, 2005, p. 3). As will become clearer in the following subsection, the following considerations will only focus on covariance- and variance-based SEM because they count to be the reference and are in accordance with each other with respect to their underlying formality of the causal model and the modelling process. It is the **idea** of a **Structural Equation Model** to express non-observable – so-called latent – variables through observable, i.e. measurable – so-called manifest – variables so that based on theory-driven hypotheses about the causal relations between these latent variables their manifest formings can be statistically analysed with respect to correlations (Schwaiger & Zimmermann, 2009, p. 433). Therefore, it is the **aim** of the SEM-approach that based on a theoretical or an intrinsically, logically reasoning considerations about causal dependencies can be investigated (Backhaus et al., 2011, p. 65). This investigation of causal dependencies is based on the **main assumption** that causality between variables cannot be proved through a statistical modeling but that a Structural Equation Model is only able to test, if because of content-based postulated hypotheses and their underlying assumptions a potential causal relationship cannot be rejected (Reinecke, 2005, p. 12). Therewith, it is the **central conclusion** of the Structural Equation Modeling approach that the empirical data for the validation of these assumptions have to be of metrical nature and that the value of a parameter within a Structural Model indicates the meaning of a – potential – causal

relationship, whereas the quality and the quantity of the sample determines how strong a relationship, i.e. its value, has to be so that a causal interpretation becomes possible (Reinecke, 2005, p. 13). The **main contributions** of the Structural Equation Modelling approach can be summarised with respect to this context of research because, firstly, SEM are able to test several variables and their causal interdependencies simultaneously because of being classified as a multivariate approach so that the requirements of the outlined research problem are fulfilled (cf. Subsection 3.1.2). Secondly, SEM have a confirmatory (in contrast with an exploratory) character because once hypotheses with regard to contents are expressed they can be tested. Therefore, Structural Equation Models combine theory-driven hypotheses with regard to contents about relationships with empirically collected data for testing them (Reinecke, 2005, p. 3). Thirdly, SEM allow the differentiation of a structural from a measurement model because they explicitly distinguish between observable (so-called manifest) and non-observable (so-called latent) variables. Therefore, a higher achievement potential of them can be constituted because they outrun classical variance analysis that do not distinguish between latent and manifest variables (Reinecke, 2005, pp. 3–4). Fourthly, SEM enable to explain variations of the independent variables because variances and covariances constitute the basis of data. Therewith, groups of covariants can be built so that differences between the parameters of the model and the groups can be detected and tested (Reinecke, 2005, p. 4). Hence, a **main imitation** exists with regard to the philosophy of science because SEM are not able to detect causality in a strict scientific sense so that only correlations of events can be detected (Backhaus et al., 2011, pp. 70–71; Raithel, 2009, p. 545).

Consequences
for the
descriptive
scientific aim

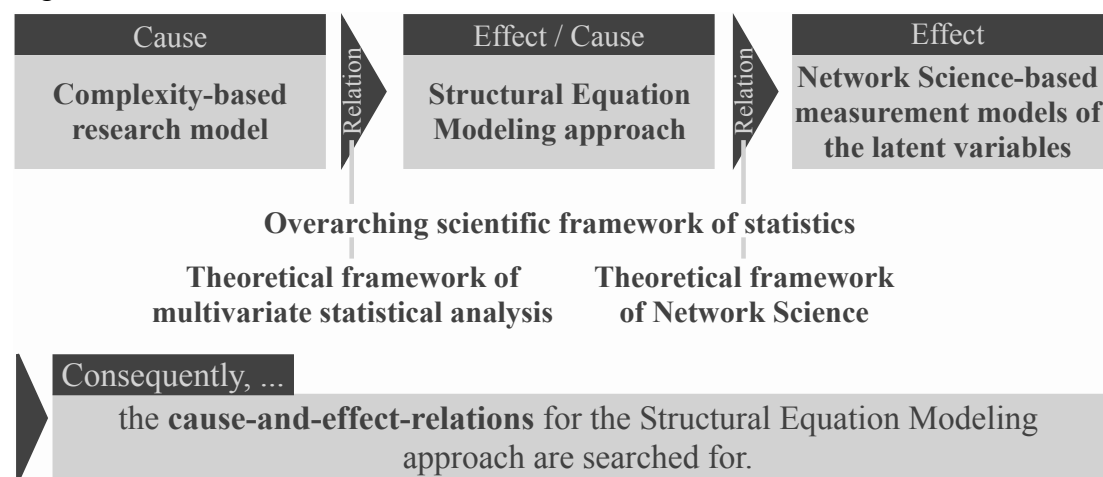
Consequently, Structural Equation Models are a class of statistical methods consisting of a structural model with latent, i.e. non-observable, and measurement models with manifest, i.e. measurable, variables that are able to test causal relationships by proving if content-based postulated hypotheses cannot be rejected statistically.

3.1.2 Analytic research task: Why to use a Structural Equation Model

The **analytic scientific aim** of this subsection is targeted towards the question why to use a Structural Equation Model as a solution approach. Therefore, the corresponding **cause-and-effect relations for Structural Equation Models** have to be investigated so that the perspectives are two-folded. For doing so, the **overarching scientific framework of the scientific discipline of statistic** is selected because of enabling to select theoretical frameworks for explaining the **cause-** and **effect-perspectives** for and of Structural Equation Models (cf. Figure 3-4).

Analytic research
task of
Subsection 3.1.2

Figure 3-4: In search for the cause-and-effect relations of SEM



Source: Own illustration.

The **cause-perspective** broaches the issue of the **causal relation between the research model and the Structural Equation Modeling approach** because it has to be examined, if Structural Equation Models are a convenient solution approach. Therefore, the features of the research model will be confronted with the features of the SEM-approach. In order to do so, the **theoretical framework of multivariate statistical analysis** is used.

Cause-
perspective

The **theoretical framework of multivariate statistical analysis** is **subject of consideration in the field of statistics** because the differentiation between uni- vs. bi- vs. multivariate approaches had been used in the previous subsection as a category to distinguish between **different statistical approaches** (Schwaiger & Zimmermann, 2009, p. 423). Therefore, the **theoretical framework of multivariate statistical analysis** is **classified** as a statistical approach that takes several variables into account at the same time (Schwaiger & Zimmermann, 2009, p. 423). Therefore, an overview about how to classify such statistical methods is needed so that an appropriate approach from the field of statistics can be selected for the course of

Theoretical
framework of
multivariate
statistical
analysis

research. Such an approach about a **typology of statistical methods** is offered by (Schwaiger & Zimmermann, 2009) who suggest the following categories for a characterization:

- **Uni- vs. bi- vs. multivariate approaches:** Statistical approaches can be distinguished with respect to the amount of variables (one, two or several) that are taken into account.
- **Descriptive vs. inductive approaches:** While descriptive approaches describe a dataset on hand, inductive approaches use probabilistic theories in order to derive conclusions from the considered sample about the whole population.
- **Parametric vs. non-parametric approaches:** while parametric approaches consider single parameter such as e.g. the expectation value of a distribution, non-parametric approaches are free of distributions.
- **Approaches of the dependence vs. interdependence analysis:** While approaches of a dependence analysis distinguish between dependent and independent variables so that the existence and strength of directed cause-and-effect relations are considered, both directions of a causal relationship are investigated during an interdependence analysis.
- **Manifest vs. latent variables:** While manifest variables are directly observable in reality and therefore measurable, most theory-based research problems content latent variables that are not observable and hypothetical.
- **Structure exploring vs. structure proving approaches:** Structure exploring approaches do not require any theoretical preliminary considerations because relationships between the considered variables have to be explored through the methods. On the other side, structure proving approaches serve to investigate hypotheses about causal relationships that have been preliminary considered through theoretical and logical reasoning. Therefore, existing theoretical hypotheses shall be empirically tested and – from a statistical point of view – confirmed.⁷⁶

Due to the fact that the outlined research problem has been specified as the need to test causal relations of several – latent – variables simultaneously, it can be derived that a multivariate statistical method is needed. Despite of the fact that according to (Schwaiger & Zimmermann, 2009) the separation into **structure-proving** and **structure-exploring-approaches** is not completely disjunct, this category shall be used because it is the mostly used form of a typology to structure the most important techniques for an analysis (Schwaiger & Zimmermann, 2009, p. 424). Such an introduction into multivariate statistical methods that are distinguished

⁷⁶ These explanations of the categories are a summary of (Schwaiger & Zimmermann, 2009, pp. 423–424) where longer explanations can be found.

with respect to structure-proving and structure-exploring-approaches is offered by (Backhaus et al., 2008):

- The primary goal of **structure-proving-approaches** consists of proving causal relationships for what the following techniques are counted among: regression analysis, time series analysis, variance analysis, discriminance analysis, logistic regression, cross tabulation and contingency analysis, conjoint analysis, nonlinear regression, Structural Equation Models and confirmatory factor analysis and selection-based conjoint analysis (Backhaus et al., 2011, pp. 11–13).
- On the contrary, **structure-exploring-approaches** are targeted towards to discover new relationships in a set of data, such as the factor analysis, cluster analysis, neuronal nets, multidimensional scaling, correspondence analysis (Backhaus et al., 2011, pp. 14–15).

Besides this separation into structure-exploring and structure-proving approaches a further classification can be done. With the help of the **preliminary studies in the working group** (cf. (Müller-Martini, 2008; Wycisk, 2009)) it can be referred to (Backhaus et al., 2008) in which **basic multivariate methods** are distinguished from **complex ones** so that their book introduces basic multivariate statistical methods in more detail while the complex ones are just shortly introduced. To fill this gap, (Backhaus et al., 2011) edited a new book *Advanced multivariate analytical methods* in which the complex ones from the other books are introduced in detail. In this conjunction, multivariate statistical methods can be separated into approaches of the first and second generation, whose essential characteristic for the separation consists in the fact that only the last ones are able to prove hypothetical constructs, i.e. latent variables that are not directly observable so that **basic** approaches can be distinguished from **complex** ones.

- **Basic:** Regression analysis, time series analysis, variance analysis, discriminant analysis, logistic regression, cross and contingency analysis, factor analysis, cluster analysis, conjoint analysis.
- **Complex analytical methods** are able to prove hypothetical constructs, such as the nonlinear regression, Structural Equation Models, confirmatory factor analysis, multidimensional scaling, correspondence analysis, selection-based conjoint-analysis.

As a result, with the help of the two categories for classification with respect to the application-orientation (structure-proving- and structure-exploring approaches) as well as the type (basic and complex multivariate statistical methods) different

categories arise with whom it becomes possible to classify the multivariate-approaches more specifically. Although it seems likely to use these two categories for a user-friendly visualisation, it has not been done so that the results are transferred into the following matrix (cf. Table 10). Consequently, with the help of the two categories of application-orientation and type, **Structural Equation Models** can be **assigned within the field of statistics** as a **complex** and a **structure proving multivariate statistical method**.

	Types	
	Basic	Complex
Application-oriented		
Structure-proving	Regression analysis, time series analysis, variance analysis, discriminant analyseis logistic regression, cross and contingency analysis, conjoint analysis,	Nonlinear regression, Structural Equation Models and confirmatory factor analysis, selection-based conjoint-analysis
Structure-exploring	Factor analysis, cluster analysis,	neuronal nets, multidimensional scaling, correspondence analysis.

Table 10: Categorisation of statistical methods

Against this background, it is the **idea** to check whether the research problem can also be classified as being multivariate, complex and structure proving targeted towards the **aim** to test the suitability of the solution approach. What are the **features of the research model**?

- A **multivariate statistical method** is needed because the latent variables of the structural complexity, the company value and Cooperative Competitive Advantages constitute multiple variables.
- A **complex statistical approach** is needed because with the help of the theoretical foundation direct relationships can be distinguished so that exogeneous variables can be differentiated from endogeneous ones; additionally, the outlined latent variables are non-observable so that they have to be expressed through so-called manifest ones.
- A **structure-proving approach** is needed because the theoretical frameworks enable to derive assumptions about their relationship that have to be validated respectively falsified.

Therefore, Structural Equation Models seems to be a promising solution approach because they have been characterised as a multivariate, structure-proving and complex statistical method. Their investigation of causal dependencies is based on

the **main assumption** that causality between variables cannot be proved through a statistical modeling but that a Structural Equation Model is only able to test, if because of content-based postulated hypotheses and their underlying assumptions a potential causal relationship cannot be rejected (Reinecke, 2005, p. 12). Therewith, it is the **central conclusion** of the Structural Equation Modeling approach that the empirical data for the validation of these assumptions have to be of metrical nature and that the value of a parameter within a Structural Model indicates the meaning of a – potential – causal relationship, whereas the quality and the quantity of the sample determines how strong a relationship, i.e. it's value, has to be so that a causal interpretation becomes possible (Reinecke, 2005, p. 13). Therefore, the **framework of multivariate statistical analysis contributes** to this approach of justifying the usage of a Structural Equation Modeling approach because of the features of the research model that is just **limited** through the fact that a causality of the research model cannot be proved in a strict scientific sense. But what are the effects of using this solution approach?

The **effects-perspective** broaches the issues about the effects of using a Structural Equation Model as the proposed solution approach because after having analysed that the Structural Equation Modelling approach fits to the outlined research model it becomes clear that **measurement models for the latent variables** have to be conducted. For this, the **theoretical framework of Network Science** will be used because of enabling to make the non-observable variables measurable so that **Network Science-based measurement models** will be the result.

Effects-
perspective

The **test theory** can be **assigned into the scientific theory** because of its **aim** comprising the **idea** of determining about how knowledge can be gained through statistical methods in a strict scientific sense (T. A. E. Ebert & Raithel, 2009, p. 516 et sqq.). It is **based on the general assumption** that empirical data collections, e.g. through surveys, and measurements cannot be done without errors because, for example in the field of social sciences, repeated measurements during Paneldesigns would lead to different results of a person. The reason for this is that either the disposition that has to be measured changes between the time steps of the measurements or the differences are the result of error of measurement (T. A. E. Ebert & Raithel, 2009, p. 515). For this reason, it is the **central conclusion** of the **test theory** to formulate a mathematical model that separates a measurement x into the true score τ and an measurement error ε . Because of this the **test theory contributes** to the research by offering the two fundamental approaches of the reflective measurement and the formative measurement.

Test theory

Reflective
measurement

The **aim** of the **reflective measurement approach** comprises the **idea** that the measuring indicators mirror, i.e. “reflect”, the formings of the construct and are therefore to be considered as the results of them. The reflective measurement approach is **based** on the classical test theory stating that the result of a measurement X_0 (observed score) can be defined as a function of the true score X_T and an error term X_E , that can be differentiated with respect to random and systematic influences (T. A. E. Ebert & Raithel, 2009, pp. 516–518). Therewith, it is the **central conclusion** that every indicator x (afflicted with an error δ) is considered to be an effect of the behind standing construct ξ and named as a reflective indicator. The matrix contains Δ_x the individual weights λ_i representing the strength of the relationship between the latent and manifest variables.

Formula 3-1: $X_0 = X_T + X_E \rightarrow x = f(\xi) = \Delta_x \xi + \delta$ (Factor model)

Formative
measurement

The **aim** of the **formative measurement approach** comprises the **idea** that the measuring indicators are located in front of the construct and are therefore to be considered the causing effect so that these indicators build, i.e. form, the construct. The **basic assumption** of the formative measurement approach states that the true score X_T is considered to be a function of the observed score X_0 and an error term X_E . In this conjunction, a construct can be measured through formative indicators x , whereby the construct η is determined through the indicators. Hereby, it is assumed that the indicators are measured without any errors while the construct is assigned with the error (ζ). Therefore, it is the **conclusion** of the formative measurement approach to formulate a regression model in which the measurement is formally represented through a simple regression model. Hereby, every indicator x (afflicted with an error δ) is considered to be an effect of the behind standing construct ξ and named as a reflective indicator. The matrix contains Δ_x the individual weights λ_i that represent the strength of the relationship between the latent and manifest variables.

Formula 3-2: $X_T = X_O + X_E \rightarrow \eta = f(x) = \Gamma_x x + \zeta$ (Regression model)

Consequently, the theoretical framework of the **test theory** for the effects of using the Structural Equation Modeling approach has been outlined pointing to the question about how to measure the constructs of interest?

The **theoretical framework of Network Science** can be **assigned into the field of Systems Theory** because of its interdisciplinary character and its abstract approach to formally represent – inter alia – socio-technical systems such as economic ones (Dorogovtsev, 2010; Newman, 2003). Therefore, Network Science is also a physically motivated methodology that can be transferred to research topics of socio-economic systems.⁷⁷ While the **origin** of using a physically motivated methodology for the context of socio-economic systems can be traced back to Mandelbrot who first of all “had analysed economic and social relations in terms of modern statistical physics” (Mantegna & Stanley, 2007, p. 4; Schulz, 2003, p. V), the **origin** of Network Science in particular seems to be older because “the term of a network originates from the field of mathematical graph theory in which a network is defined to be a set of items, i.e. nodes, with connections between them, i.e. links” (Dorogovtsev, 2010, p. 4) wherefor the Königsberg-Bridge-Problem is mostly referred to. Therefore, a **network** is “a collection of nodes connected by links” whereby nodes “correspond to the individuals ... and links to the connections between them” (Mitchell, 2009, p. 234). Hence, according to (Newman, 2003, p. v) the concept of complex networks is young because it “came to use in the late 1990s when researchers from very distinct sciences – computer scientists, biologists, sociologists, physicists, and mathematicians – started to intensively study diverse real-world networks and their models”. According to the (National Research Council, 2005) of the U.S. **network science** is **defined** as “the study of network representations of physical, biological, and social phenomena leading to predictive models of these phenomena”. Therefore, the **aim** of Network Science can be depicted through the **idea** of an interdisciplinary academic approach. This interdisciplinary academic approach combines an abstract mathematical representation from graph theory and the field of statistical mechanics from the discipline of physics in order to study the stochastic behaviour of systems that are composed of a large number of interacting parts including theories and methods from physics, data mining and information visualisation from computer science, inferential modelling from statistics and social structures from sociology (Newman, 2003, p. 2 et sqq.). Its **main assumption** is that a complex network has non-trivial topological features – i.e. features that do not occur in simple networks such as lattices or random graphs – that can be identified as, e.g., the small-world effect, transitivity or clustering and degree distributions so that a connection with the behaviour of systems become possible (Newman, 2003, p. 7). Against this background, it is the **central conclusion** of Network Science that “systems taking the form of networks” such as physical, biological, social or economic ones can be

Theoretical
framework of
Network Science

⁷⁷ Other methodological approaches are e.g. stochastic differential equations, multiagent systems or stylised models.

characterised through similar patterns, i.e. the type of the structural relations and the same phenomena on the system level (Dorogovtsev, Mendes 2002). Therefore, these different systems, such as a logistic network, can be described within the same framework so that through the same common features the same behaviour is expected to arise. For these reasons, the **major contributions** with respect to the course of research can be depicted in the following way: Firstly, the theoretical frameworks of Systems Theory in general and Network Science in particular meet the requirements of the outlined epistemological, ontological and methodological scientific positions. Secondly, Network Science seems to be a promising approach for connecting the interdisciplinary topics because of its abstract but applicable representation. For example, (Boccaletti, Latora, Moreno, Chavez, & Hwang, 2006) point out that in order to investigate global properties of such systems like efficiency or robustness one has “to model them as graphs whose nodes represent the dynamical units, and whose links stand for the interactions between them”. Thirdly, despite of the often-made claim for interdisciplinary approaches and that Network Science is “rapidly becoming a lingua franca across virtually all of the sciences from anthropology to physics” (Borgatti & Li, 2009), a gap of knowledge of using Network Science in the field of Strategic and Supply Chain Management can be stated. With regard to (R. Albert & Barabási, 2002; Amaral & Ottino, 2004; Bala & Goyal, 2000; Benson & Benson, 1975; Boccaletti et al., 2006; Borgatti & Foster, 2003; Candace, Hesterly, & Borgatti, 1997; Choy, Lee, & Lo, 2003; Dorogovtsev, 2010; Erdogmus, Kapanoglu, & Koc, 2005; Gulati, 1999; Hoang & Antoncic, 2003; Jharkharia & Shankar, 2007; Kanssøn & Ota, 1989; Katz & Shapiro, 1985; Newman, 2003; Rowley, 2012) Network Science has not been used in the context of managerial economics for measuring the effects on the competitiveness. Hence, the framework of Network Science is connected with **limitations**, too. Most importantly, (Newman, 2003) who has written a standard work about the structure and function of complex networks states that the scientific community has made impressive progress about the “characterization and modelling of network structure”, but insights “of the effects of structure on system behavior on the other hand are still in their infancy. It remains to be seen what the crucial theoretical developments will be in this area.” In addition, Physics is characterised through an abstract approach, i.e. some things are neglected through the process of simplification. For example, behavioural-oriented insights from the field of social sciences will be neglected so that the developed solution approach is by definition a simplification.

In consequence, why to use Network Science with regard to the development of the explanation approach in general and the complexity-based research model and the measurement approach in particular? In (Colmorn et al., 2013, p. 54) different

centrality measures have been discussed based on research in the field of Network Science. This discussion of different centrality measures differentiated between centrality measures for the individual level (e.g. the in-out-degree of an individual node) and for the level of the whole network (e.g. the statistical distribution over all these individual in-out-degrees). Because of this differentiation, Network Science is able to connect the structural complexities from a multilevel perspective. Therewith, a connection between the individual and the network level can be achieved by considering the statistical centrality measures of a whole network. This connection does not allow a causal relation between the individual and the network level as outlined above, but it allows to express certain forms of behaviour on the system or network level through the statistical distribution over all the individual centrality measures.

With regard to the analytic scientific aim Network Science can be identified as being an interdisciplinary theoretical approach that can be assigned to Systems Theory for measuring the structural complexity of systems taking the abstract representation of networks. Therefore, it is promising because network science is connected with **statistical properties** so that the structural relations on the individual level can be connected with dynamic phenomena on the system level through statistics.

Conclusions for
the effects-
perspective

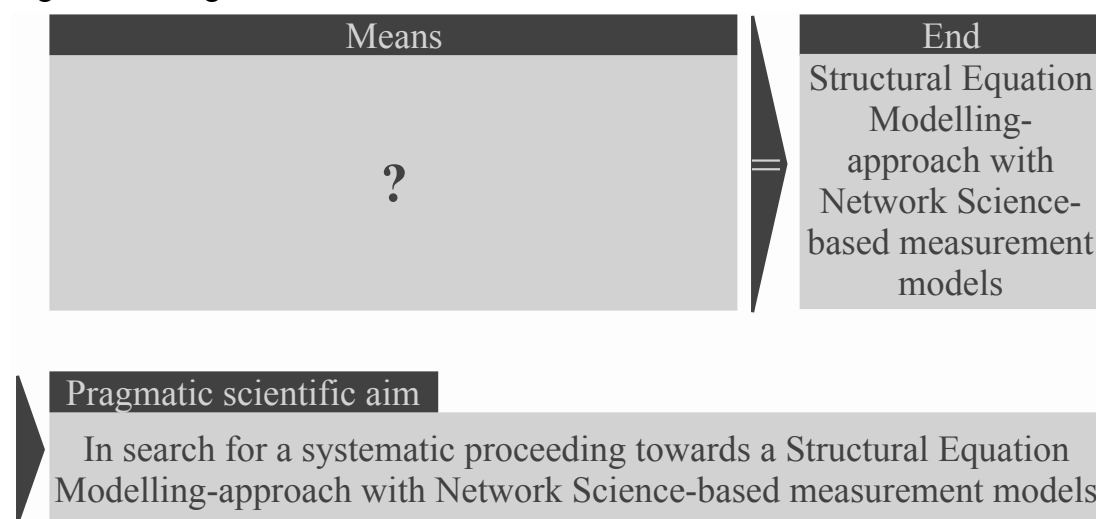
3.1.3 Pragmatic research task: How to use the Structural Equation Modelling approach containing network science-based measurement models?

Pragmatic
research task of
Subsection 3.1.3

Because of the results of the previous subsection it has become clear to use the Structural Equation Modeling approach to test the outlined potential causal relationships. Therefore, it is the **pragmatic scientific aim** of this subsection to outline which means has to be used, i.e. how to systematically proceed, in order to appropriately use the Structural Equation Modeling approach for testing the potential causal relationships of the outlined research problem (cf. Figure 3-5). In order to do so, the general proceeding for doing a Structural Equation Modelling approach – including a general guideline for measuring constructs – will be depicted before the framework of Network Science-based measurement models will be given.

In search for the
end-means-
combination

Figure 3-5: Pragmatic scientific aim of Subsection 3.1.3



Source: Own illustration.

Process for the
development of a
complete
Structural
Equation Model

(Backhaus et al., 2011, p. 78; Raithel, 2009, p. 545; Reinecke, 2005, pp. 10–11) refer to the same **process for the development of a complete Structural Equation Modeling approach**. Therefore, **eight steps** for the modelling and analysis of Structural Equation Models can be distinguished.

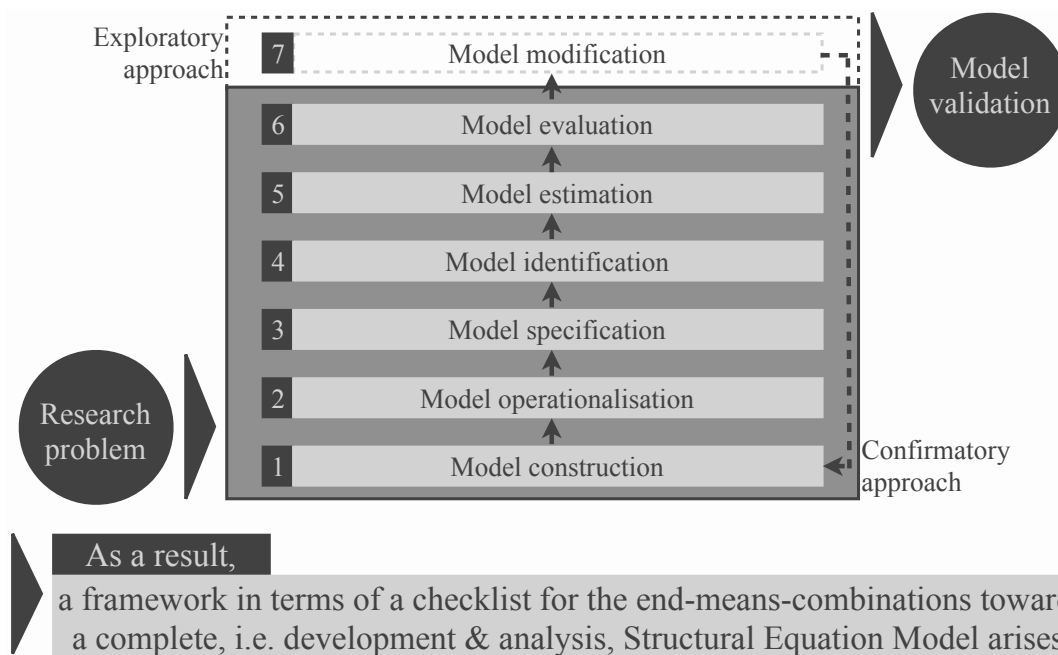
1. **Construction:** A research problem is translated into substantial hypotheses reflecting the causal relationships between the latent variables.⁷⁸
2. **Operationalisation:** The constructs are concretized by identifying the relevant set of indicators and their relations with the constructs.⁷⁹

⁷⁸ (Raithel, 2009, pp. 544 & 545 – 546).

⁷⁹ (Raithel, 2009, pp. 545 & 546 – 547).

3. **Specification:** The mathematical formulation of the model equations allows identifying the parameters that have to be estimated.⁸⁰
4. **Identification:** Based on the formal model specification the ability of the available data for estimating of the parameters can be determined.⁸¹
5. **Estimation:** The selection of the evaluation methods that best fits the estimation of the model.⁸²
6. **Evaluation:** Goodness-of-fit, i.e. the quality, with respect of the ability to reproduce of the empirical data is evaluated.⁸³
7. **Modification:** while the first six steps contain the confirmatory character, the modification in step 7 deals with an explorative strategy because the research tries to increase the Anpassungsgüte through gezielte change in the model.⁸⁴
8. **Validation:** At the end, the model has to be validated with respect to the goodness (cross validation) that is idealistically achieved through a new collected data set or a randomly selected partial sample.⁸⁵

Figure 3-6: A recommended modelling and analysis process



Source: According to (Raithel, 2009, p. 545).

Therefore, as illustrated in Figure 3-6 a complete process for a complete Structural Equation Modeling approach – comprising the model development and the

⁸⁰ (Raithel, 2009, pp. 545 & 547 – 548).

⁸¹ (Raithel, 2009, pp. 545 & 548 – 550).

⁸² (Raithel, 2009, pp. 545 & 550 – 552).

⁸³ (Raithel, 2009, pp. 545 & 552 – 558).

⁸⁴ (Raithel, 2009, pp. 545 & cf. 558 – 560).

⁸⁵ (Raithel, 2009, pp. 545 & 580).

analysis – arises so that the **overarching means** for the pragmatic scientific aim can be identified.

Containment for this chapter to the first three steps

The considerations are **contained** to the first three steps of the outlined framework because it is the overarching aim of this third chapter to develop a solution approach while the fourth chapter will deal with the analysis and the empirical validation.⁸⁶ Therefore, only the **first three steps** will be considered because they deal with the modelling, i.e. the development. As a result, the **construction**, the **operationalisation** and the **specification of the model** have to be considered for identifying the means.

1st step:
Construction

The **first step of the construction** comprises the **idea** to derive substantial hypothesis about a construct of interest based on literature reviews, interviews of experts, stimulating examples or logical reasoning because it is the **aim** to mirror these theoretically assumed relations between the latent variables in the substantial hypotheses in a structural model (Backhaus et al., 2011, p. 66). This is grounded on the **basic assumptions** that the considered constructs of interest are so-called latent variables that cannot be directly observed and that their assumed potential causal relationship with each can be represented through positive or negative relations. Hereby, the dependent latent variables are labelled as endogeneous one while the independent latent variables are called exogeneous variables and they are formally represented through small Greek letters (Backhaus et al., 2011, p. 66). Against this background, it is the **central conclusion** that the research model at the end of Chapter 2 can be constructed into a structural model as outlined in Table 11 in which the not applicable and positive and negative hypothesized relations between the variables of the research model are shown.

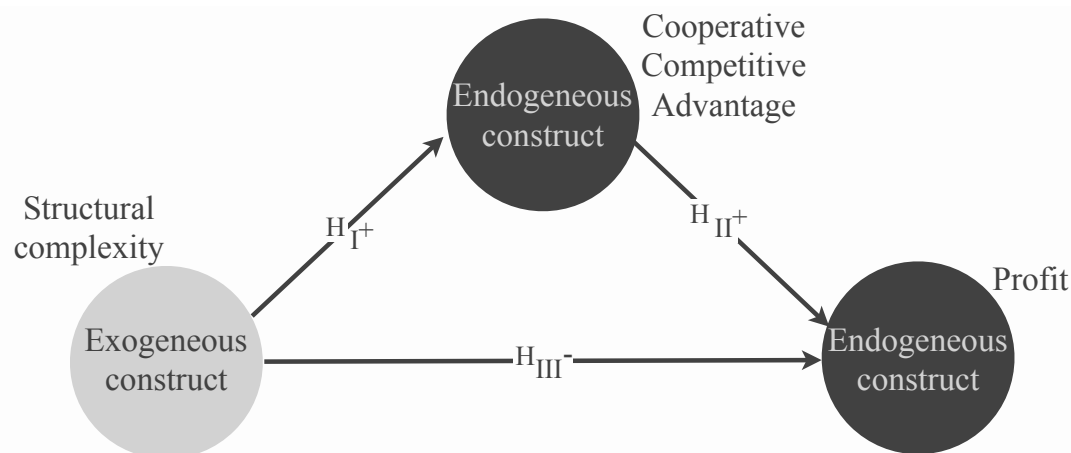
Latent variables	Complexity	Cooperative Competitive Advantage	Profit
Complexity	Not applicable	+	-
Cooperative Competitive Advantage	Not considered	Not applicable	+
Profit	Not considered	Not considered	Not applicable

Table 11: Translation of the research model into the SEM approach

⁸⁶ Steps 7 and 8 will be discussed in chapter 5.

Therewith, the **main contribution** of the **first step of the construction** consists of a path diagram because of the following reasons: A path diagram is able to mirror the assumed positive (+) or negative (-) relations between the considered variables within the construct of interest (cf. Figure 3-7) (Backhaus et al., 2011, pp. 72,77–78). Formally, such a path diagram can be clarified through two structural relations and additionally the structural model of the latent variables can be written in a matrix notation instead of two equations (Backhaus et al., 2011, p. 72). Secondly, it can be distinguished between explaining and explained constructs. As outlined in the section about the quantitative methods, explaining constructs can be assigned as so-called exogeneous variables that are not influenced in the model through other variables while the explained constructs are labelled endogeneous variables that are influenced in the model through other variables. Hence, a **main limitation** exist because it is important to mention that it has to be ensured that important variables are not neglected that are necessary for the explanation of the construct of interest/research problem. Otherwise, the model would have limited comprehensibleness. This last sentence refers to the limitations of the SEM-approach as well as to the discussion and reflection. As a **result**, with the help of the 1st step of the outlined SEM-framework, a model – containing exogeneous and endogeneous variables with assumed positive or negative relations – could be constructed by translating, transferring and integrating the research model into a path diagram.

Figure 3-7: Construction of the structural model with the help of a path diagram



As a result,

the research model can be translated into a path diagram.

Source: Cf. (Raithel, 2009, p. 546).

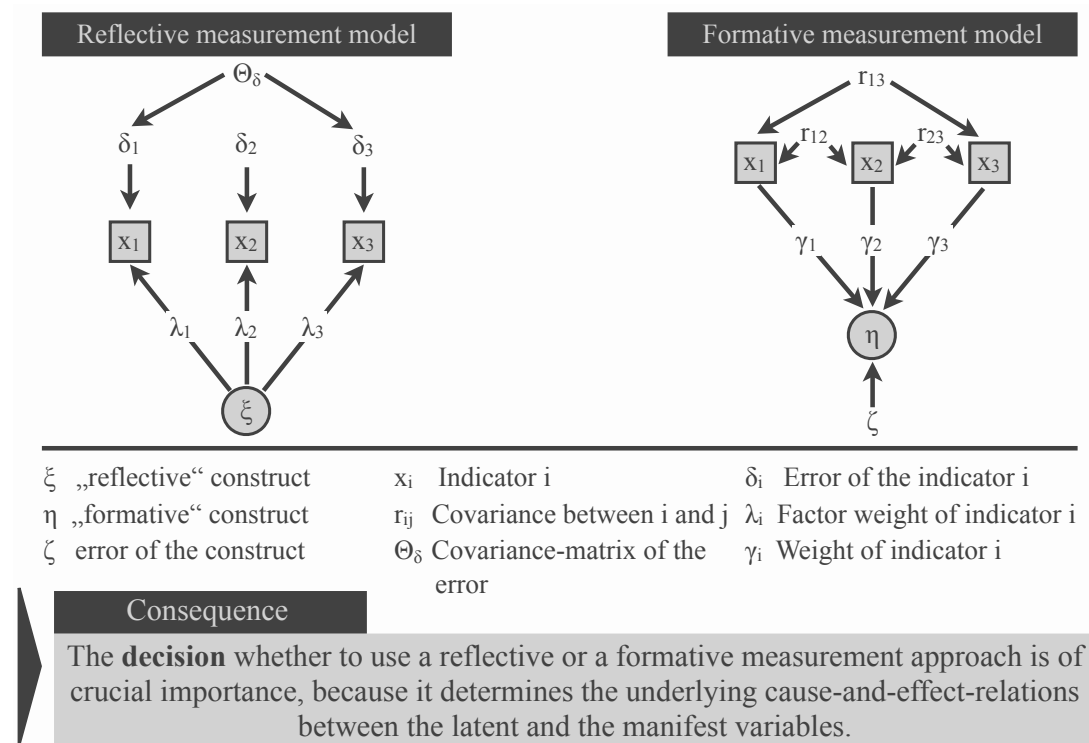
2nd step:
Operationali-
sation

At the center stage of the 2nd step stands the **operationalization** (Raithel, 2009, pp. 546–547) because the latent variables are – per definition – not directly observable so that they have to be made measurable through so-called manifest variables (T. A. E. Ebert & Raithel, 2009, p. 511 et sqq.). In general, it is the **idea** of the **operationalisation** to identify indicators that are standing in a direct causal link (=manifest variable) with the latent variable targeted towards the **aim** to detect the direction and the strength of this causal link between the indicator and the construct x (T. A. E. Ebert & Raithel, 2009, p. 513). It is grounded on the **basic assumption** that in principle two basic **types** of the **operationalisation** of a construct, i.e. the conjunction of the theoretical construct with the observable and therefore measurable variables (indicators) can be **distinguished**: the **reflective** and the **formative measurement approach** (Raithel, 2009, p. 546) (cf. Figure 3-8). Therefore, it is the **central conclusion** that the decision whether an indicator is of reflective or formative nature is of crucial importance because it determines whether a factor or a regression model will be used for the measurement so that different results can arise.⁸⁷ A **main contribution** of these two different types of operationalisation exists because depending on the way of looking at a scientific problem a more specific analysis can be achieved so that either the exploration of the causes and/or effects respectively the interest on the control and/or measurement of a construct stands at the centre stage (T. A. E. Ebert & Raithel, 2009, p. 511). A **main limitation** refers to the problem of missoperationalisation because a missoperationalisation refers to a false causal direction between an indicator and the construct (T. A. E. Ebert & Raithel, 2009, pp. 515–517; Raithel, 2009, pp. 546–547). For example, in the case that an actual formative measurement approach is conducted in a reflective way, the parameters of the structural model overestimated while in contrast an actual reflective model that is conducted in a formative way by mistake leads to an underestimation of the structural parameters (T. A. E. Ebert & Raithel, 2009, p. 526). The actual **limitation** consists of the question that is still discussed in the scientific literature, if constructs exist or can be identified/classified that are reflective or normative by nature but no unique statements between the formative and reflective approach could be concluded so far.⁸⁸ As a **result**, with the help of the 2nd step of the SEM-framework, two types of operationalisation for developing measurement models arises so that the decision whether they are of formative or reflective nature is of crucial importance.

⁸⁷ (Raithel, 2009, p. 547). A more detailed discussion about their differences and their implications for the Structural Equation Modeling approach can be found in (Albers & Hildebrandt, 2006; Eberl, 2004).

⁸⁸ Cf. the discussion in (Eberl, 2004).

Figure 3-8: Reflective vs. formative operationalisation



Source: With reference to (T. A. E. Ebert & Raithel, 2009, p. 517)

Reflective model	Formative model
Theoretical considerations	
1. Name of construct	
Construct exists independently of the selected measure	Construct is a combination of its indicators
2. Direction of the causal relation between indicator and construct	
• Causal direction from construct to indicator • Change of the construct leads to a change of the indicators • Change of an indicators does not necessarily lead to a change of the construct	• Causal direction from indicator to construct • Change of the construct does not nescessariyl lead to a change of all indicators • Change of an indicators leads to a change of the construct
3. Characteristics of the indicators	
• Indicators are manifested by the construct • Indicators belong to the same theme • Indicators are exchangeable • Adding or eliminating one of the indicators does not change the content of the construct	• Indicators define the construct • Indicators do not have to be part of the same theme • Indicators are not exchangeable • Adding or eliminating one of the indicators can change the content of the construct

Table 12: Checklist for the operationalisation with reference to (T. A. E. Ebert & Raithel, 2009, p. 527).

3rd step:
Specification

In the centre stage of the **3rd step** stands the **specification**. It is the **idea** of the **specification** to formalise the outlined relations in the path diagram by **aiming** to derive mathematical equations for each of these relations (Backhaus et al., 2011, p. 79; Raithel, 2009, p. 547). This is **based** on the **assumption** of presuming linear relations between the constructs in general so that a system of linear equations arises (Backhaus et al., 2011, p. 80; Raithel, 2009, p. 548). The setting of such a system of linear equations is also **grounded** on the **LISREL-notation** that serves nowadays as a unique system for notating the variables and equations for all different types of Structural Equation Models that are listed in Figure 3-9 (Backhaus et al., 2011, p. 76; Raithel, 2009, p. 549). Hereby, the observable variables are symbolised through a rectangle (with Latin letters x and y) while the non-observable constructs are shown through circles in the path diagram indicated through Greek letters (ξ or η). Against this background, it is the **central conclusion** that a completely specified model consists of the Structural Model and the measurement model(s) for the exogenous and the measurement model(s) for the endogeneous factor models because the structural model shows the theoretically hypothesized relations between the variables, whereby the endogeneous variables are explained through the causal relations and the exogenous variables are not further explained in the model. Secondly, the measurement model for the latent exogeneous variable contains empirical indicators that serve for the operationalisation of the exogeneous one and reflect the assumed relationships between these indicators and the exogeneous variables. Thirdly, the measurement model for the latent endogeneous variable contains empirical indicators that serve for the operationalisation of the exogeneous one and reflect the assumed relationships between these indicators and the endogeneous variables (Backhaus et al., 2011, p. 77). Because of this, a system of equations arises which can be – depending on the selected type of operationalisation – formalized through the mathematical equations with the help of the regression equations:

Formula 3-3: Structural Equation Model (3) $\eta = B\eta + \Gamma\xi + \zeta$

Formula 3-4: Endogeneous factor model (4) $y = \Lambda_y \eta + \varepsilon$

Formula 3-5: Exogeneous factor model (5) $x = \Lambda_x \xi + \delta$

The measurement model with the exogeneous factor model reflects the relations between the exogeneous, manifest variables (x) and their corresponding independent, reflectively measured latent variables (ξ). The measurement model with the endogeneous factor model mirrors the relations between the endogeneous, manifest

variables (y) and the corresponding reflectively measured dependent latent variables (η). The Structural Equation Model contains the relations between the exogenous and endogenous constructs. Hereby, B is the coefficient-matrix for the direct relations between the η -Variables, Γ is the coefficient-matrix for the direct relations between the exogenous ξ -variables and the endogenous η -variables as well as Λ_y (Λ_x) is the matrix for the factor loads of y on η (x on ξ) (Backhaus et al., 2008, pp. 79–81; Raithel, 2009, pp. 547–549)..

Figure 3-9: LISREL-notation

	Matrix	Dim	arithmetic mean	LISREL Syntax	Kovariance	Dim	LISREL Syntax	Description
Structural model	η [eta]	$(r \times 1)$	0	-	$\text{Cov}(\eta) = E(\eta\eta')$	$(r \times r)$	-	Latent endogeneous variable
	ξ [ksi]	$(s \times 1)$	0	-	$\Phi = E(\xi\xi')$ [Phi]	$(s \times s)$	PH	Latent exogeneous variable
	ζ [zeta]	$(r \times 1)$	0	-	$\Psi = E(\zeta\zeta')$ [Psi]	$(r \times r)$	PS	Error in the structural equations
	B [Beta]	$(r \times r)$	-	BE	-	-	-	Direct effects of η on η
	Γ [Gamma]	$(r \times s)$	-	GA	-	-	-	Direct effects of ξ on η
Measurement model	x [x]	$(q \times 1)$	0	-	$\Sigma_{xx} = E(xx')$ [Sigma-x]	$(q \times q)$	-	Observed exogeneous variable
	Λ_x [Lamda-x]	$(q \times s)$	-	LX	-	-	-	loads of x on ξ
	δ [delta]	$(q \times 1)$	0	-	$\Theta_\delta = E(\delta\delta')$ [Theta-delta]	$(q \times q)$	TD	errors of x -variables
	y [y]	$(p \times 1)$	0	-	$\Sigma_{yy} = E(yy')$ [Sigma-y]	$(p \times p)$	-	Observed endogeneous variable
	Λ_y [Lamda-y]	$(p \times r)$	-	LY	-	-	-	loads of y on η
	ε [epsilon]	$(p \times 1)$	0	-	$\Theta_\varepsilon = E(\varepsilon\varepsilon')$ [Theta-epsilon]	$(p \times p)$	TE	errors of y -variables

The diagram illustrates the Structural Equation Model (SEM) with three main components:

- Exogenous factor model:** $x = \Lambda_x \xi + \delta$. It shows an observed variable x (rectangle) influenced by a latent variable ξ (circle) through the loading matrix Λ_x (rectangle), and an error term δ (circle).
- Structural Equation Model:** $\eta = B \eta + \Gamma \xi + \zeta$. It shows a latent variable η (circle) influenced by another latent variable η (circle) through the coefficient matrix B (circle), a latent variable ξ (circle) through the coefficient matrix Γ (rectangle), and an error term ζ (circle).
- Endogeneous factor model:** $y = \Lambda_y \eta + \varepsilon$. It shows an observed variable y (rectangle) influenced by a latent variable η (circle) through the loading matrix Λ_y (rectangle), and an error term ε (circle).

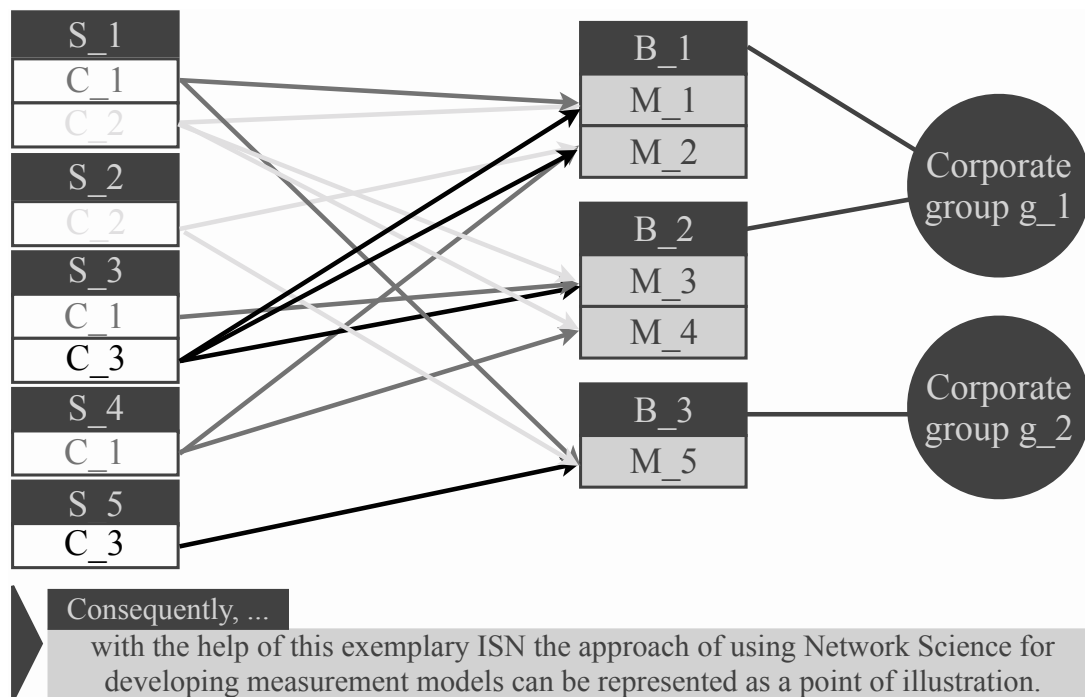
Source: According to (Raithel, 2009, pp. 548 & 549).

The **main contribution** refers to the system of equations for the manifest and latent variables because with the help of such a system of equations a statistical analysis of the underlying assumed causal relations becomes possible. This is only **limited** through the fact that with an increasing number of variables the number of equations increases faster so that it has to be identified, if the system of equations is solvable pointing to the next step that will be outlined in Section 4.2 (Raithel, 2009, p. 548). As a **result**, with the help of the 3rd step of the SEM-framework, the setting of a system of equations arises with whom it becomes possible to statistically analyse the underlying assumed causal relations once the measurement models are developed and “filled” with empirical information. Hence, the question arises about how to develop such measurement models that are in accordance with the outlined scientific positions.

Network
Science-based
measurement
models

Targeted towards the **aim** of developing measurement models for the latent exogenous and the two latent endogeneous variables, it is the **idea** to use the above-introduced framework of Network Science for representing the three measurement models because by considering the **preliminary studies** of (Colmorn et al., 2013; Colmorn & Hülsmann, 2012, 2013) it can be **basically asumed** that a network defines a set of elements, i.e. nodes, that are connected with each other, i.e. through links, and these nodes and links can represent all types of entities and relationships so that it is in accordance with the ontological scientific position. Therefore, a network with a link from *A* to *B* exists, if *A* supplies to *B* because the discipline of network science is open to study whatever relations one is interested in so that an International Supply Network can be understood as an ego network by defining nodes and links (Borgatti & Li, 2009; Newman, 2003). Therefore, it is the **central conclusion** that by transferring this concept to the automotive industry, nodes represent corporate groups, brands and models while the links represent supply relationships as a special form of cooperation. Therewith, a matrix of supply relationships arises Y_{ij} in which a supply relationship between a 1st tier supplier *j* and a brand *i* can be represented through an entry of 1 (0, if no relation exists) so that the International Supply Networks of a brand can be mathematically represented column-wise. For the sake of simplification, this will be illustrated with the help of an exemplary ISN as outlined in Figure 3-10. Hereby, the exemplary ISN between car manufacturers and first tier supplier comprise five supplier (S_1 – S_5), three brands (B_1, B_2, B_3). Hereby, the suppliers supply three different components (C_1, C_2, C_3) to five different models (M_1 – M_5) that are produced by the brands. Their assignments are represented with the help three different colors for the component supplies (C_1: red or middle grey, C_2: green or light gray, C_3: blue or dark grey).

Figure 3-10: Illustration of an exemplary ISN for the Network Science-approach



Source: Own illustration.

It is the **main contribution** of using the framework of Network Science that measurement models can be developed in the following Sections 3.2 – 3.4 because the framework allows to calculate e.g. the amount of supply relationships a model or a brand has, but with regard to the **limitations** it has to be admitted that the framework of Network Science for itself does not allow any operationalisation because it has to be connected with theoretical frameworks from the field of Strategic Management and Complexity Science. As a **result**, a framework in the form of an abstract formalisation of the ISN for the development of the measurement models has been introduced.

Consequently, with respect to the pragmatic scientific aim means could be identified towards the end of the further development of a Structural Equation Modeling approach because of the 1st, 2nd and 3rd steps of the SEM-framework and the approach of Network Science-based measurement models. Therewith, a systematic methodological approach for the solution approach has been found.

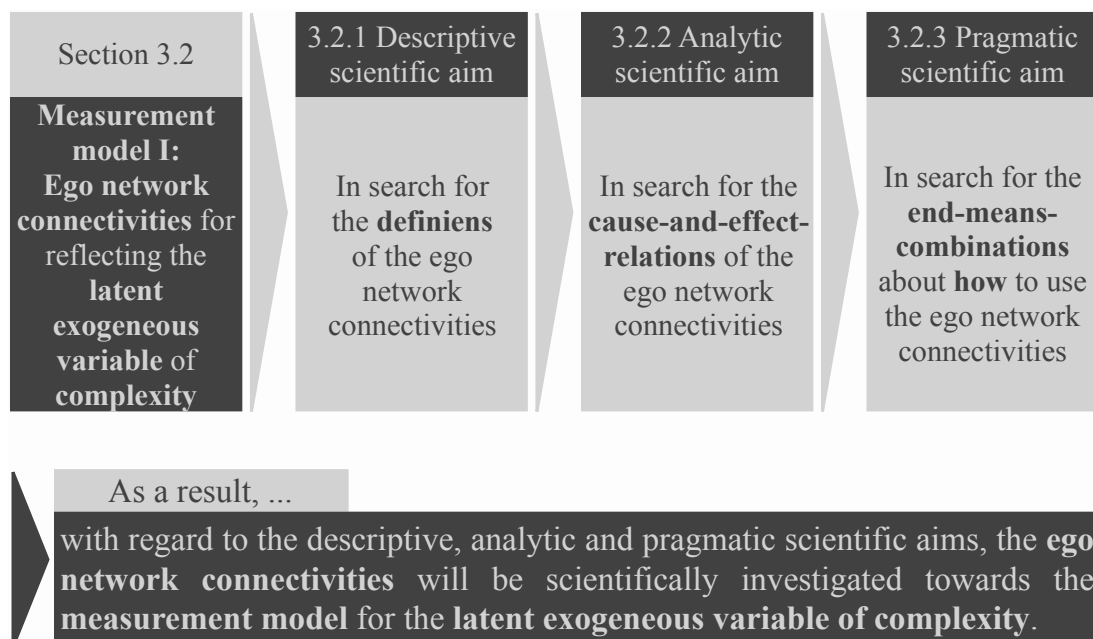
Conclusions for the pragmatic scientific aim

3.2 Measurement model I: Ego network connectivities for reflecting the latent exogeneous variable of the structural complexity

Overview over Section 3.2

It is the **aim of Section 3.2** to clarify the **ego network connectivities** for measuring the **exogeneous latent variable** of the **structural complexity** because as a result of Section 2.1 their measurement model for the Structural Equation Modeling approach is needed. Therefore, with respect to the three scientific research task the **ego network connectivities** will be firstly disambiguated (Subsection 3.2.1) before their cause-and-effect relations for their usage (Subsection 3.2.2) and their end-means combinations about how to use them (Subsection 3.2.3) will be given. As a result, they will have been scientifically investigated towards the measurement model for the latent exogeneous variable of the structural complexity (cf. Figure 3-11). In order to do so, the following considerations will focus on **previous studies** because research about how the theoretical framework of Complexity Science can be used in the context of International Supply Networks (Colmorn et al., 2013), how it can be used for the investigation of supply relationships of the German automotive industry (Colmorn & Hülsmann, 2013) and how it can be connected with the company's performance (Colmorn & Hülsmann, 2012) had been done so that published scientific results will be partly summarised or used to ground the considerations on.

Figure 3-11: Overview over Section 3.2



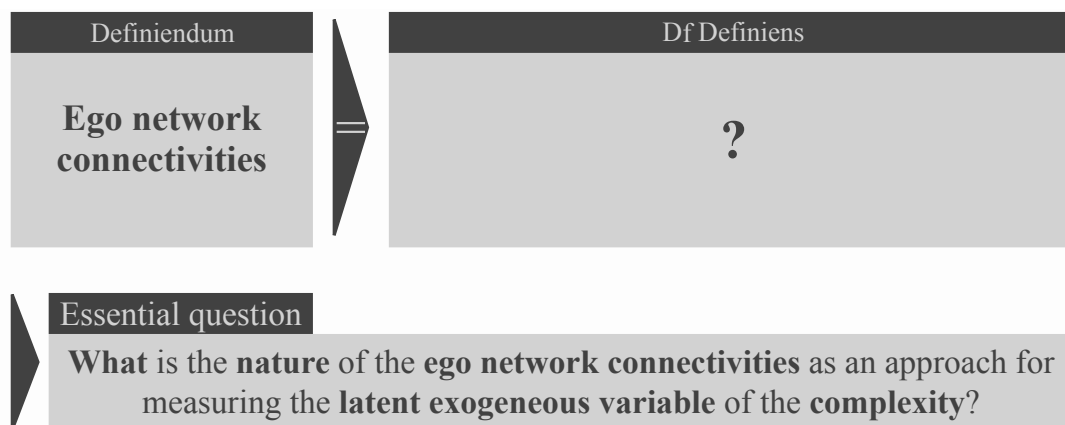
Source: Own illustration.

3.2.1 Descriptive research task: What are the ego network connectivities?

The **ego network connectivities** have to be disambiguated because they will be used for the measurement model for the latent exogeneous variable of the structural complexity. Therefore, it is the **descriptive scientific aim** of this subsection to **search for the definiens of the ego network connectivities** (cf. Figure 3-12).

Descriptive research task of Subsection 3.2.1

Figure 3-12: In search for the definiens of the ego network connectivities



In search for the definiens of the ego network connectivities

Source: Own illustration.

The **idea** of the **definiendum of the ego network connectivities** consists of representing an International Supply Network as an ego network in which the focal firm and its suppliers are represented through nodes that are connected through links with each other.⁸⁹ Therewith, the **definiendum of the ego network connectivities** can be **assigned into the field of Network Science** because of the abstract approach to formally represent different kinds of network through nodes and links whose **origin** can be traced back to the mathematical field of graph theory.⁹⁰ This **approach** is **based** on the **assumption** that the amount and/or diversity of the elements and/or connections, i.e. links, of a network indicate(s) the structural complexity in an International Supply Network because of the results of the considerations about complexity science in Section 2.2. Therewith, this **idea** is **targeted towards the aim** to measuring the amount and diversity of elements and/or connections (so-called in-going or out-going degrees) within an ego network as well as the connections with elements from other ego networks so that two different types of **ego network**

Definiendum of the ego network connectivities

⁸⁹ This approach was introduced in (Colmorn et al., 2013) based on the research of (Borgatti & Li, 2009).

⁹⁰ (Dorogovtsev, 2010, p. 1; Newman, 2003, p. 2), cf. also (R. Albert & Barabási, 2002; Amaral & Ottino, 2004; Boccaletti et al., 2006; Costa, Rodrigues, Travieso, & Villas Boas, 2007; Jiang, Gao, & Chen, 2009)

connectivities can be **distinguished**. As a **central conclusion**, the **ego network connectivities of $enc_A - enc_D$** can be **defined** in the following way:

$$\text{Formula 3-6: } enc_A^{b_i} = \frac{\sum_{j=1}^{S(b_i)} \sum_{k=1}^{C(s_j)} c_k(s_j(b_i))}{S(b_i)}$$

The **ego network connectivity of enc_A** calculates the relation of the amount of suppliers to the amount of the supply relationships pro component, i.e. the type of relationship, of the ego network of a brand b_i by determining the average value of all the supply relationships over all the suppliers of the ego network of a brand b_i .

$$\text{Formula 3-7: } enc_B^{b_i} = \frac{\sum_{l=1}^{M(b_i)} enc_B^{m_l}}{M(b_i)} \quad \text{with}$$

$$\text{Formula 3-8: } enc_B^{m_l} = \frac{\sum_{j=1}^{S(m_l)} \sum_{k=1}^{C(s_j)} c_k(s_j(m_l))}{S(b_i)}$$

The **ego network connectivity of enc_B** calculates the average relation of the amount of suppliers to the supply relationships over all models of an ego network of a brand b_i .

By introducing the measures μ for the extent if a company supplies firms with many suppliers and v for the extent if a company is supplied by firms with many customers, the following equations with a scaling component λ can provide an “inverse measure of the firm’s bargaining power (Borgatti & Li, On Social Network Analysis in a Supply Chain Context, 2009). Therewith, the **ego network connectivity of enc_C** calculates the average relation of the amount of all the supply relationships a delivering supplier to a brand has in an ego network of a brand b_i .

$$\text{Formula 3-9: } enc_C^{b_i} = \frac{\sum_{j=1}^{S(b_i)} v_i(s_j(b_i))}{\sum_{j=1}^{S(b_i)} \sum_{k=1}^{C(s_j)} c_k(s_j(b_i))}$$

The **ego network connectivity of enc_D** calculates the average relation of the amount of all the supply relationships a delivering supplier has over all the models of a brand in an ego network of a brand b_i .

$$\text{Formula 3-10: } enc_D^{b_i} = \frac{\sum_{l=1}^{M(b_i)} enc_D^{m_l}}{M(b_i)}$$

Hereby, it is as it follows:

Formula 3-11:
$$enc_D^{m_l} = \frac{\sum_{j=1}^{S(b_i)} v_i(s_j(b_i))}{\sum_{j=1}^{S(m_l)} \sum_{k=1}^{C(s_j)} c_k(s_j(m_l))}$$

Capital letter refers to the total amount, e.g. $B = 3$ different brands and $S = 5$ different supplier.

$S(b_i)$: Total amount of suppliers of the ego network of the brand b_i .

$s_j(b_i)$: All the suppliers j of the ego network of the brand b_i .

$C(s_j)$: Total amount of components of the supplier s_j .

$c_k(s_j)$: All the components k of the supplier s_j .

$c_k(s_j(b_i))$: Goes through all the components k of the supplier s_j that are supplied to ego network of the brand b_i .

M : Total amount of different models m_l .

$S(m_l)$: Total amount of suppliers of the model m_l .

$s_j(m_l)$: All the suppliers j of the model m_l .

$c_k(s_j(m_l))$: Goes through all the components k of the supplier s_j that are supplied to the model m_l .

$v_i(s_j(b_i))$: Amount of alternative supply relations to further brands b_x , from a supplier s_j supplying to the brand b_i .

Herewith, the **main contribution** can be summarised in a way that the **ego network connectivities of $enc_A - enc_D$** are ratios containing measures about the amount and diversity of elements and relationships so that indicators for the structural complexity arise. Hence, it is the **main limitation** that they are just a small extraction of potential ways to measure the structural relations.

Consequently, with regard to the descriptive scientific aim the definiens of **ego network connectivities of $enc_A - enc_D$** can be identified as being measures for the structural complexity in an International Supply Network because of indicating the amount and diversity of elements and relations.

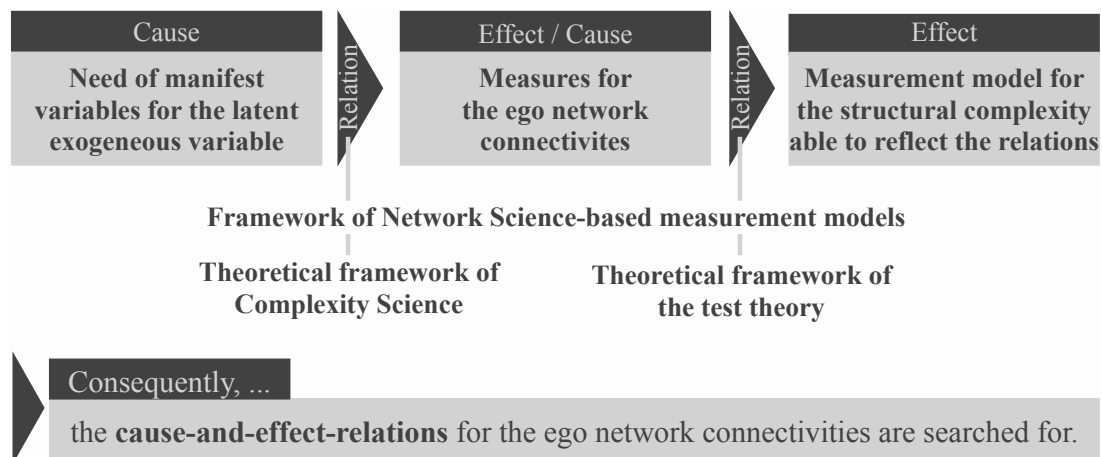
Conclusions for the descriptive scientific aim

3.2.2 Analytic research task: Why to use ego network connectivities?

Analytic research
task of
Subsection 3.2.2

The **analytic scientific aim** of this subsection deals with the **cause-and-effect relations for using the ego network connectivities** while the cause-perspective deals with the reasons for using them, the effects-perspective explains the effects towards the overarching intention for getting a measurement model (cf. Figure 3-13). Against this background, the overarching theoretical framework is multivariate statistics because of the Structural Equation Modeling approach. In the end, the cause-and-effect relations will have been considered from a content- and a statistical-based perspective because the theoretical framework of the cause-perspective is Complexity Science and of the effects-perspective is the test theory.

Figure 3-13: In search for the cause-and-effect relations of the measures $enc_A - enc_D$



Source: Own illustration.

Cause-
perspective

The **cause-perspective** deals with the need of manifest variables for the latent exogenous variable of structural complexity because an explanation about why to use the measures of the ego network connectivities is needed. For this reason, with the help of the **theoretical framework of Complexity Science** the **explanation of the ego network connectivities for measuring the structural complexities** can be given. Therefore, the **ego network connectivities of $enc_A - enc_D$** will be considered individually before the conclusions will be integrated.

Ego network
connectivity enc_A

The first **ego network connectivity of enc_A** can be **classified** as an **ego network connectivity within an ego network** and for the **absolute connectivities of an ego network**. The **ego network connectivity of enc_A** comprises the **idea** to measure the absolute connectivities of the ego network of a brand b_i targeted towards the **aim** to determine the ratio of the incoming supply relationships of the ego network of a brand b_i to the amount of the different suppliers this ego network of a brand b_i is

connected with. This is **based** on the **assumption** that the absolute amounts of the absolute relationships of the ego network of a brand b_i in relation with the absolute diversity of the different suppliers the ego network of a brand b_i is connected with mirrors the structural complexity because it contains information about the amount and diversity of supply relationships/connections that have been identified as indicators for the complexity in chapter 2. Therefore, it is the **central conclusion** that the higher the forming of the **ego network connectivity of enc_A** is, the higher is also the structural complexity of the ego network of a brand b . This can be illustrated with the help of the exemplary ISN of subsection 3.1.3 as it is shown in Table 13.

	B₁			B₂			B₃		
S₁	2			2			1		
	1	1	0	0	2	0	1	0	0
S₂	1			0			1		
	0	1	0	0	0	0	0	1	0
S₃	2			2			0		
	0	0	2	1	0	1	0	0	0
S₄	1			1			0		
	1	0	0	1	0	0	0	0	0
S₅	0			0			1		
	0	0	0	0	0	0	0	0	1
Σ_{S(B)}	6			5			3		
	2	2	2	2	2	1	1	1	1
Ξ_{S(B)}	4			3			3		
enc_A	= 6/4 = 1,5			= 5/3 = 1,667			= 3/3 = 1		

Table 13: Exemplary illustration of the ego network connectivity of enc_A .

The second **ego network connectivity of enc_B** can be **classified** as an **ego network connectivity within an ego network** and for the **average connectivities over the model connectivities of an ego network**. The **ego network connectivity of enc_B** consists of the **idea** to measure the average connectivities over the models m_j of the ego network of a brand b_i . This is targeted towards the **aim** to determine the average ratio of the incoming supply relationships for the models m_j of the ego network of a brand b_i to the amount of the different suppliers this ego network of a brand b_i is connected with. This is **based** on the **assumption** that the absolute average of the absolute relationships of the ego network of a brand b_i in relation with the absolute diversity of the different suppliers the ego network of a brand b_i is connected with mirrors the structural complexity because it contains information about the amount and diversity of connections. Therefore, it is the **central conclusion** that the higher the forming of the **ego network connectivity of enc_B** is,

Ego network
connectivity enc_B

the higher is also the structural complexity of the ego network of a brand b . This can be shown with the help of the exemplary ISN (cf. Table 14).

	M ₁			M ₂			M ₃			M ₄			M ₅		
S ₁	2			0			1			1			1		
	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0
S ₂	0			1			0			0			1		
	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
S ₃	1			1			2			0			0		
	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0
S ₄	0			1			0			1			0		
	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
S ₅	0			0			0			0			1		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Σ _{S(M)}	3			3			3			2			3		
	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
E _{S(M)}	2			3			2			2			3		
Σ _{S(M)} / E _{S(M)}	3/2			3/3			3/2			2/2			3/3		
	B ₁						B ₂						B ₃		
enc _B	= (3/2 + 3/3)/2 = 5/4						= (3/2 + 2/2)/2 = 5/4						= (3/3)/1 = 1		

Table 14: Exemplary illustration of the ego network connectivity of enc_B .

Ego network
connectivity enc_C

The **ego network connectivity of enc_C** is **classified** as an **ego network connectivity with other ego networks** and for the **absolute connectivities of an ego network**. The **ego network connectivity of enc_C** comprises the **idea** to measure the absolute connectivities of the ego network of a brand b_i targeted towards the **aim** to determine the ratio of the incoming supply relationships of the ego network of a brand b_i to the amount of alternative supply relationships a supplying supplier has because of the **basic assumption** that their absolute amounts and diversity mirrors the structural complexity. Therefore, it is the **central conclusion** that the higher the forming of the **ego network connectivity of enc_A** is, the higher is also the structural complexity of the ego network of a brand b_i (cf. Table 15).

	B_1			B_2			B_3			$v_1(S_i)$			$v_2(S_i)$			$v_3(S_i)$		
S_1	2			2			1			3			1			1		
	1	1	0	0	2	0	1	0	0	1	2	0	0	1	0	1	0	0
S_2	1			0			1			1			0			1		
	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
S_3	2			2			0			1			2			0		
	0	0	2	1	0	1	0	0	0	0	0	1	0	0	2	0	0	0
S_4	1			1			0			1			1			0		
	1	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0
S_5	0			0			1			0			0			0		
	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
$\sum_{S(B)}$	6			5			3			6			4			2		
	2	2	2	2	2	1	1	1	1	2	3	1	1	1	2	1	1	0

$$enc_C = 6/6 = 1 \quad = 4/5 = 0,8 \quad = 2/3 = 0,66$$

Table 15: Exemplary illustration of the ego network connectivity of enc_C .

The fourth **ego network connectivity of enc_D** is **classified** as an **ego network connectivity with other ego networks** and for the **average connectivities over the model connectivities of an ego network**. Therefore, the **idea** of the **ego network connectivity of enc_D** is to take the alternative relationships of a supplying supplier – in average over the models of a brand – into account. Therewith, it is the **aim** to determine the amount of relationships of a supplier that is not only supplying the component to the ego network of a models m_i but also to the ego networks to the models m_j and to build the average value over all the ratios of the models of a brand b_i . This is grounded on the **basic assumption** concerning the structural complexity, too. Therefore, it is the **central conclusion** that the higher the forming of the **ego network connectivity of enc_D** is, the higher is also the structural complexity of the ego network of a brand b_i as illustrated in Table 16.

Ego network
connectivity enc_D

	M ₁			M ₂			M ₃			M ₄			M ₅			Σ _(Mi)		
S ₁	2			0			1			1			1			5		
	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0	2	3	0
S ₂	0			1			0			0			1			2		
	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	2	0
S ₃	1			1			2			0			0			4		
	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	1	0	3
S ₄	0			1			0			1			0			2		
	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0
S ₅	0			0			0			0			1			1		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Σ _{S(M)}	3			3			3			2			3			14		
	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	5	5	4
	v ₁ (S _i)			v ₂ (S _i)			v ₃ (S _i)			v ₄ (S _i)			v ₅ (S _i)					
S ₁	3			0			2			2			1					
	1	2	0	0	0	0	0	2	0	0	2	0	1	0	0			
S ₂	0			1			0			0			1					
	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0			
S ₃	2			2			2			0			0					
	0	0	2	0	0	2	0	0	2	0	0	0	0	0	0			
S ₄	0			1			0			1			0					
	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0			
S ₅	0			0			0			0			0					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Σ _{S(v₁)}	5			4			4			3			2					
	1	2	2	0	1	2	0	2	2	0	2	0	1	1	0			
Σ _{S(v₁)} / Σ _{S(M)}	5/3			4/3			4/3			3/2			2/3					
	B ₁						B ₂						B ₃					

enc_D	$= (5/3 + 4/3)/2 = 3/2$	$= (4/3 + 3/2)/2 = 17/12$	$= (2/3)/1 = 2/3$
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Table 16: Exemplary illustration of the ego network connectivity of enc_D .

Against the background of these examinations, the **ego network connectivities of $enc_A - enc_D$** are grounded on the **basic assumption of Complexity Science** as outlined in Section 2.2 so that the amount and diversity of links/connections indicate the structural complexity of a system. Therefore, with the help of **Complexity Science the central conclusion** can be drawn that the higher the formings of the **ego network connectivities of $enc_A - enc_D$** are the higher is also the structural complexity of the considered ISN. Therewith, it is the **main contribution** of the **ego network connectivity of $enc_A - enc_D$** of presenting measures that are able to mirror the structural complexity of an ISN by determining relations between the amount and/or diversity of incoming supply relationships while a **main limitation** exists with regard to the relational character because the ratios get their power of explanation only in comparison with the values of other ISN so that a normative determination in the sense of e.g. “if enc_A is larger than 0.5, than...” is not possible.

Conclusions for
the cause-
perspective

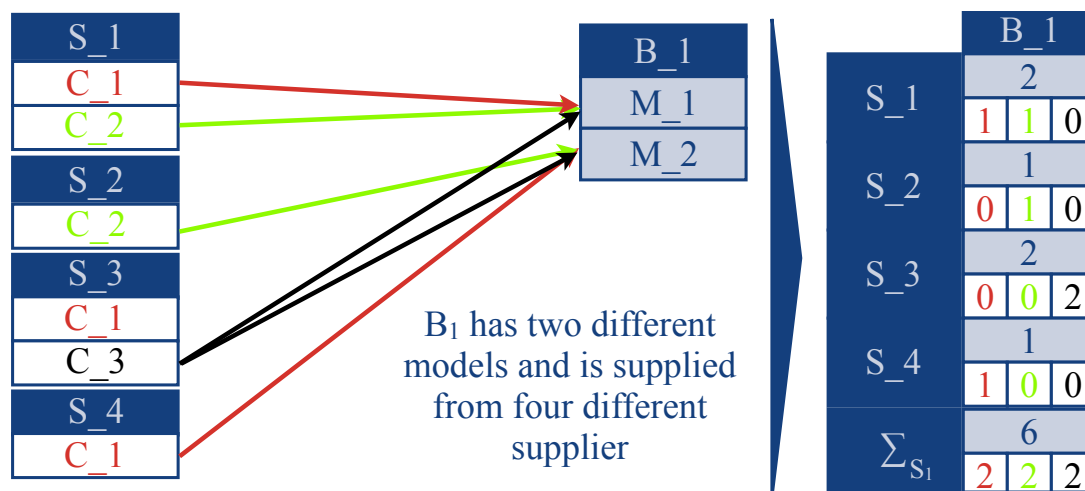
Consequently, with regard to cause-perspective of the analytic scientific aim it could be shown that the **ego network connectivities of $enc_A - enc_D$** are able to represent the structural complexity because the shown ratios in the equations could be traced back to indicating the amount and or diversity of the elements and relationships so that they could be grounded on the outcomes of Complexity Science in Section 2.2. But what are the effects?

Effects-
perspective

The **effects-perspective** has the causal relation between the measures of the ego network connectivities and the measurement model for the latent exogeneous variable as the subject of consideration. This is because despite of the fact that it has been examined if these measures are able to mirror the structural complexities, now it is needed to analyse whether they lead to a measurement model. As a consequence, the ego network connectivities are analysed from a **test theoretical perspective**. Against this background of the **classical test theory**, it is the **idea** of the **effects-perspective** to determine if the ego network connectivities are of reflective or formative nature because this influences the outcomes of the measurement essentially as has been outlined in Subsection 3.1.3. **Based** on the **assumptions** of the classical test theory it is the **aim** to use the checklist for the operationalisation as shown in Table 12. As a result, it is the **central conclusion** that the ego network connectivities are of **reflective nature** because of the following reasons: Firstly, the

indicators of the ego network connectivities **are manifested by the construct** because they have been developed as ratios for the amount and diversity of the structural relations for the structural complexity so that the first outlined characteristic is fulfilled. Secondly, the **indicators belong to the same theme** because they are all developed for mapping the structural complexity so that the second characteristic is fulfilled. Thirdly, the **indicators are exchangeable** because the structural complexity could still be measured by using another ratio from the field of Complex Network Science that were used e.g. in (Colmorn et al., 2013; Colmorn & Hülsmann, 2012, 2013) so that the third characteristic is fulfilled. Fourthly, **adding or eliminating one of those indicators does not change the content of the construct** because e.g. the selection of the first two ego network connectivities would still focus on the structural complexities within an ISN so that the fourth characteristic is fulfilled. Finally, with reference to (Backhaus et al., 2011, p. 109) the main characteristic of reflective indicators consists of the fact that a change of the latent variable would result in a change of all indicator variables because the latent variable stands as a cause behind the manifest ones. Therefore, if the latent variable would be shifted from the structural to the dynamic complexity, then the indicators would have to be replaced, too. This **contribution** of pointing to a reflective measurement is **limited** through the fact that their connection with the structural complexity is based upon the definitions of complexity in section 2.2.1 so that depending on the definition one is willing to take the ego network connectivities could just be understood as connectivities lacking a theoretical foundation.

Figure 3-14: Exemplary determination of enc_A for B_1



Source: Own illustration.

Conclusions for
the effects-
perspective

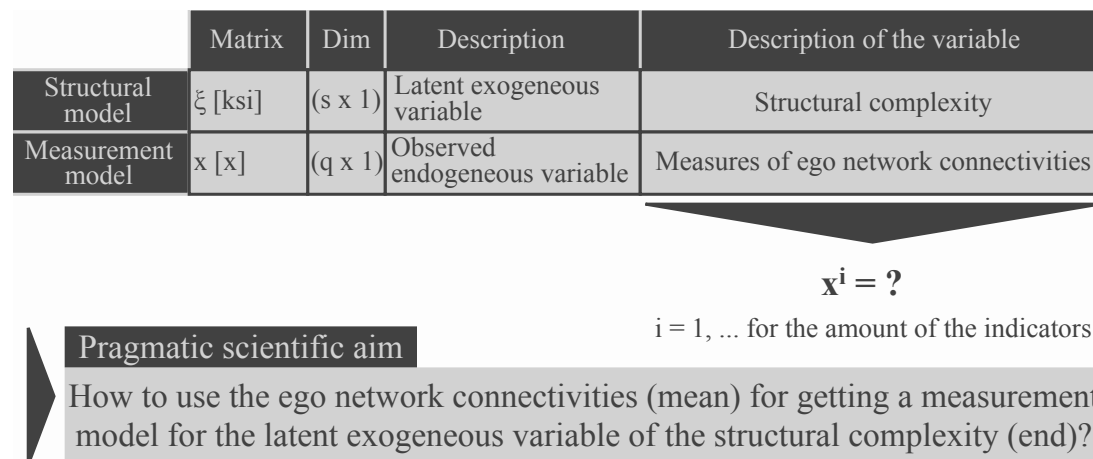
Consequently, with regard to effects-perspective it has been argued that the **ego network connectivities of $enc_A - enc_D$** do reflect the structural complexity because it has been argued that the latent variable has to be considered as a causing factor standing behind the indicating measurable variables so that they are the result and therefore of reflective nature.

3.2.3 Pragmatic research task: How to use the ego network connectivities?

What is the aim of this subsection? The aim of this subsection is the pragmatic scientific aim. The **pragmatic scientific aim** deals in general with the end-means combinations. The end-means combinations have to refer in this subsection to the question about how to use the outlined measures of the ego network connectivities. This question about the usage of the ego network connectivities must be connected with the Structural Equation Modelling approach. The Structural Equation Modeling approach was outlined in the first section of this chapter as the solution approach. Hereby, in Section 3.1.3 it was outlined about how to use it. Therefore, the usage of the ego network connectivities has to be combined with the usage of the SEM approach so that they are translated with the outlined framework of this statistical method. Consequently, it is the **pragmatic scientific aim** of this subsection to outline how to use the ego network connectivities as a measurement model for the latent exogeneous variable (cf. Figure 3-15).

Pragmatic
research task of
Subsection 3.2.3

Figure 3-15: Pragmatic scientific aim of Subsection 3.2.3

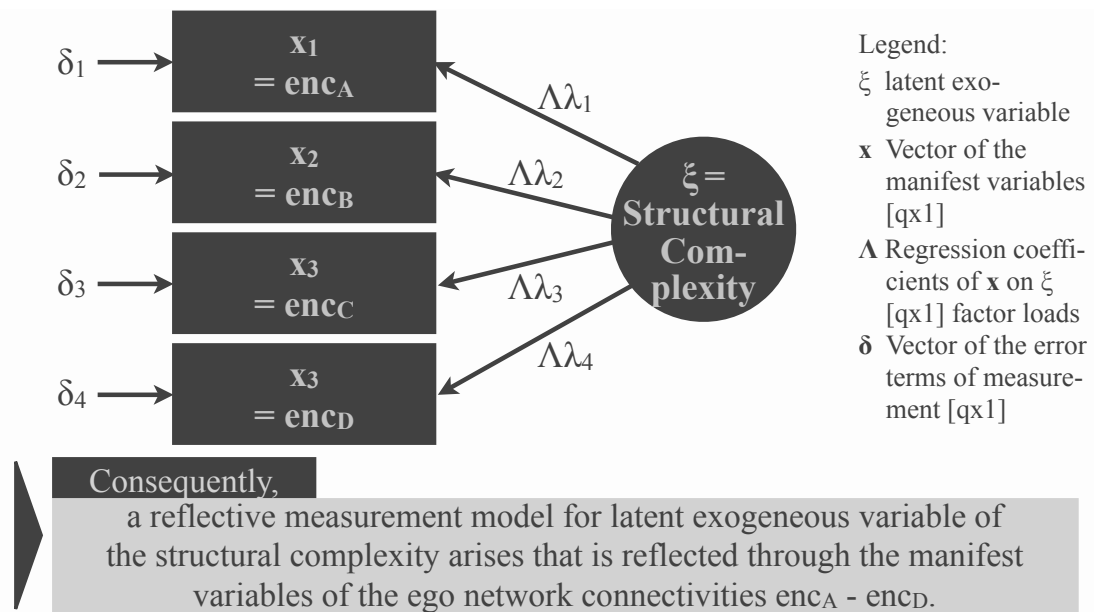


Source: Own illustration.

This **mean** for getting a measurement model for the latent exogeneous variable is **assigned to the SEM-approach** because it has been introduced as the solution approach. Hereby, the LISREL-notation was identified as the general mean for using the SEM-approach. Within the LISREL-notation **different variables** were introduced for labelling the constructs of the structural and measurement models. Therewith, with reference to Figure 3-9 this **mean** for getting a measurement model for the latent exogeneous variable can be identified as ξ for the latent exogeneous variable and x for the observable endogeneous variables. Therefore, it is the **idea** to assign each of the outlined measures of Complex Network Science to the LISREL-

notation $\mathbf{x}$ with the **aim** to have a corresponding measurement model for the latent exogeneous variable of complexity. This assignment is grounded on the **basic assumption** that the variables **reflect** the complexity so that the **central conclusion** as a measurement model is illustrated in Figure 3-16 while the **main contributions** refer to the formal LISREL-notation for getting a measurement model, the **main limitations** are the result of the fact that further research is needed about justifying the reflective formalisation of the ego network connectivities for the structural complexity.

Figure 3-16: Reflective measurement model for the structural complexity



Source: Own illustration.

Conclusions for the pragmatic scientific aim

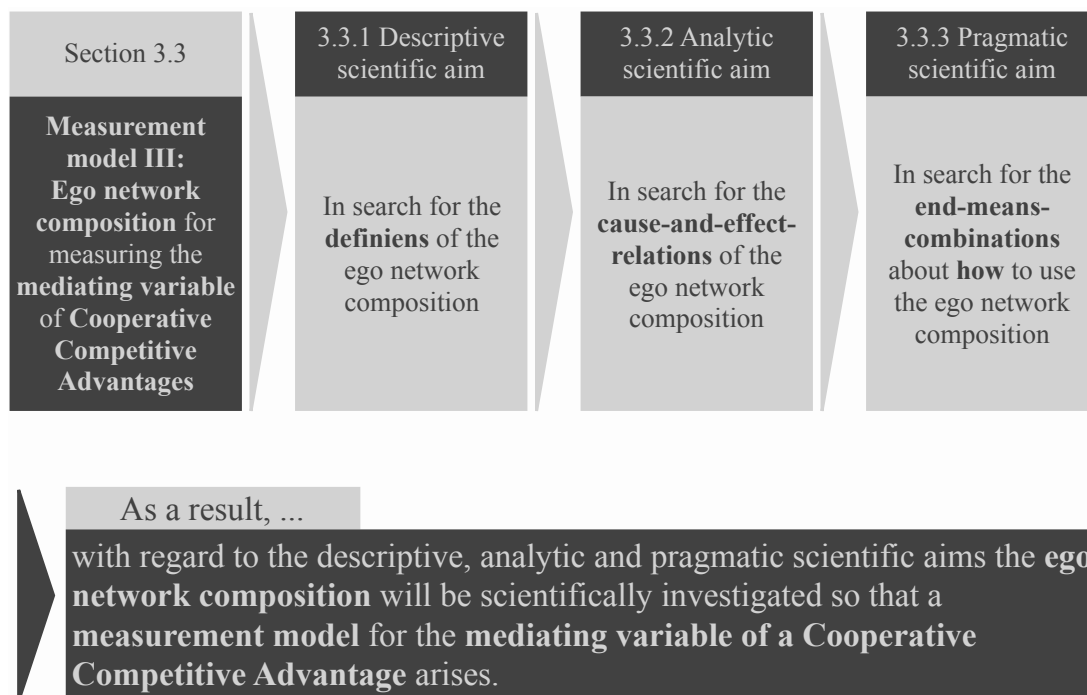
Consequently, as a mean for getting a measurement model the **ego network connectivities of $enc_A - enc_D$** could be assigned to the LISREL-notation in a reflective way.

3.3 Measurement model II: The ego network composition for reflecting the mediating variable

It is the **aim of Section 3.3** to clarify the **measurement model for the latent mediating variable of the competitiveness on the network level** because it has been outlined in section 2.3 that Cooperative Competitive Advantages can be traced back to the cooperative interplay towards the function to contribute to the competitiveness on the network level. Therefore, with respect to the three scientific research task they will be firstly disambiguated (Subsection 3.3.1) before the cause-and-effect relations for their existence (Subsection 3.3.2) and the end-means combinations about how to use them (Subsection 3.3.3) in the context of transferring them to Cooperative Competitive Advantage of an International Supply Network will be searched for (cf. Figure 3-17).

Overview over
Section 3.3

Figure 3-17: Overview over Section 3.3



Source: Own illustration.

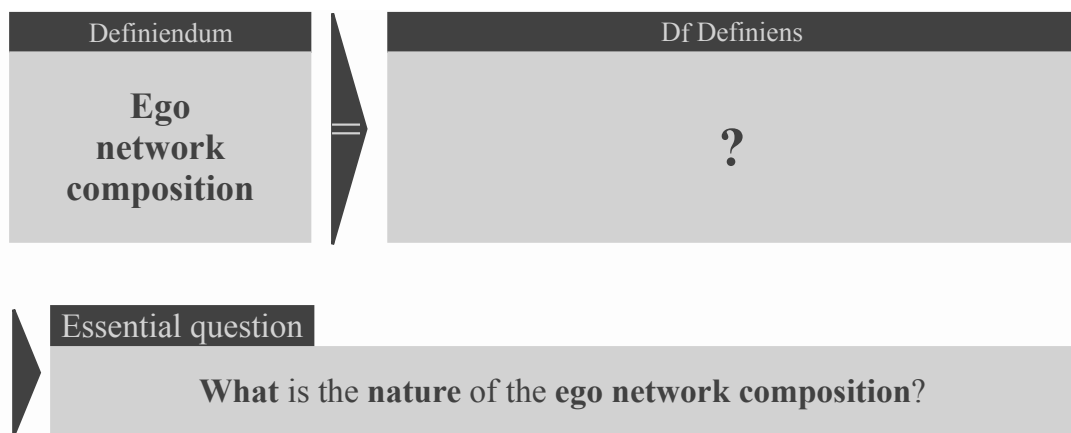
3.3.1 Descriptive research task: What is the ego network composition?

Descriptive
research task of
Subsection 3.3.1

The **descriptive scientific aim** of this subsection is targeted towards the disambiguation of the ego network composition because as will be outlined in the next subsection it is possible to logically connect the **ego network composition** with the framework of the target areas of logistics so that they can be used for measuring Cooperative Competitive Advantages of International Supply Networks. For this reason, the corresponding **definiens is searched for** (cf. Figure 3-18).

In search for the
definiens of the
ego network
composition

Figure 3-18: In search for the definiens of the ego network composition



Source: Own illustration.

Definiendum of
an ego network
composition

The **origin** of the **definiendum of an ego network composition** goes back to the work *On Social Network Analysis in a Supply Chain context* of (Borgatti & Li, 2009). By considering this reference to the social network analysis (cf. the explanation in Chapter 2) the **ego network composition** has to be **assigned** more to **Network Science** in general as to Complex Network Science in particular because it is not connected with statistical properties as it is in Complex Network Science. In addition to that, the ego network composition is also explicitly labelled by (Borgatti & Li, 2009, p. 13) as a quality of the ego network. Therefore, the **definiendum of the ego network composition** can be **classified** as a measure from the abstract mathematical representation of Network Science for the target area of quality in the field of logistics. The **ego network composition** expresses the **idea** to introduce an “attribute” to the companies a focal firm is connected with in its ISN because the “strength of the focal firm can be derived from the strength of its trading partners” so that each partner is attributed through a value *a* e.g. the expenses for Research and Development or the number of employees (Borgatti & Li, 2009, p. 13). Therewith, it is the **aim** to understand the strategic networks of the automotive industry as ego networks of the car manufacturers as the focal firms. The reason for this can be seen

in the depiction that an ego network comprises a focal actor, known as the ego, and the “set of actors with any kind of tie to ego”, known as alters, and “all ties among alters and between the alters and the ego” so that qualities q of the ego’s alters become a “useful ego-network property” (Borgatti & Li, 2009, pp. 13–14, 20). Against this background, it is the **basic assumption** that such a composition can be mathematically represented as a matrix X in which $X_{ij} = 1$ indicates that the firm i has a cooperative relation with firm j while $X_{ij} = 0$ indicates that no cooperative relation exists at all. In this conjunction, “the row sums of this matrix give the number of outgoing ties for each node”, i.e. the out-degree centrality (cf. below) that could indicate the number of different customers for each firm while the column sums represents the number of incoming ties, i.e. the in-degree centrality that could indicate the number of different suppliers. As a **resulting conclusion**, the **ego network composition** is **defined** according to (Borgatti & Li, 2009) as the average of the “attribute values for a given ego’s alters” (Borgatti & Li, 2009, p. 13):

Formula 3-12:
$$q_i = \sum_j x_{ji} \cdot a_j$$

Hereby, the attribute a can refer to $a_i^1 = \text{Number of employees}$ and $a_i^2 = \text{Number of supplying components}$ so that the **main contribution** can be summarised in a way that the concept of an ego network is “probably the closest to a supply chain theorist’s intuitive understanding of an international supply network” (Borgatti & Li, 2009, p. 13) and that with the help of equation Formula 3-12 the attributes, e.g. for the existence of CCA, can be quantitatively calculated for an ISN of a car manufacturer. With respect to the **main limitation** one should bear in mind that ego network measures are only useful, when the full network – e.g. the ego networks of all the German car manufacturers – is assembled because only the comparison of these measures allows to derive conclusions so that they do not have value through themselves.

Consequently, the **ego network composition** q is classified as an abstract measure from Network Science for the logistic target area of quality that is expressed through the mathematical equation Formula 3-12 in which the attributes a will refer to the number of employees and the number of supplying components as indicators for different characteristics of the cooperating suppliers.

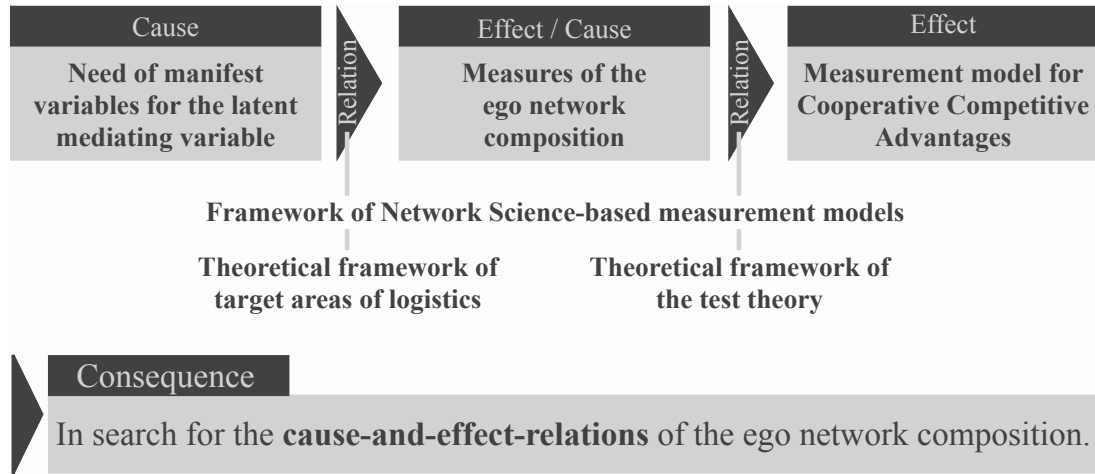
Consequences
for the definiens

3.3.2 Analytic research task: Why to use the ego network composition?

Analytic research
task of
Subsection 3.3.2

The **analytic scientific aim** of this subsection deals with the **cause-and-effect relations for using the ego network composition q** while the cause-perspective deals with the reasons for using them, the effects-perspective explains the effects towards the overarching intention for getting a measurement model (cf. Figure 3-19). By considering the overarching theoretical framework of multivariate statistics and the methodological approach to use Network Science-based measurement models, the cause-and-effect relations will have been considered from a content- (target areas of logistics) and a statistical-based perspective (test theory) so that the measurement model for Cooperative Competitive Advantages will be scientifically analysed.

Figure 3-19: Illustration of the cause-effect-relations of the ego network composition



Source: Own illustration.

Cause-
perspective

The **cause-perspective** addresses the question, if the above-defined **ego network compositions of the qualities $q^{1,2,3}$** are the result of the need of manifest variables for the latent mediating variable because an operationalisation of Cooperative Competitive Advantages was the result of Subsection 3.1.3 for the development of a Structural Equation Modeling approach. Therewith, the **cause-perspective** can be **assigned to the theoretical framework of the target areas of logistics** because it was used in Subsection 2.3.2 to analyse the existence of Cooperative Competitive Advantages. The **idea** of the **ego network composition of the qualities $q^{1,2,3}$** is to introduce a so-called quality vector q_i for a car manufacturer i in which the attributes a of all the suppliers in the ego network of the car manufacturer i are summarised. Therefore, it is the **aim** to interpretate the attributes connected with all the cooperating partners of the ego network composition as an expression of the quality

from the target areas of logistics of the whole ego network of the car manufacturer i . This approach is **based** on the **attributes** $a^{1,2,3}$.

The **attributes** $a^{1,2,3}$ have to be **assigned** to a resource-based view (RBV) because a resource-orientation was selected in section 2.3 for explaining the emergence of Cooperative Competitive Advantages. Therewith, it is the **idea** to connect the **attributes** $a^{1,2,3}$ with a resource that has been identified within the theoretical framework of resource-based approaches, whereby this approach is **based** on the **underlying assumption** of the Resource-based View. Because of this it is the **aim** that these resource-based factors are measurable so that an operationalisation for the quality q of the ego network composition arises. These measurable indicators shall be e.g. the number of employees, the revenue and the amount of supplying components.

Attributes $a^{1,2,3}$

- The **number of employees** can be connected with the RBV because these so-called human resources represent the human capital of a company comprising the Know How, capabilities, experiences etc. so that it shall assumed for the sake of simplification that the higher the number of employees the higher the human capital (cf. e.g. (Bea & Haas, 2005, p. 29)).
- The **revenue** could be connected with the RBV because it can effect the so-called tangible resources that are listed in a balance sheet so that it can be assumed that the higher the revenue the higher e.g. investments in production technologies (cf. e.g. (Bea & Haas, 2005, p. 29)).
- The **number of different supplying components** can be connected with the RBV because they could be understood as so-called intangible resources that are immaterial assets such as technological Know How that are hard to quantify so that it could be assumed that the higher the number of different supplying components the higher technological Know How (cf. e.g. . (Bea & Haas, 2005, p. 29)).

Therefore, it is the **central conclusion** that these attributes are indicators for a source for a – Cooperative – Competitive Advantage because this can be explained with the help of the RBV so that the **main contribution** consists of the theoretical foundation for operationalisation. Hence, it is the **main limitation** that these attributes constitute only a small fraction of potential indicators and that the scientific literature is not consistent about the main indicators for the RBV.

Against this background and with regard to the **ego network composition of the qualities** $q^{1,2,3}$ it is the **central conclusion** that the higher the quality $q^{1,2,3}$ – that is the result of the sum of all the **attributes** $a^{1,2,3}$ over all the supply relationships – the higher is also the forming of the Cooperative Competitive Advantage. This shall be

explained with the help of the **exemplary ISN**. In Table 17 different formings based on random choice are listed for the **attributes** $a^{1,2,3}$. Therewith, the **ego network composition of the qualities** $q^{1,2,3}$ can be calculated by following

Formula 3-12. The results are illustrated in Table 18.

	a_1 [Number of employees]	a_2 [Revenue in Mio. €]	a_3 [Amount of components]
S_1	50	5	2
S_2	40	4	1
S_3	30	3	2
S_4	20	2	1
S_5	10	1	1

Table 17: Attributes by random choice for the exemplary ISN.

The **main contributions** refers to the logistics target area of quality because of the idea of composing the quality of an ego network with the help of attributes that are assumingly based with indicators from the Resource-based View. Therefore, by summing up all the attributes in and ego network of a brand b_i a relational quantitative measure for the latent variable of Cooperative Competitive Advantages arises. Hereby, the **main limitation** with regard to the theoretical foundation has to be assumed because e.g. a connection with the Relational View is missing and theoretical approaches about the ego network composition cannot be found. Therewith, this approach is more a result of the methodology of Systems Theory than the result of a social scientific procedure.

	B_1			B_2			B_3		
	q_1	q_2	q_3	q_1	q_2	q_3	q_1	q_2	q_3
S_1	2*50	2*5	2*2	2*50	2*5	2*2	1*50	1*5	1*2
S_2	1*40	1*4	1*1	0*40	0*4	0*1	1*40	1*4	1*1
S_3	2*30	2*3	2*2	2*30	2*3	2*2	0*30	0*3	0*2
S_4	1*20	1*2	1*1	1*20	1*2	1*1	0*20	0*2	0*1
S_5	0*10	0*1	0*1	0*10	0*1	0*1	0*10	0*1	0*1
$q_j (B_i)$	220	22	10	180	18	9	90	9	3

Table 18: Exemplary illustration of the ego network connectivity of enc_A .

Conclusions for
the cause-
perspective

Consequently, the ego network compositions can be understood as the result of the need for the operationalisation of Cooperative Competitive Advantages because it seems to allow a theoretical substantiation with the help of the Resource-based View. Therefore, by following the approach of Systems Theory a measurement model could be developed.

Thereby the considerations of the **effects-perspective** have to be **assigned to the theoretical framework of the test theory**. For this reason, it is the **aim** of the **effects-perspective** to figure out whether the measures are of reflective or formative nature from a **test theoretical perspective**. With reference to the effects-perspective in Subsection 3.2.2, the **basic assumptions** with regard to the **classical test theory** remain so that due to the checklist for an operationalisation the **central conclusion** can be drawn. Firstly, the indicators for the ego network composition are manifested by the construct because they have been developed as ratios towards the quality of an ego network. Secondly, the indicators belong to the same theme because they are all based on the RBV for mapping a Cooperative Competitive Advantage. Thirdly, the indicators are exchangeable because e.g. a ratio based on customer survey is also thinkable. Fourthly, adding or eliminating one of those indicators does not change the content of the construct because e.g. the empirical validation will neglect the aspect of the revenue for avoiding a conflict with financial ratios for the company success. Finally, a change of the latent variable would also lead to a change of the indicators because in this case only the target area of quality is selected so that the target area of e.g. time would require different indicators. Therefore, due to the fact that all the characteristics of reflective manifestation are fulfilled it can be **concluded** that this measurement model is of reflective nature so that a **contribution** towards the development of the solution approach is achieved. Of course, this is again strongly **limited** by the facts that other indicators for the operationalisation and other factors for reflecting a CCA are neglected. Moreover, the methodological approach of Systems Theory to derive a measurement model that is only weakly substantiated without doing an extensive literature review for finding the “best” indicators further **limits** the approach.

Effects-
perspective

Consequently, with regard to effects-perspective it has been argued that the **ego network composition of $q_{1,2,3}$** does reflect a Cooperative Competitive Advantage because it has been argued that despite of their methodological limitations the latent variable has to be considered as causing factor standing behind the measurable indicators.

Conclusions for
the effects-
perspective

Altogether, a measurement model for the competitiveness on the network level has been developed. In this regard, the content has to be distinguished from the methodological approach because ratios have been derived from Network Science and they were interpreted with the help of the framework of the logistics target areas, but they could have been interpreted with the help of other frameworks as well. Therefore, it has to be highlighted that the measurement model consists of two

approaches: The methodological approach is based on Network Science while its interpretation with regard to the content for the area of application is based on the target area of logistics. These two approaches should not be mistaken with each other e.g. in the critical discussion of the contributions and limitations.

3.3.3 Pragmatic research task: How to use the ego network composition?

It is the **pragmatic scientific aim** of this subsection to outline how to use the **ego network composition q** in the sense of a **means** towards the **end of a measurement model of the mediating variable** (cf. Figure 3-20).

Pragmatic research task of Subsection 3.3.3

Figure 3-20: In search for the end-means combinations of the ego network composition

	Matrix	Dim	Description	Covariance
Structural model	η_1 [eta]	$(r \times 1)$	Latent endogeneous variable	Cooperative Competitive Advantages
Measurement model	y_1 [y]	$(p \times 1)$	Observed endogeneous variable	Ego network composition q

$$y_1^i = ?$$

$i = 1, 2, 3$ for the amount of the indicators

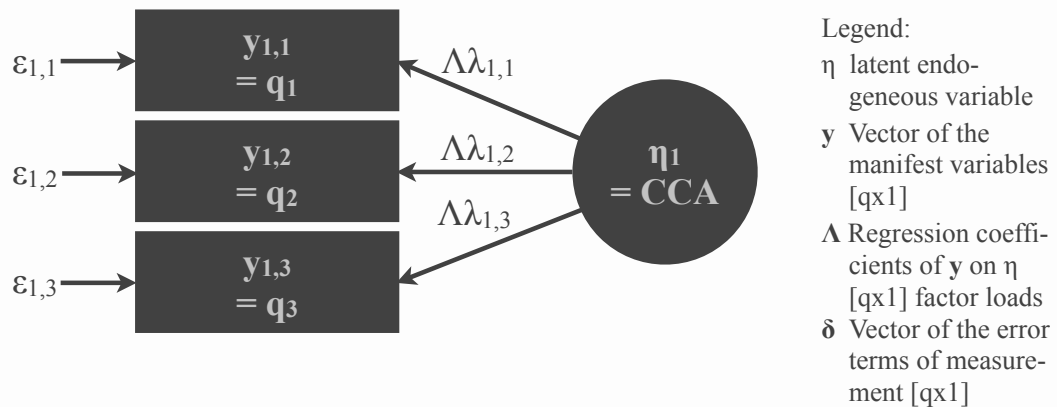
Pragmatic scientific aim

How to use the **quality q** of the target areas of logistics as a **mean** for getting a **measurement model (end)** for the latent endogeneous mediating variable?

Source: Own illustration.

This **mean** for getting a measurement model for the latent exogeneous variable is **assigned to the SEM-approach** because it has been introduced as the solution approach. Hereby, the LISREL-notation was identified as the general mean for using the SEM-approach. Within the LISREL-notation **different variables** were introduced for labelling the constructs of the structural and measurement models. Therewith, with reference to Figure 3-9 this **mean** for getting a measurement model for the latent endogeneous mediating variable can be identified as ξ for the latent exogeneous variable and x for the observable endogeneous variables. Therewith, it becomes clear that the observable indicators for measuring CCA have to be transferred to the LISREL-notation as illustrated in Figure 3-20. Because of this it is the **idea** to assign each of the outlined measures of the ego network composition q to the LISREL-notation with the **aim** to have a corresponding measurement model for the latent endogeneous mediating variable of CCA. This assignment is grounded on the **basic assumption** that the variables **reflect** the CCA so that the **central conclusion** as a measurement model is illustrated in Figure 3-16.

Figure 3-21: Reflective measurement model as an end-mean-combination



Consequently,
a reflective **measurement model for latent endogeneous mediating variable** of Cooperative Competitive Advantage arises, because it is reflected through the manifest variables of $q_{1,2,3}$.

Source: Own illustration.

With regard to the pragmatic scientific aim the **main contribution** can be summarised in a way that a measurement model for the latent endogeneous-mediating variable arises. The reason for this is that the ego network compositions $q^{1,2,3}$ can be transferred to the LISREL-notation so that the means towards the end are identified. The **main limitation** consists of a limited power of explanation because this end-means-combination does not have a valid meaning for itself so that they are based on the analytic consideration of the previous subsection.

Conclusions for
the pragmatic
scientific aim

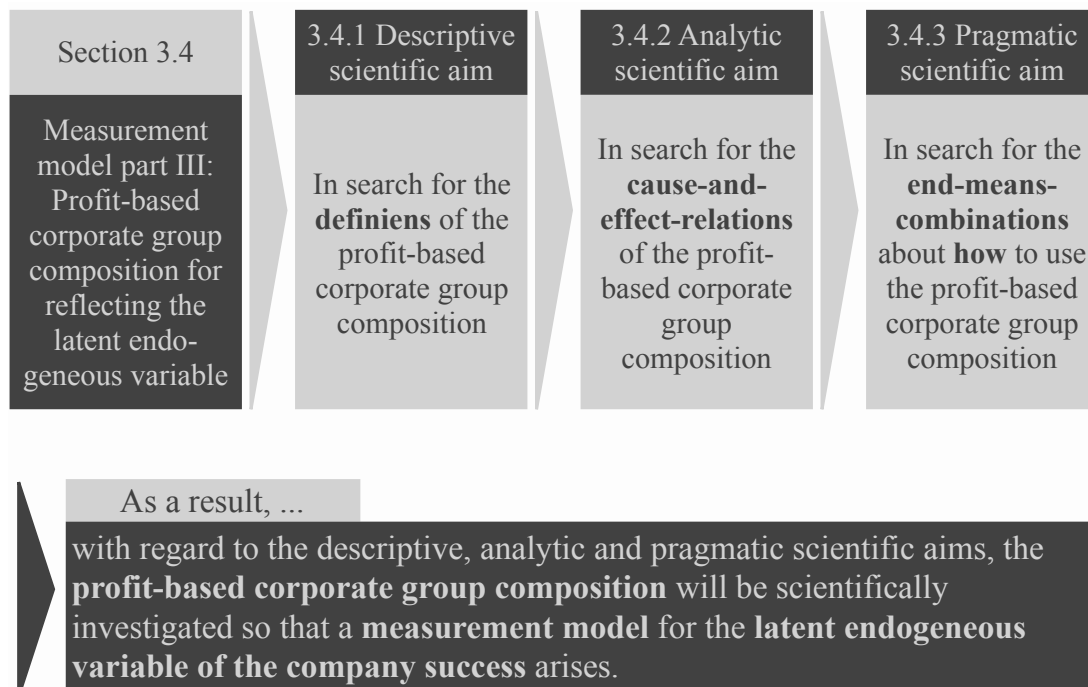
Consequently, with the help of the SEM-framework a measurement model for the latent endogeneous-mediating variable of the CCA arises because the ego network compositions $q^{1,2,3}$ can be transferred to the LISREL-notation so that CCA are operationalised and specified through measureable indicators and mathematical equations as a mean towards the end of a measurement model.

3.4 Measurement model III: Profit-based corporate group composition for reflecting the latent endogeneous variable

It is the **aim of Section 3.4** to clarify the **profit-based corporate group composition** as the partial model for measuring the company success as an indicator for the competitiveness on the individual level. Therefore, with respect to the three scientific research task the term will be firstly disambiguated (Subsection 3.4.1) before it will be analysed (Subsection 3.4.2) and the end-means combinations for the usage as a partial model (Subsection 3.4.3) will be given (cf. Figure 3-22).

Overview over
Section 3.4

Figure 3-22: Overview over Section 3.4



Source: Own illustration.

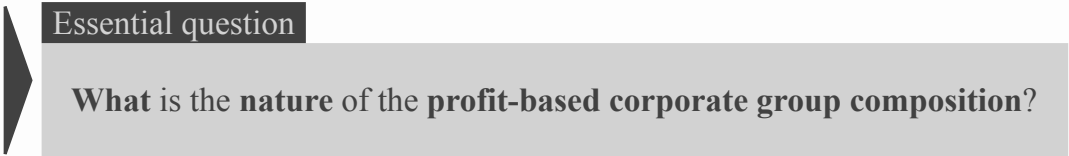
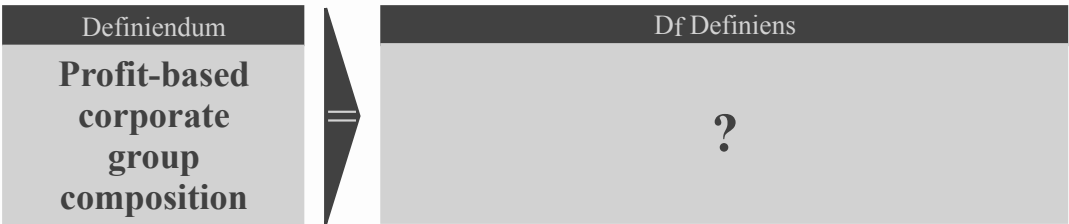
3.4.1 Descriptive research task: What is the profit-based corporate group composition?

Descriptive research task of Subsection 3.4.1

The **descriptive scientific aim** of this subsection consists in the descriptive scientific research task comprising a disambiguation of the concept of the profit-based corporate group composition because the next subsection will analyse its usage in the context of a measurement model for the company success. For this reason, the corresponding **definiens is searched for** (cf. Figure 3-23).

In search of the definiens for the profit-based corporate group composition

Figure 3-23: In search for the definiens of the profit-based corporate group composition



Source: Own illustration.

Definiendum of the profit-based ego composition

The **definiendum of the profit-based corporate group composition** can be **traced back** to the concept of the ego network composition because an ego network composition has been introduced for the ISN of a brand so that a corporate group composition approaches to the network of the brands within a corporate group. Therefore, it can also be **assigned to the field of Network Science** because it can also be **classified** as a measure for the abstract mathematical representation of Network Science to be connected with values from the value-based management. Against this background, the **definiendum of the profit-based corporate group composition** approaches the **idea** to assign a vector to each corporate group, i.e. the car manufacturer as the focal firm of the strategic network, targeted towards the **aim** to fill in the vector entries with measures from the value-based management that are able to indicate the company success. This is grounded on the following **basic assumptions**: Firstly, the EBIT, i.e. the Earnings before Income and Taxes, shall be used as a variable for indicating the company success (Bea & Haas, 2005, p. 72; Wiehle, Diegelmann, Deter, Schömig, & Rolf, 2010, p. 76) because of the profit-

orientation on the individual level that was introduced in Section 2.4. Secondly, it is assumed that such an EBIT-based value for a corporate group, e.g. 100 for the BMW Group, will be used for each brand within the corporate group (e.g. 100 for BMW, 100 for Mini and 100 for Bentley) because on the one side in the annual report such financial ratios are usually only depicted for the whole corporate group so that for the sake of practicability empirical information can be retrieved for each ego network of a brand b_i ; on the other side, this approach highlights the potential effects of the complexities in and of an ISN because from a statistical perspective their effects are weighted by being connected with unique measures for the command variable so that the network idea is supported. Therefore, as a **central conclusion** the **definiendum of the profit-based corporate group composition** can be **defined** as a vector so that the following equation arises (Bea & Haas, 2005, p. 72; Wiehle et al., 2010, p. 76):

Formula 3-13: $EBIT = \text{Operative income/earnings before interest and taxes}$

Formula 3-14: $EBIT_k = EBIT_{k(cg)}$

I.e., the EBIT of brand k is the EBIT of the corporate group it is affiliated with.

Formula 3-15: $cgc = \begin{bmatrix} EBIT_{b=1} \\ \dots \\ EBIT_{b=69} \end{bmatrix} [k \times 1]$

$k = 1 \dots K$ for the total amount of brands.

The **main contribution** consists of enabling to store measures for indicating the company success from the field of the value-based management into a Network Science-based framework because the EBIT is a well-accepted financial measure in the annual reports for determining the company success that is independent of the financial structures and the effects of the respective taxation laws (Bea & Haas, 2005, p. 72; Wiehle et al., 2010, p. 76). Nevertheless because of the strong assumptions as outlined above that were motivated by the approach of Network Science, the power of explanations are strongly **limited** so that the validity of this approach might of be limited range during the empirical validation (Cf. the explanation at the end of Section 3.4.2).

Consequently, the ego composition e_k for the corporate group k is classified as an abstract measure from Network Science that is defined through the mathematical equations Formula 3-13 – Formula 3-15 in which the vector entries are filled in with values from the value-based management, i.e. the EBIT of a corporate group for each of its brands.

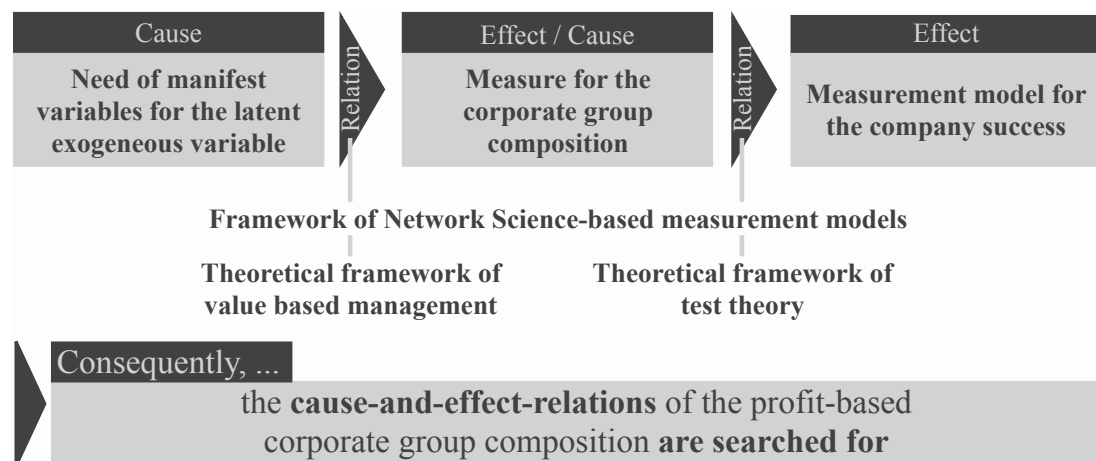
Consequences
for the definiens

3.4.2 Analytic research task: Why to use the profit-based corporate group composition?

Analytic research
task of
Subsection 3.4.2

It is the **analytic scientific aim** to analyse the corporate group composition because it has to be examined if it is able to work as a measurement model for the latent endogeneous variable of the company value. For this reason, with the help of the theoretical framework of the value-based management the cause-perspective will reason the usage while the effects-perspective tries to examine if a measurement model for the Structural Equation Modelling approach from a test theoretical perspective (cf. Figure 3-24).

Figure 3-24: In search for the cause-and-effect relations of the measure of *cgc*



Source: Own illustration.

Cause-
perspective

Because of the definiens of the **profit-based ego composition**, the **cause-perspective** examines whether it can be used for measuring the latent endogeneous variable. The consideration of the **operating income for the corporate group composition** can be assigned within the field of the **Strategic Management** because it is a concept of the value-based management (Wiehle et al., 2010, p. 76). A **classification of different concepts** in the field of the value based-management is given by (Hahn & Hintze, 1999, p. 350 et sqq.). In this connection, it can be seen that the main criteria for the classification of different concepts in the field of the value-based management are the original initiator, e.g. some of them are registered, and the time period that is considered. The time period can be further subdivided into periode-overlapping and periode-oriented that is further divided into the profitability and the excess profit (cf. Table 19).

Measure of succes	Periode-overlapping	Periode-oriented	
		Profitability	Excess profit
Rappaport	Shareholder Value	Revenue rentability	Economic Profit
Copeland	Equity Value	Return on Invested Capital (ROIC)	
Stern & Steward	Market Value Added		Economic Value Added (EVA)
Lewis	Market value of the equity capital	Cash Flow Return on Investment (CFROI)	Cash Value Added (CVA)
Hahn		Return on Investment (RoI)	Calculatory result

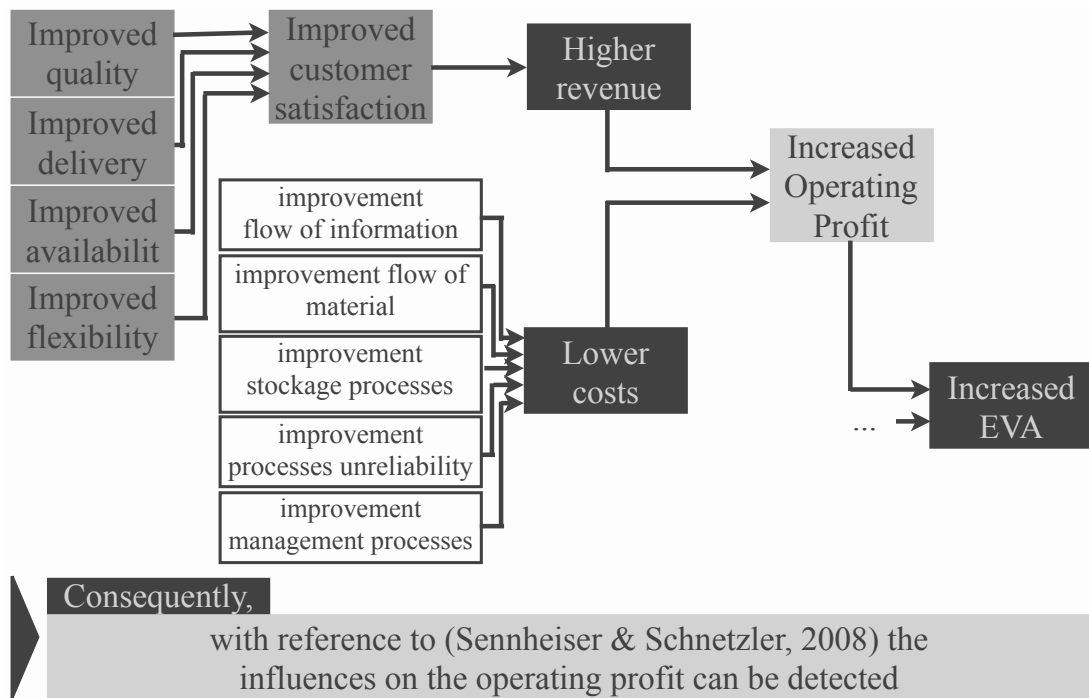
Table 19: Approaches of the value-based management according to (Hahn & Hintze, 1999, p. 350)

An approach that can be **characterised** for measuring the excess profit is the **Economic Value Added (EVA)** and it is the **idea** to use the **EVA** for the cause-perspective because follows the logic of the value-based management that the profit of a company has to generate additional value for the investors, i.e. the owners, of a company and because of its analysis in the field of the value-based Supply Chain Management according to (Sennheiser & Schnetzler, 2008) so that these considerations can be tied up to the results of Ssection 2.3.2 and 2.4.2. The **original development** of the **EVA** goes back to the consultancy of Stern Steward & Company as a registered trademark that is **defined** as follows (Stern, Shiely 2001):

Formula 3-16:
$$EVA = \left(\frac{NOPAT \times 100\%}{Invested\ Capital} - WACC \right) \times Invested\ capital$$

For this reason, the **Economic Value Added** is targeted towards the **aim** to determine the economic value added – i.e. the generated value through the company – as the difference between the operating profit and the capital costs as illustrated in Figure 3-25 (Grant, 2010, p. 38). The reason for this can be understood against the background of its **main assumption** that a company “should be viewed as successful only if the return on its projects is better than the rate investors could expect to earn for themselves ... in the capital market” (Bodie et al., 2009, p. 649; Christopher, 2005, pp. 94–95) so that the capital costs constitute opportunity costs of the invested capital so that a company creates only value if the company’s “economic capital employed is greater than the cost of that capital” (Bodie et al., 2009, p. 649). Therefore, **EVA** is an approach for measuring the company performance relative to its market environment because of measuring the company performance relative to the other company performances.

Figure 3-25: Value contribution of the SCM to the EVA



Source: With reference to (Sennheiser & Schnetzler, 2008).

It is the **central conclusion** that with the help of the **EVA** the meaning of the operating profit can be understood because as illustrated in Figure 3-25 the operating profit constitutes an essential part of the **EVA** (cf. Formula 3-16) whose dependence from the target areas of logistics had been analysed in the value-based management SCM according to (Sennheiser & Schnetzler, 2008). Therewith, the Economic Value Added as an approach for measuring the company performance enables a more differentiated consideration. For example, the EVA is positive if the profit of the company is greater than the opportunity costs of the invested capital (Bodie et al., 2009, p. 649; Grant, 2010, p. 38). On the other side, the EVA is negative if the opportunity costs of the invested capital are greater than the profit. Hereby, despite of having a positive profit, the EVA can still be negative because the performance of the company is evaluated relative to the average performance in the market (Bodie et al., 2009, p. 649; Grant, 2010, p. 38). Because of this well-accepted positioning of the **EVA** within the field of the value-based management, it can be assumed that the operating income including its position in the above-introduced cause-and-effect relations of the value-based SCM according to (Sennheiser & Schnetzler, 2008) allows justifying the usage of the operating income as a measure for the profit-orientation. This is **limited** through the fact that only an indirect justification has been done with the help of the framework of the value-based management by using the **EVA**. Additionally, this consideration constitutes a stylised approach because only a limited amount of influencing factors are considered with regard to the value-

based management SCM according to (Sennheiser & Schnetzler, 2008) so that other influencing factors are neglected.

Consequently, the profit-based corporate group composition can be used for measuring the company success because with reference to (Sennheiser & Schnetzler, 2008) cause-and-effect relations between the target areas of logistics and the operating profit are outlined within the framework of the Economic Value Added.

Consequences
for the cause-
perspective

The **effects-perspective** broaches the issue of the causal relation between the measures of the profit-based corporate group composition and the measurement model for the latent endogeneous variable because with regard to the test theory it has to be investigated whether they are able to mirror the company success. Therefore, it is the **idea** of the **effects-perspective** to determine, if the corporate group composition is of reflective or formative nature towards the **aim** of the checklist for the operationalisation because **based on the assumptions** of the test theory the type of specification influences the outcomes of the measurement essentially. It can be **concluded** that the corporate group composition is of reflective nature because of the following reasons: The indicator of profit-based corporate group composition is manifested by the construct because against the background of the analytic considerations in Subsection 2.4.2 it has been selected as a measure for the company success because of competitiveness on the individual level. Furthermore, the indicator is exchangeable because as can be seen with the help of the framework of the value-based management the Economic Value Added can for example also be considered as a measure for the company success (cf. (Colmorn & Hülsmann, 2012)). Finally, the adding of such an additional indicator would not change the content of the construct because as has been outlined different measures for the company success respectively company value exist in the literature (cf. the different approaches in (Wiehle et al., 2010)). As a consequence, the characteristics of the reflective specification are med because a change of the latent variable of the company success to e.g. the organizational change would require a new manifestation. Therefore, the profit is considered to be standing as an essential cause behind the construct of the company success. The **contribution** of enabling a measurement model for the latent endogeneous variable is **limited** through the fact that single indicator for the company success has a reduced power explanation respectively specification.

Effects-
perspective

As a result, a measurement model for the competitiveness on the individual level has been developed. In this regard, the content of the profit as part of the EVA-framework has to be distinguished from the methodological approach because ratios

have been derived from Network Science and they were interpreted with the help of the framework of the Economic Value Added. Nevertheless, they could have been interpreted with the help of other frameworks or ratios as well so that it has to be highlighted that the measurement model consists of two approaches: The methodological approach is based on Network Science while its interpretation with regard to the content for the area of application is based on a profit-ratio. These two approaches should not be mistaken with each other e.g. in the critical discussion of the contributions and limitations. Moreover, the interpretation through a ratio from managerial economics should be understood as a first approach towards testing the power of explanation of the developed measurement approach.

Consequences
for the effects-
perspective

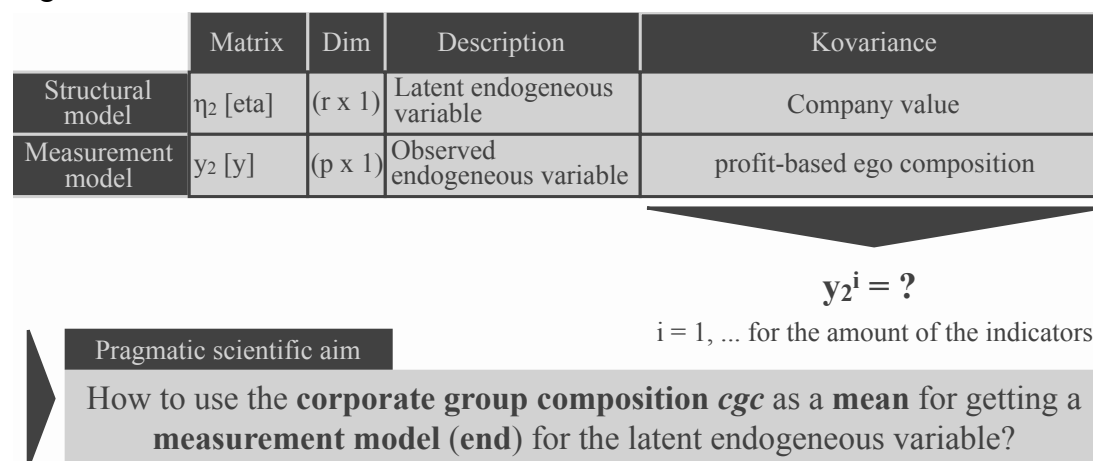
Consequently, the outlined profit-based corporate group composition reflects the latent endogeneous variable of the company success because it could be argued that it is standing as a causing factor behind the observable indicators. Therefore, a measurement model arises.

3.4.3 Pragmatic research task: How to use the profit-based corporate group composition?

In accordance with Subsection 3.2.3, the **pragmatic scientific aim** deals with the end-means combinations targeted towards the usage of the profit-based ego composition and its constituents for the SEM-framework so that a measurement model for latent endogeneous variable as a mean arises (cf. Figure 3-26).

Pragmatic research task of Subsection 3.4.3

Figure 3-26: In search for the end-means combinations



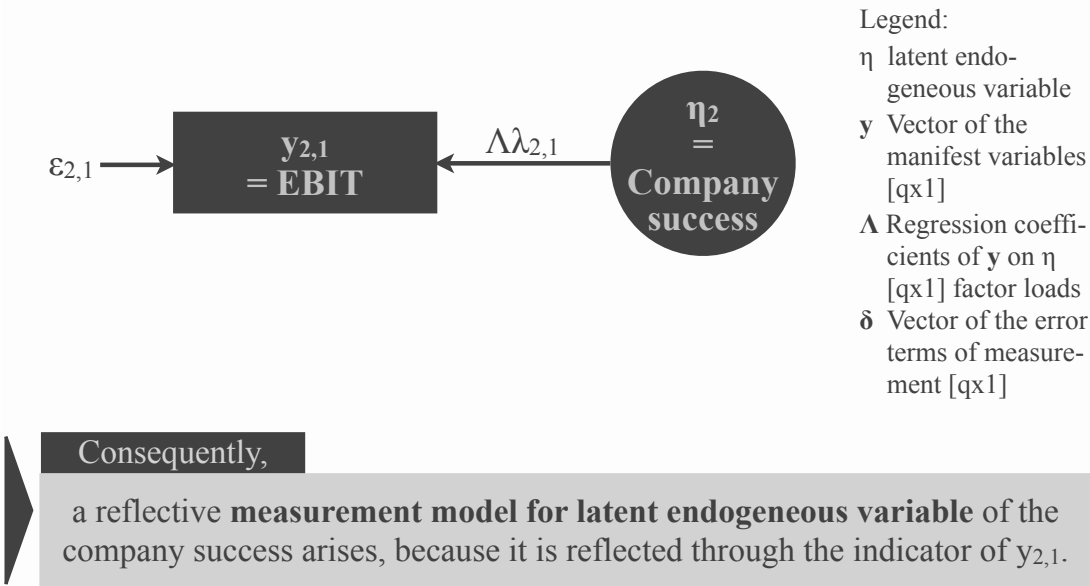
In search for the pragmatic scientific aim

Source: Own illustration.

This **mean** for getting a measurement model for the latent endogeneous variable is also **assigned to the SEM-approach**, whereby **different variables** due to the LISREL-notation can be distinguished (cf. Section 3.2.3) so that the endogeneous variable can be identified as η_2 and y_2 for its indicators (cf. Figure 3-26). Therefore, it is the **idea** to assign the measure of the EBIT to the LISREL-notation y_2 because of the **aim** to have a corresponding measurement model for the latent endogeneous variable of the company success. This assignment is grounded on the **basic assumption** that the variables from the field of the value-based management **reflect** the company success because of the analytic scientific considerations in the previous subsection. In this conjunction, the profit-based corporate group composition referring to the organisational unit of a corporate group, e.g. the BMW Group or the Volkswagen AG, can also be used for mapping the brands of these groups, e.g. MINI or Skoda because the EBIT also constitutes a network-oriented financial ratio by indicating the EBIT of the whole group as a result of all the brands includes. Hence, this result should not be understood as a simple addition. Therefore, as the **central conclusion** a measurement model arises as illustrated in Figure 3-27 also pointing towards its **main contribution** of providing a mean towards the end of proceeding with the Structural Equation Modeling approach. From an end-means-orientated

perspective this is strongly **limited** through the fact that an operationalisation with the help of one manifest indicating variable will probably lead to weak statistical results in the empirical validation.

Figure 3-27: Reflective measurement model for the corporate group composition



Source: Own illustration.

Conclusions for
the pragmatic
scientific aim

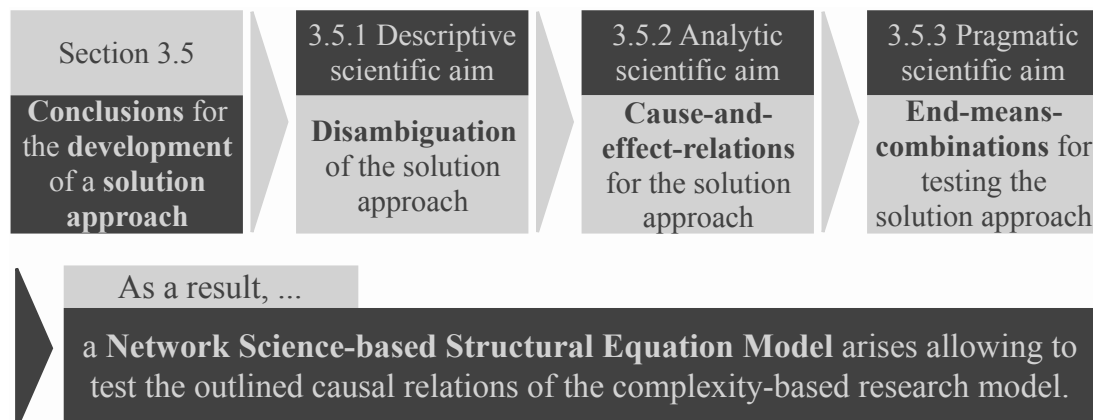
Consequently, with the help of the SEM-framework a measurement model for the latent endogenous variable of the company success arises that is operationalised and specified through measureable indicators and mathematical equations.

3.5 Conclusions towards the solution approach: A Network Science-based Structural Equation Model

It is the **aim of Section 3.5** to **conclude the results of this third chapter** because the result of chapter 2 was a complexity-based research model that outlined the need to test the potential causal relations. For this reason, the research model was the starting point for the development of a solution approach in which potential causal relationships can be tested so that a Network Science-based Structural Equation Model in Section 3.5 will be the answer to the research model of Section 2.5 (cf. Figure 3-28). In this conjunction, this section is more than just a summary because the solution approach is in general examined as a response to the research model.

Overview over
Section 3.5

Figure 3-28: Overview over Section 3.5



Source: Own illustration.

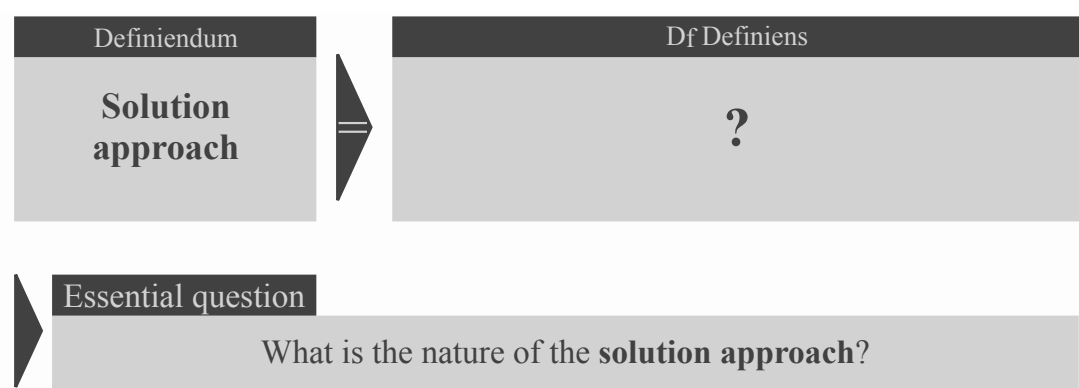
3.5.1 Descriptive research task: What is the solution approach?

Descriptive
research task of
Subsection 3.5.1

The **descriptive scientific aim** of this subsection consists of the disambiguation of the **definiendum of the solution approach** because the underlying understanding of the definiendum of a Network Science-based Structural Equation Model determines the scientific proceeding, e.g. for the empirical validation, so that the definiens of the definiendum is searched for (cf. Figure 3-29).

In search for the
definiens of the
solution
approach

Figure 3-29: In search for the definiens of the solution approach



Source: Own illustration.

Definiendum of
the solution
approach

The **definiendum of the solution approach** has to be **assigned into the field of statistics** because in Subsection 3.1.3 Structural Equation Models has been proposed as the solution approach because of fitting to the requirements of the research model and the scientific modus operandi. Besides this, it was the **idea** of using the framework of Network Science targeted towards the **aim** of deriving measurement models **based** on the **assumption** that the measurement models for the latent variables can be covered through this abstract representation because of its interdisciplinary nature so that Complexity Science and Strategic Management can be connected. As a **central conclusion** that a Network Science-based Structural Equation Model as a solution approach for the research model arises pointing to the **contributions** of being in accordance with the scientific modus operandi and of being able to operationalise the latent constructs so that a statistical analysis becomes possible. Hence, this approach is **limited** with regard that a causality of the assumed causal relationships cannot be tested in a strict scientific sense.

Consequences
for the definiens

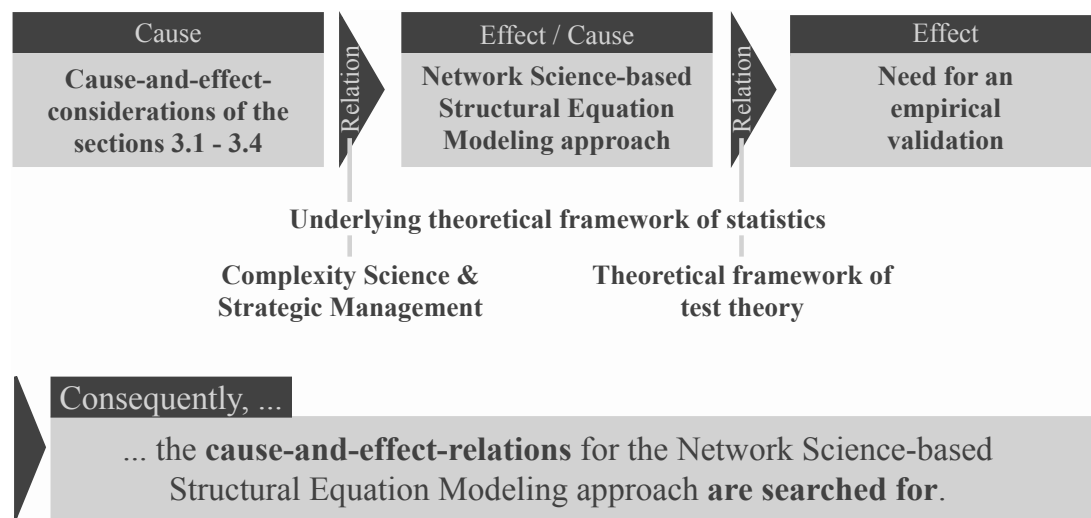
As a result, the nature of the solution approach refers to a Network Science-based Structural Equation Model being classified as a multivariate statistical method for proving if the causal relations of the reseach model cannot be rejected statistically.

3.5.2 Analytic research task: Why to use this solution approach?

It is the **analytic scientific aim** of this subsection to integrate the cause-and-effect considerations of the previous subsections into a **Network Science-based Structural Equation Model as a solution approach** because it has to be analysed if the solution approach is a response to the outlined research model. Therefore, the **cause-perspective** will analyse, if the considerations of the Sections 3.1 – 3.4 result in a solution approach before the **effects-perspective** deals with the need for an empirical validation pointing to the next chapter (cf. Figure 3-30).

Analytic research task of Subsection 3.5.2

Figure 3-30: In search for the cause-and-effect relations of the solution approach



In search for the cause-and-effect relations of the Network Science-based SEM

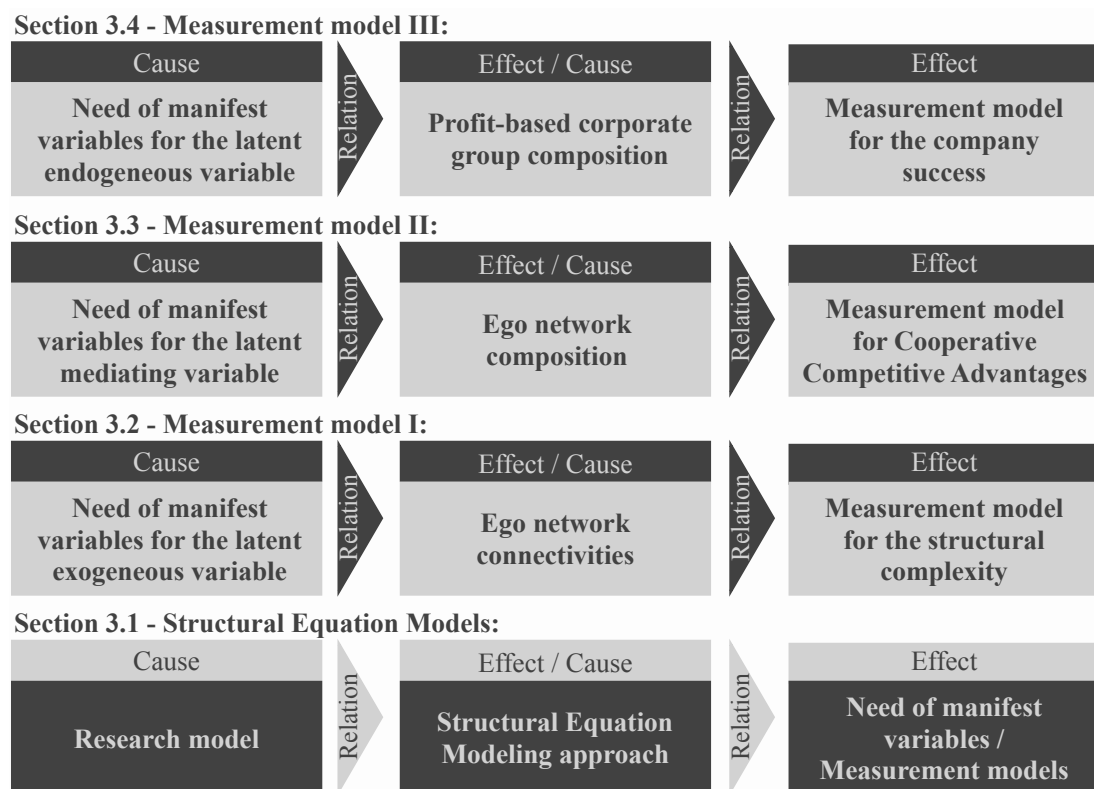
Source: Own illustration.

The **cause-perspective** deals with the **causes** for the – Network Science-based Structural Equation Model as the – solution approach. Therewith, the **cause-perspective** is **aimed** at the clarification of an essential question concerning the scientific modus operandi. The reason for this is as follows: The development of the research model in Section 2.5 was based on the theoretical framework of Systems Theory by considering the characteristics and the two functions of International Supply Networks that were considered with the help of the overarching theoretical frameworks of Complexity Science and Strategic Management. Hereby, a positive causal relation between the complexity and the competitiveness on the network as well as a negative causal relation between complexity and the competitiveness on the individual level could be derived. As a result, the measurement models for the Structural Equation Modeling approach were developed under the umbrella of Network Science because it is considered to be a well accepted approach for measuring the latent exogeneous variable of structural complexity so that a gap of

Cause-perspective

knowledge about measuring complexities in the field of managerial economics could be bridged. As a result it has to be investigated, if the three approached measurement models – the ego network connectivities, the ego network composition and the profit-based corporate group composition – are able to reflect the potential causal relationships outlined in the research model.

Figure 3-31: Overview cause-and-effect relations of the Section 3.1 – 3.4



Source: Own illustration.

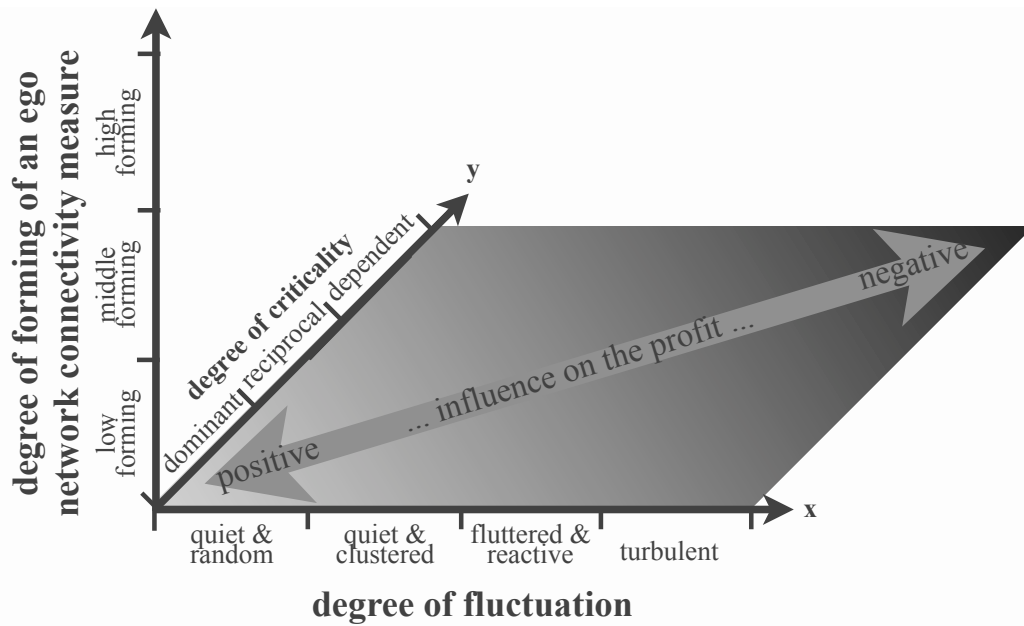
Are the ego network connectivities and the profit-based corporate group composition able to reflect the causal relation between the structural complexity and the company success of the research model?

Instead of trying to directly connect the introduced [complexity] measures, an indirect approach is followed with reference to (Colmorn & Hülsmann, 2012). The Resource-Dependence-Approach will act as a vehicle to connect the structural complexity with the profit of the focal firm by connecting the ego network connectivities with the categories of the “type of relationship” and “type of environment” of the RDA. The reasons for this are threefold: Firstly, a transformation of these nominal scales into measurable numerical scales would let the question unanswered, about how to interpret a numerical value e.g. for the type of environment. Secondly, such a transformation would let the question unanswered, about how to connect the scale with the complexity as a subject of consideration. For

example, a turbulent type of environment cannot be per se understood as more complex because the type of relationship also matters due to the different meaning of the resource for the company (cf. the definition about the dependent versus dominant type of relationship). Finally, by connecting the ego network connectivities with the two categories, it becomes possible to use research findings about the Research-Dependence-Approach so that the assumptions that are going to be derived can be grounded on a theory from the field of strategic management. Therefore, the introduced ego network connectivities shall be used in order to bridge this gap between the non-measurable categories and the impacts on the profit. For this, the degree of the forming of the complexity measure can be introduced as a third category on the z-axis. Therewith, it becomes possible to individually discuss whether a low or a high forming of the corresponding complexity measure has to be expected for a given constellation of the characteristics for the degree of fluctuation and for the degree of criticality (cf. Figure 3-32). As a simplification, only the ends of the both scales shall be discussed, namely “dominant” and “dependent” as well as “quiet & random” and “turbulent”. As can be seen, by knowing the forming of an ego network connectivity and by referring this network measure within the two categories of the degree of criticality and the degree of fluctuation it would be possible to derive assumptions about their influence on the Economic Value Added [profit]. Therefore, the following sub-sections intend to derive assumptions about how to position low and high forming of a complex network measure within the x- and y-axis.”⁹¹

⁹¹ Taken and adapted from (Colmorn & Hülsmann, 2012, pp. B17–B18).

Figure 3-32: Connecting the categories of the RDA with the complexity ratios.



Source: Adapted from (Colmorn & Hülsmann, 2012, p. B18).

“The type of relationship is to be called “dominant”, if the considered resource and the corresponding relationship have a low meaning for the focal firm while the relationship is called to “dependent”, if the resource has a high meaning for the focal firm.”⁹² Therefore, the following formings for the ego network connectivities enc_{A-D} can be assumed:

If the attributed value for an ego network connectivity shall represent the amount of supply relationships the delivering company has with other companies, than a low respectively high forming of bargaining power v_i can be expected because the dependency from the considered resources is dominant/dependent.

As a result, a typical pattern – a low forming of the ego network connectivities in a dominant and a high forming in a dependent type of relationship – occurs that can be explained with the help of the Resource-Dependence-Approach. For example, a dependent type of relationship exists, if the considered resource(s) have a high meaning for the focal firm and cannot be easily replaced by other companies. Therewith, a high value of an ego network connectivity corresponds with a high meaning for the focal firm so that a low respectively high forming of the complex network measures indicate a dominant versus dependent type of relationship in terms of the Resource-Dependence-Approach.

⁹² (Colmorn & Hülsmann, 2012, p. B19).

The environment is to be called “quiet & random”, if the critical resources for the company are stable and homogeneously distributed over the network while the environment is to be called “turbulent”, if the relationships between the companies competing with each other for critical resources, the own interactions and the interdependencies with other environmental groups have to be taken into account. With this definition, the following assumptions about the forming of the ego network connectivities enc_{A-D} can be derived as it follows:

Bargaining power v_i : If the attributed value for the bargaining power v_i shall represent the amount of supply relationships the delivering company has with other companies, than a low (“quiet and random”) respectively high (“turbulent”) forming of the bargaining power v_i can be expected because of the low/high connections that have to be considered.

For the type of environment, a pattern occurs, too because a low forming for an ego network connectivity in a quite and random and a high forming in a turbulent type of environment is expected. Hereby, the argumentation goes the same way because – by definition – a turbulent environment refers to a high number of connections that have to be taken into account that corresponds with high value for the complex network measures, e.g. the number of supply relationships of a delivering company, the amount of interconnections between the companies the focal firm is trading with and the availability or the needed technological knowledge of a very important resource for the focal firm. As a result, a low versus a high forming of the complex network measure can be based on the definition from the Resource-Dependence-Approach expected in a quite and random versus turbulent environment.

Figure 3-33: Expected forming of the ego network connectivities

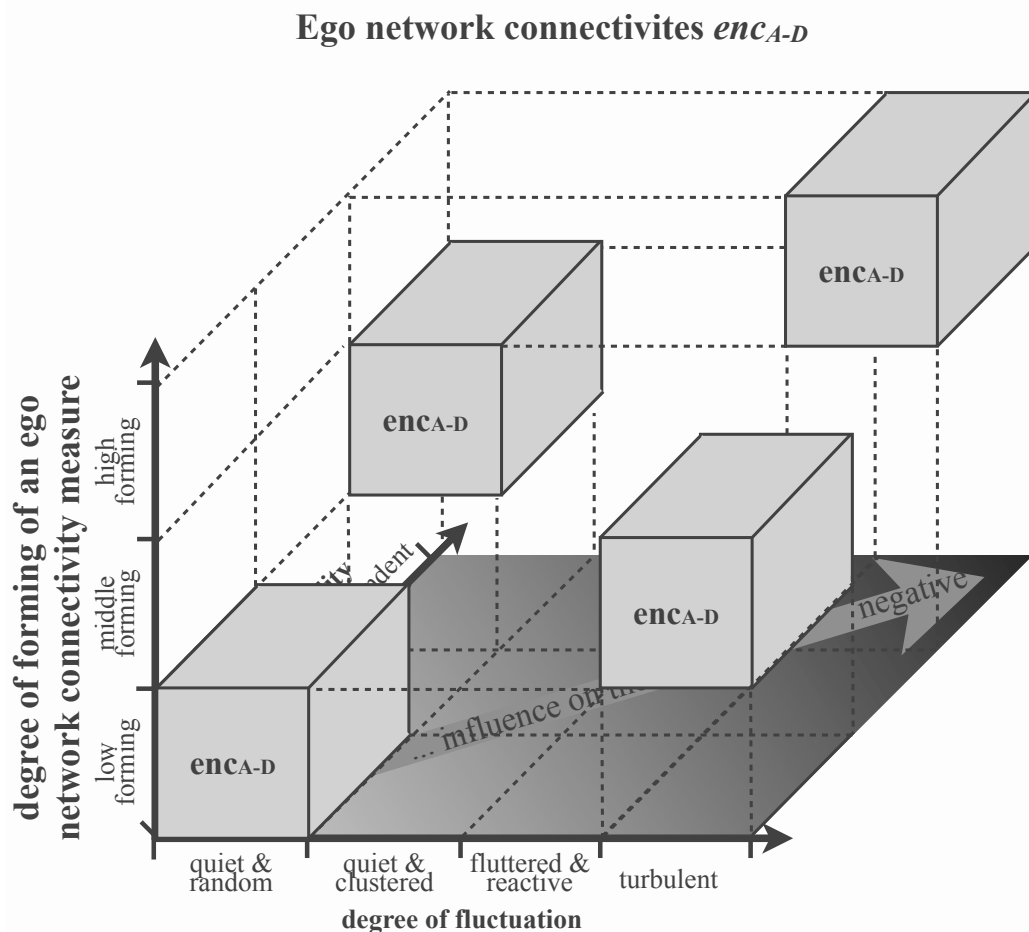
type of environment	type of relationship	
	„dominant“	„dependent“
„quiet & random“	enc_{A-D} : low + low = low	enc_{A-D} : high + low = middle
„turbulent“	enc_{A-D} : high + low = middle	enc_{A-D} : high + high = high

Source: Adapted from (Colmorn & Hülsmann, 2012).

These outlined expected forming in the two categories can be integrated into a three-dimensional space. Hereby, for the sake of simplification it shall be assumed that the addition of low and low forming results in a low forming (the same as for the

addition of high formings) while the addition of a low and a high forming leads to middle forming so that the patterns outlined in Figure 3-34 can be derived. As a result, a **main contribution** emanates from the usage of the Resource-Dependence-Approach because it was considered to be a theory to explain the intercompany behaviour that is connected with respect to the critical resources of the company. The reason for this is that this approach allows to investigate the dependency of a focal firm from its organizational, i.e. its network, environment. Because of this, measurable and therewith falsifiable assumptions could be derived that are grounded on an interdisciplinary combination of measures from Complexity Science with a theoretical framework from the Strategic Management. This contribution is weakened by the fact that the concept of the RDA concerning the type of relationship and the type of environment were represented in nominal scales. Therewith, a **main limitation** occurs with regard to the translation into expected formings because only tendencies were discussed.

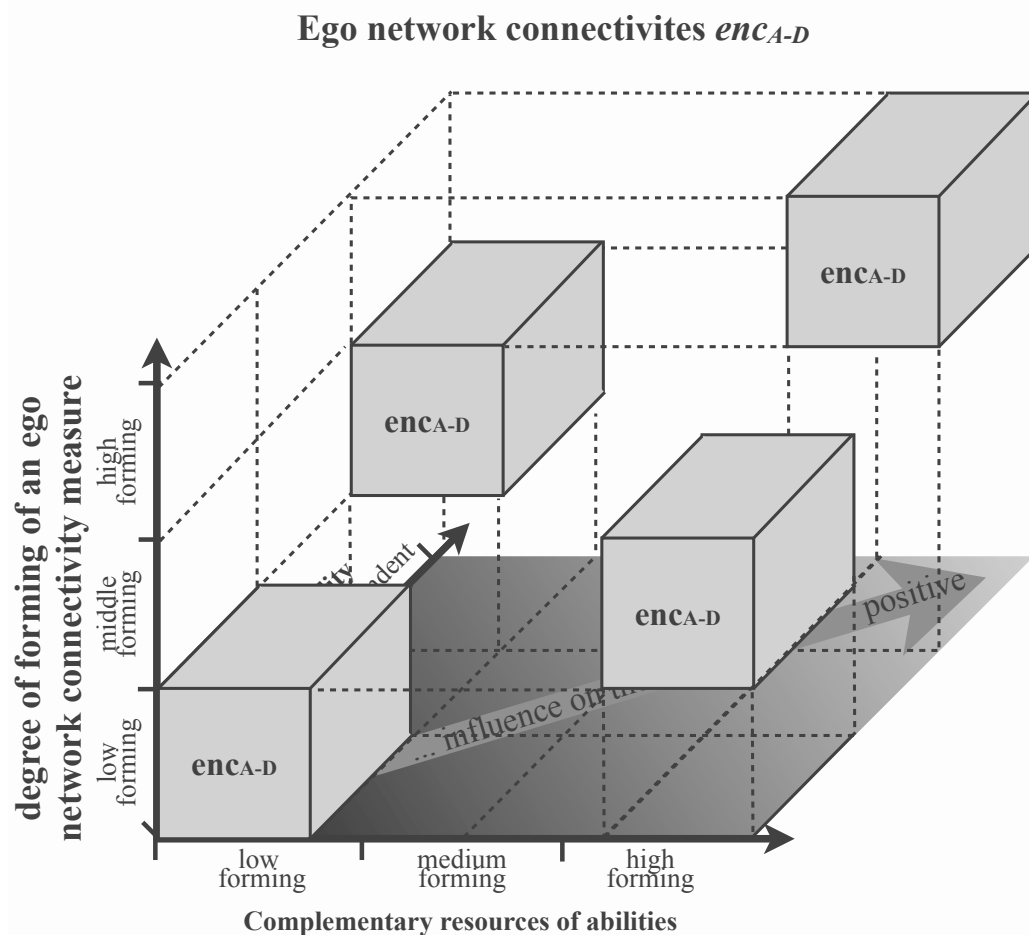
Figure 3-34: 3-dimensional representation of the expected formings



Source: Adapted from (Colmorn & Hülsmann, 2012).

In this conjunction and by following the same logic as above, it shall be **assumed** that the higher the forming of a complexity-based measure, the higher a positive influence on a CCA because the amount and diversity of cooperative relations should positively correlate with the relational specific competencies and the complementary resources of abilities. For this, it is the **central conclusion** that a 3-dimensional representation of the behavioural patterns should occur as illustrated in Figure 3-35 so that a higher forming of a measure for the structural complexity can be used as an indicator for the gain and sustain of a CCA. In this regard, a **main contribution** emanates from the usage of the Relational View because herewith it becomes possible to connect the measurable forming of the structural complexity with the positive influence on the gain and sustain of a CCA so that measurable, i.e. falsifiable assumptions, about their interrelation can be derived. Hence, this is also **limited** through the fact that these expected formings should be understood more as a stylised approach lacking an extensive literature review.

Figure 3-35: 3-dimensional representation of the expected formings for CCA.



Source: Own illustration and inspired by (Colmorn & Hülsmann, 2012, p. B15).

Conclusions for
the cause-
perspective

Consequently, with regard to the cause-perspective the Network Science-based measurement models seems to be a promising response to the outline complexity-based research model because the measures for the structural complexity could be connected with the Resource-Dependence-Approach and the Relational View so that the potential – negative and positive – causal relation of the structural complexity with the company success and CCA can be measured in a stylised approach.

Effects-
perspective

The **effects-perspective** focusses on the **effects of using this Network Science-based Structural Equation Model** because due to the fact that the usage of a specific methodology determines the scientific outcomes with respect to the research question and the corresponding scientific objectives the conclusions towards the raised research problem have to be examined. For this reason, the **effects-perspective** will focus on the **causality of Structural Equation Models**.

Causality of
SEM/meaning
for scientific
theory

The **causality of Structural Equation Models** takes an **essential part within the scientific theory** because according to (Backhaus et al., 2011; Reinecke, 2005) the differentiation between a level of observation (manifest variable) and the structural level (latent variable) points to the scientific discussion about how to connect theory and experiment. According to (Backhaus et al., 2011) the **idea** of the **causality of SEM** is to agree upon a consistent understanding of causality in which a variable X is considered to be a direct cause on the variable Y (notation: $X \rightarrow Y$), if a change of Y is the result of a change of X while all the other variables that might have a potential causal relationship with Y stay constant in a causal model. Against this background, the **aim** of the **causality of SEM** consists in the statistical analysis whether a variation in the variable of X causes a variation in the variable of Y pointing to the concept of **correlation** for which the covariance is needed (Backhaus et al., 2011, pp. 70–71; Raithel, 2009, p. 545).

Formula 3-17:
$$s(x_1, x_2) = \frac{1}{K-1} \sum_k (x_{k1} - \bar{x}_1)(x_{k2} - \bar{x}_2)$$

In this connection, in Formula 3-17 x_{k1} refers to the forming of the variable I of object k , such as e.g. k companies so that $\bar{x}_1$ represents the arithmetic average of the formings of the variable 1 over all objects $k = 1, \dots, k$). In this conjunction, x_{k2} and $\bar{x}_2$ represent the formings of the variable 2 for object k respectively the arithmetic average over all formings of variable 2 from 1 till k . Because of the fact that the variability of the value of the empirical covariance between two variables cannot be determined in advance, the total value of the empirical covariance does not give any

hint about how strong the relation between the two variables is. For this reason, the empirical covariance is normally standardized on an interval with which it becomes possible to derive unique conclusions about the strength of the relationships between the two variables so that the so-called **correlation coefficient** is **defined** as follows (Backhaus et al., 2011, pp. 70–71):

Formula 3-18:
$$r_{x_1, x_2} = \frac{s(x_1, x_2)}{s_{x_1} \cdot s_{x_2}}$$

Hereby, $s(x_1, x_2)$ is the above introduced covariance between the variables of x_1 and x_2 while $s_{x_1} = \sqrt{\frac{1}{K-1} \sum_k (x_{k1} - \bar{x}_1)^2}$ and $s_{x_2} = \sqrt{\frac{1}{K-1} \sum_k (x_{k2} - \bar{x}_2)^2}$ are the standard deviations of the variables of x_1 and x_2 . Against this background, the **causality of Structural Equation Models** is based on the followings **assumptions**:

- If based on empirical values the value for a covariance is calculated to be around zero, then it can be assumed that no linear relation between these two variables exists. That means they are not observed more often as expected through the statistical mean.
- If the value is bigger/smaller than zero, then both values move into the same/opposite direction, indeed more often as expected in a stochastic process.

Therewith, the correlation coefficient can take values between -1 and +1 so that with respect to the **causality of Structural Equation Models** it can be stated that the more a value gets closer to the absolute value of 1, the more a dependency between the variables has to be assumed. Therefore, it is the **central conclusion** that for the quantification of such a causal relationship between two variables, the empirical correlation between two variables can be relied upon pointing to the **main contribution** that strong indications towards causality can be determined with the help of statistics. Hence, some **limitations** exist. Firstly, the correlation coefficient does not enable to derive clear statements about which variable has to be considered as the causing one because x_1 could be causing x_2 ($x_1 \rightarrow x_2$) and vice versa ($x_2 \rightarrow x_1$) or a relation between x_1 and x_2 is the result of an exogenous hypothesized variable $zeta$ so that in general three different possible interpretations of the correlation are thinkable. Secondly, the approaches connected with SEM merely prove, if – based on content-driven postulated hypotheses and their underlying assumptions – a causal relationship cannot be statistically rejected because the multivariate statistical approaches offer a structure that is neutral with respect to their interpretation. Thirdly, in a strict scientific sense a causal analysis with SEM needs a timely sequence for unfolding cause-and-effect relations so that a longitudinal research

design is favoured. Finally, the quality and size of the empirical sample determines the power of explanation of the statistical analysis.

Conclusions for
the effects-
perspective

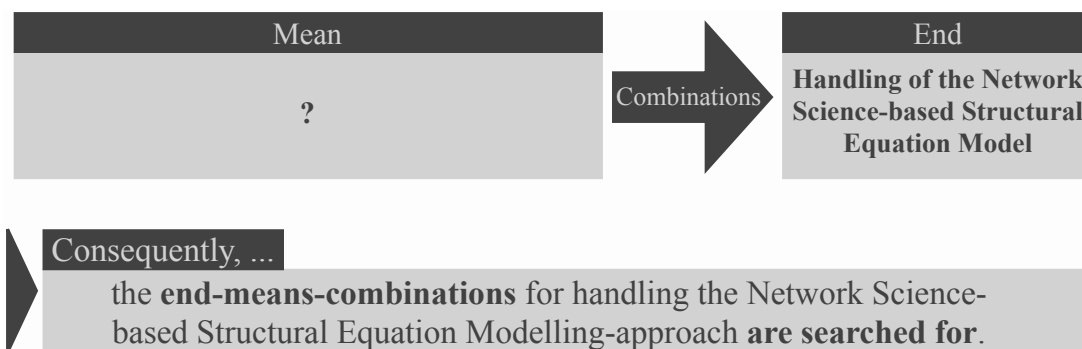
Consequently, with regard to the effects-perspective Structural Equation Models are able to give strong indications towards causality because of their statistical analysis of correlations. Therefore, this methodological approach is able to statistically prove the outlined potential causal relations of the complexity-based research model.

3.5.3 Pragmatic research task: How to use this solution approach?

The **end-means combinations** of this subsection are **targeted towards the handling of the Network Science-based Structural Equation Model** as the solution approach for the research model (cf. Figure 3-36). Therewith, the **pragmatic scientific aim** of this subsection consists of identifying a methodological approach as a mean for the end of handling the research model. Hereby, the methodological approach is considered **specifically with respect to the course of research and in general with respect to scientific theoretic aspects**.

Pragmatic
research task of
Subsection 3.5.3

Figure 3-36: In search for the end-means combinations of the solution approach



Source: Own illustration.

It is the **idea** to outline the final **system of equations** as a result of the considerations in the previous sections because by having such a **system of equations** the statistical analysis can be theoretically done. The final **system of equations** is **based** on the **assumptions** of the structural and the measurement models that can be formulated into **falsifiable hypotheses** for the further proceedings:

System of
equations

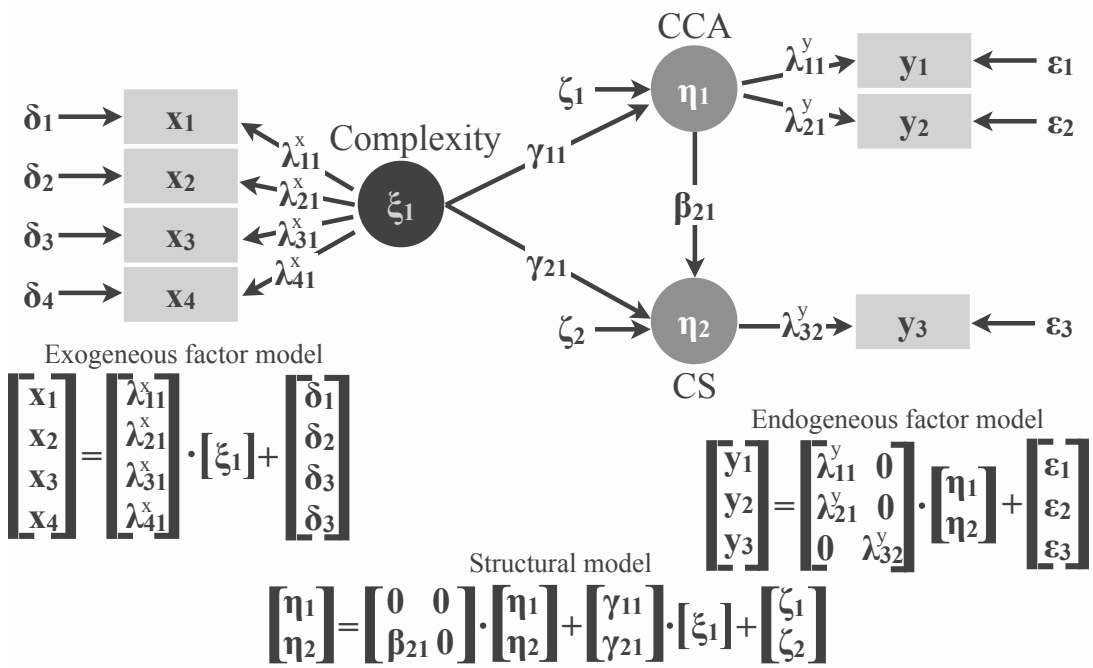
H₁: The structural complexity does not positively influence a Cooperative Competitive Advantage.

H₂: The structural complexity does not negatively influence the company success.

H₃: A Cooperative Competitive Advantage does not positively influence the company success.

As a **central conclusion** the final **system of equations** arises as outlined in Figure 3-37.

Figure 3-37: Final system of equations



Consequently, ...

a completely developed Network Science-based Structural Equation Model arises comprising a **system of equations** for the empirical validation

Source: Own illustration.

Therewith, a **main contribution** lies in a mathematical formalization of the above-introduced relationships so that a statistical analysis of the solution approach becomes possible while a **main limitation** exists with regard to the fact that this final **system of equations** only constitutes one solution approach for the outlined research model because much more manifest indicators for the latent variables, e.g. further complexity or profit-related ratios, could be conducted. Therewith, it should be more understood as an approach grounding the path for future research in the case that the first statistical results will lead to some promising results.

Conclusions as a result of the pragmatic scientific aim

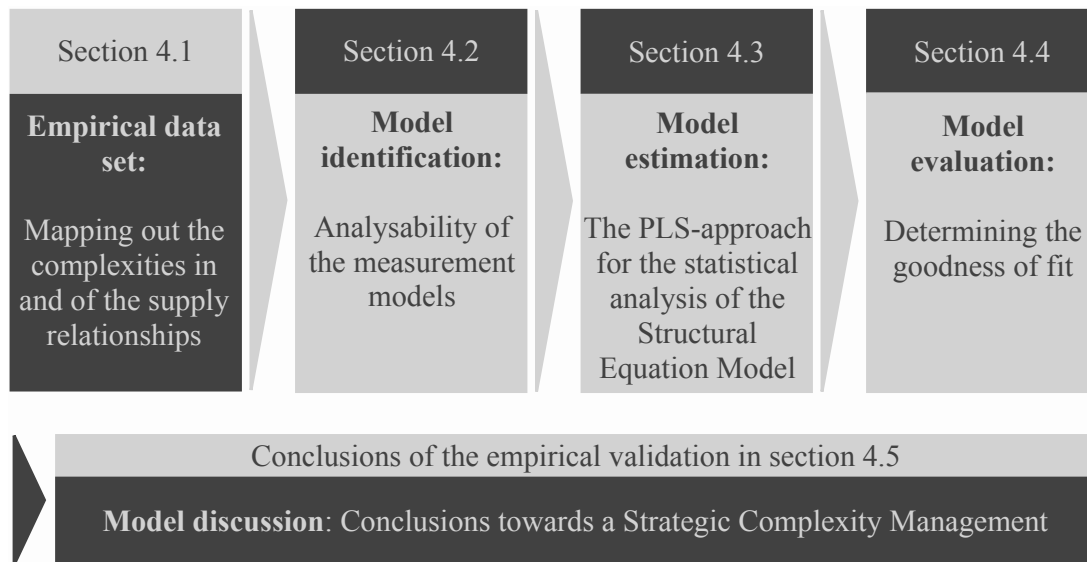
Consequently, a solution approach could be developed because the final system of equations represents a completely specified Network Science-based Structural Equation Modeling approach. Therefore, the need to empirically validate its outlined relations through the analysis of statistical covariances arises.

4 Empirical validation: Statistical analysis of the Complexity Effects

As a result of Chapter 3, a Network Science-based Structural Equation Modeling approach for testing the causal relationships between the characteristic of an ISN and its two functions towards the competitiveness on the individual and the network level has been developed. These constructs had been identified in the research model as non-observable latent variables that have been made observable through the outlined measurement models (cf. Sections 3.2, 3.3 and 3.4). The potential causal relations were grounded with the help of theoretical approaches in the research model so that it is the **aim of this chapter** to **empirically validate the methodological approach of a complexity-based Structural Equation Model** as the solution approach for the research model. With the help of the outlined process of modelling and analysing a complete Structural Equation Model as shown in Figure 3-6, the structural proceeding of the sections in this chapter is the result of the model identification, the model estimation and the model evaluation as the 4th, 5th and 6th step. With regard to the objectives of this thesis, the chapter will conclude with a discussion towards a strategic complexity management (cf. Figure 4-1).

Overview over
Chapter 4

Figure 4-1: Overview over Chapter 4



Source: Own illustration.

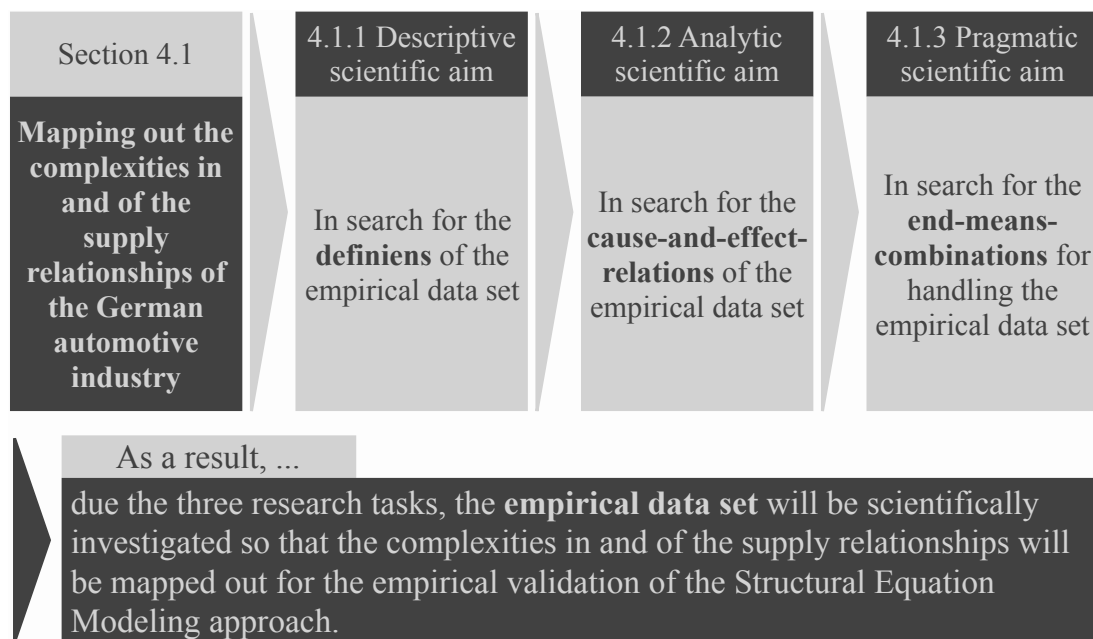
4.1 Empirical data set: Mapping out the complexities in and of the supply relationships of the German automotive industry

Overview over Section 4.1

It is the aim of Section 4.1 to map out the complexities in and of the supply relationships of the German automotive industry because a data set for the empirical validation of the developed Network Science-based Structural Equation Model as the proposed solution approach for the complexity-based research model is needed. As a result, the empirical data set will have been scientifically investigated at the end of this section so that the complexities in and of the supply relations will be mapped out. As a point of clarification, two empirical data sets can be distinguished that are subject of consideration of Section 4.1 and 4.2:

- a) The **first empirical data set** deals with mapping out the complexities in and of the supply relationships of the German automotive industry because of the complexity based-research model so that it is the subject of consideration of this section.
- b) The **second empirical data set** deals with the three measurement models for the Network Science-based Structural Equation Modeling approach. The reason for this is that the identification is an essential step of a complete SEM so that this data set will be the subject of consideration of Section 4.2.

Figure 4-2: Overview over Section 4.1



Source: Own illustration.

4.1.1 Descriptive research task: Defining the empirical data set

Due to the fact that it is the overarching aim of this section to map out the German automotive industry for the empirical validation, it is the **descriptive scientific aim** to **define** the corresponding **empirical data set**. For this reason and as illustrated in Figure 4-3, the **definiens of the empirical data set is searched for** so that the essential question about its nature can be answered. For this, the first data set is selected for collecting the empirical information concerning the complexities.

Descriptive research task of Subsection 4.1.1

Figure 4-3: In search for the definiens of the empirical data set



In search for the definiens of the empirical data set

Source: Own illustration.

The – depiction of the – **empirical data set** can be **assigned into the field of statistics** because as a teaching method for dealing with quantitative information, i.e. data, statistics is also considered to be a mathematical subdiscipline about the collection, the manipulation, the analysis, the interpretation and the presentation of data (Kromrey, 2009; Schwaiger & Zimmermann, 2009, p. 421). Therefore, the conclusion can be drawn that the empirical data collection for achieving an empirical data set constitutes an essential step in the field of statistics. According to (Kromrey, 2009, p. 299) in the field of empirical social research **approaches for the collection** of an **empirical data set** as strategies for the empirical information retrieval can be generally separated into approaches of a content analysis, observation and survey/interview while one could also just prefer to generally distinguish between primary, i.e. data that are directly collected, and secondary data, i.e. information that are indirectly derived from primary collected ones. In addition to that, not only because of the different types about how to collect the empirical data but also with respect to what is represented, different empirical data sets about the German automotive industry can be distinguished in principle because different forms of – vertical and horizontal – cooperation – as outlined in Section 2.1 – can be

Depiction of the empirical data collection

distinguished. In this conjunction, the **empirical data set** is **classified** as secondary data because it is the result of a content analysis whereby it is the **idea** to do the statistical analysis with an empirical data set about the supply relationships. Therewith, the supply relationships are standing in the focus of attention targeted towards the **aim** to gain an empirical data set. The **origin** of the **empirical data set** has to be declared to the German industry magazine (AUTOMOBIL PRODUKTION, 2011a, 2011b, 2013a, 2013b) as part of the publisher *verlag moderne industrie GmbH*. The access to their information was liable to pay costs that were privately paid by the author himself. As a result, the **empirical data set with focus on the supply relationships** is grounded on the **basic assumption** that the information provided by the above-mentioned sources are reliable and contains the overwhelming majority because besides their statements a provement is hardly to achieve. As a **central conclusion**, an empirical data set about the supply relationships of the German automotive industry arises in which the **supply relations outlined through the empirical data collection** have to be **classified** as one with plurivalent assignments because e.g. a supplier can supply one or several components to one or several models so that this plurivalent assignment is represented through these four thinkable cases. The **main contribution** of this approach consists of closing a gap of knowledge in the scientific literature and to overcome the problems of doing a survey because the suppliers were not willing to participate so that an empirical data set fulfilling the requirements (cf. next subsection) arises. Hence, the **main limitation** has to be declared in the way that it cannot be proved in a strict scientific meaning, if the outlined supply relations do comprehensively reflect the automotive industry. In this regard, the empirical data set could be biased, i.e. from a statistical point of view a systematic error could exist because e.g. some companies or components or component groups were constantly ignored or neglected. This bias that is hard to check could significantly distort the results of the measurement in a positive or negative way.⁹³

Consequences
for the
descriptive
scientific aim

Consequently, the empirical data set can be defined as secondary data from a content analysis for the supply relationships of the German automotive industry in which 69 brands, 787 car models, 564 suppliers and 592 components are contained that are related with each other through plurivalent assignments of the supply relationships.

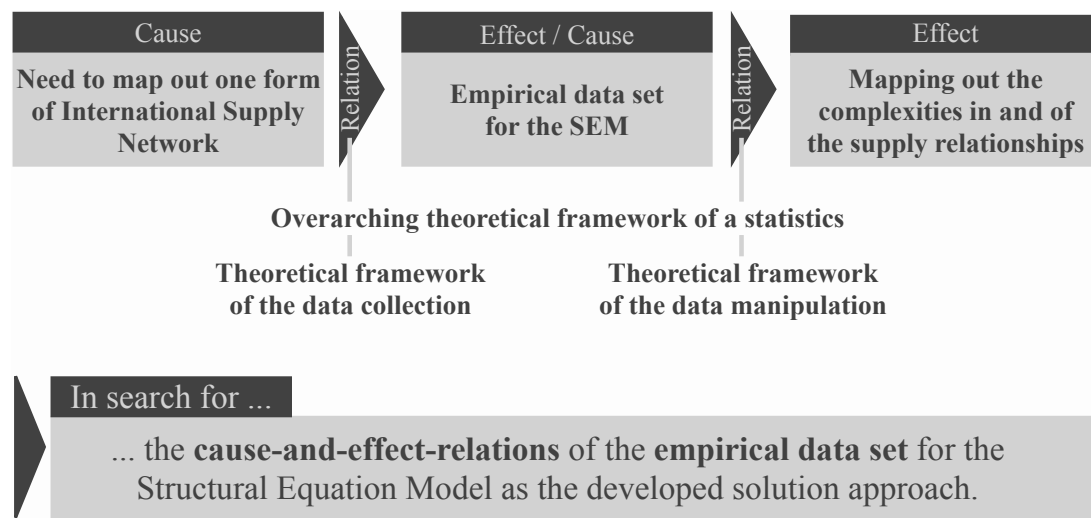
⁹³ Cf. the discussion of the empirical results in section 4.5.

4.1.2 Analytic research task: Cause-and-effect relations for the empirical data set of the supply relationships

The **analytic scientific aim** of this subsection for examining the empirical data set consists of two perspectives: while the **cause-perspective** deals with the **reasons**, the **effects-perspective** points to the **consequences with respect to the complexities**.

Analytic research task of Subsection 4.1.2

Figure 4-4: In search for the cause-and-effect relations of the empirical data set



In search for the cause-and-effect relations of the empirical data set

Source: Own illustration.

The **cause-perspective** broaches the issue about the **collection of the information** because it has to be examined how to gain information about one form of an International Supply Network for the developed SEM-approach. Therefore, this analytic consideration can be **assigned into the field of statistics** due to the fact that the data collection is defined as strategies for the empirical information retrieval (Schwaiger & Zimmermann, 2009, p. 419 et sq.). In principle, different empirical data sets about the German automotive industry can be distinguished because different forms of – vertical and horizontal – cooperation – as outlined in Section 2.1 – can be differentiated from each other so that each single form of cooperation constitutes a network so that for example (Colmorn et al., 2013) use the expression of a network of value creation networks. Hereby, it can be assumed that each single network leads to different formings of the hypothesized effects because of their different nature with different focal points. The **empirical data set** is **contained** to the supply relationships because of the following reasons: Firstly, for investigating the effects of each type of cooperative network a step-wise empirical validation is

Cause-perspective

needed because only by holding the other influences constant (*ceteris paribus*) the effects can be detected. Therefore, in a strict scientific sense each network has to be tested individually before different combinations can be tested at the same time. Secondly, for testing the complexity effects the network of the supply relationships seems to be more promising because of a higher number and variety of supply relationships e.g. in comparison with horizontal forms such as marketing agreements so that the features of complexity are better met. Thirdly, by considering the stages of development of the term of logistics (cf. Section 2.1), this type of network seems to be a more fundamental one because the exchange of material was the initial point for the development of ISN. Therewith, a hierarchy of the forms of cooperation can be assumed in a way that the exchange of material is the grounding aspect while the other forms of cooperation (e.g. for the exchange of information) are more sophisticated. For these reasons, it is assumed that the containment of the empirical data set to supply relationships for the first empirical validation is a promising approach. The reason for the data collection can be traced back to a **gap of knowledge** because, for example, according to (Brintrup et al., 2011) (cf. (Colmorn et al., 2013)) maps about the supply relationships of the automotive industry are missing. By doing research, maps about the supply relationships of the German automotive industry could not be found. Therefore, it is the **idea** to analyse whether the above-depicted empirical data set can be traced back to the requirements of the developed solution approach. Hereby, this approach is **based** on the **assumption** of the complexity-based research model because of the considerations in Section 2.2 so that the – structural - complexity is considered to be the exogeneous variable. Therefore, it is the **aim** to split up the information contained in the empirical sources to map out the structural complexity. Therefore, it is the **central conclusion** that this data collection should be separated with regard to the structural relations, i.e. the elements and relations, because of the definiens of the structural complexity.

Elements

In Section 2.1, the elements of the International Supply Networks of the German automotive industry were identified as **organisational units**. These organisational units can be further subdivided because the value creation system of the automotive industry had been classified as a strategic network in which a focal firm coordinates its supplying partners. For this reason, the **organisational units** are further subdivided into the **car manufacturers** and **suppliers as elements** of the – German – automotive industry. Hence, two further differentiations can be done: On the one side, the organisational units of the car manufacturers as elements of the automotive industry can be differentiated because of a corporate group that contains several brands (both are organisational units) (Grant, 2010, pp. 177–180; Wöhe, 2000, p. 315 et sqq.) so that a **corporate group** and the **brand** can be distinguished with

respect to super-elements and elements; on the other side, the **car manufacturers** and **suppliers as elements** can be further distinguished on a sub-level because of the models produced by the brands and the components produced by the suppliers. Therefore, each of these elements is further specified through the **sub-elements of the models** and the **sub-elements of components** (cf. also the focus on the production-related understanding of the definiens of the ISN of the – German – automotive industry in Section 2.1). As a result, for mapping out the elements, individual data sets for the corporate groups as super-elements, brands and suppliers as elements as well as models and components as sub-elements have to occur.

An **individual data set for the corporate groups** arises because with reference to (Diez, 2012, p. 31) presenting an overview about the biggest car manufacturers worldwide so that **three German corporate groups of the BMW Group, Daimler AG and Volkswagen AG** can be identified (cf. also (Deutsche Börse, 2014; VDA e.V., 2014)). These three German corporate groups contain thirteen car manufacturers, i.e. brands, (cf. (BMW Group, 2013; Daimler AG, 2013; Volkswagen Aktiengesellschaft, 2013) excluding Bugatti*) as illustrated in Figure 4-5. Further corporate groups are Ford, General Motors, Fiat, AvtoZAZ, Bogdan, Caterham, PSA Peugeot-Citroen, Renault-Nissan, Fisker Automotive, GAZ, Tata, Proton, McLaren, MG, Morgan, Saab, TagAT, UAZ, Geely, BYD, Chery, Chrysler, Toyota, Great Wall, Honda, Hyundai Kia, Iran Khodro, Lifan, Mazda, Mitsubishi, Mahindra, Suzuki. For saving space, in the Appendix “Empirical data set” the models, their brands, their region and the corporate groups they are affiliated with are shown.

Corporate groups
as super-
elements

Figure 4-5: Individual data set for the three German corporate groups

Corporate group	Car manufacturers (brands)
BMW Group	BMW, Mini, Rolls-Royce
Daimler AG	Mercedes-Benz, Smart, Maybach
Volkswagen AG	Audi, Bentley, Bugatti*, Lamborghini, Seat, Skoda, Porsche, Volkswagen
As a result, an individual data set for the three German corporate groups containing thirteen car manufacturers as brands arises	

Source: With reference to (Diez, 2012, p. 31) (Bold refers to German).

An **individual data set for the brands** arises because from (AUTOMOBIL PRODUKTION, 2013c) the brands could be manually collected so that the following individual set for the brands⁹⁴ as elements – as illustrated in Figure 4-6 – arises. The full information can be found in the Appendix.

Brands and
supplier as
elements

⁹⁴ Alfa Romeo, Aston Martin, Audi, AvtoZAZ, Bentley, BMW, Bogdan, Bugatti, Buick, BYD, Cadillac, Caterham, Chery, Chevrolet, Chrysler, Citroen, Dacia, Daihatsu, Dodge, Ferrari, Fiat, Fisker Automotive, Ford, GAZ, Geely, Great Wall, Honda,

Figure 4-6: Individual data set for the brands as elements

No.	Brand	Region	Corporate group
B_1	Audi	Germany	Volkswagen
...	...	...	...
B_10	Volkswagen	Germany	Volkswagen
B_11	Alfa Romeo	Europe	Fiat
...	...	...	...
B_44	Vortex	Europe	TagAZ
B_45	Buick	International	GM
...	...	...	...
B_69	Toyota	International	Toyota

An individual data set of 69 brands arises in which the brands are ordered alphabetically with respect to their region and their affiliated corporate group.

Source: Information manually retrieved from (AUTOMOBIL PRODUKTION, 2013c)

An **individual data set for the supplier** arises, too, because information for the suppliers could be collected with the help of the information shown in (AUTOMOBIL PRODUKTION, 2013c) that could be manually depicted into an individual data set about 564 German suppliers as illustrated in Figure 4-7.

Figure 4-7: Individual data set for the supplier as elements

No.	Supplier	Zip	City	Country
S_1	2E mechatronics GmbH & Co. KG	73249	Wernau	Germany
S_2	3A Composites GmbH	49090	Osnabrück	Germany
...	...	...	...	...
S_564	Zizala Lichtsysteme GmbH	3250	Wieselburg	Austria

A database arises in which 564 German-speaking supplier are listed with their assigned zip-code, city and country.

Source: Own illustration.

Models and components as sub-elements

Information for the **individual data set for the models as sub-elements** of the car manufacturers could be collected because from (AUTOMOBIL PRODUKTION, 2013c) the models could be manually taken. As a result, an individual data set for the models as sub-elements of the car manufacturers arises in which 787 different models – represented through a control variable from M_1 to M_787 – are affiliated

Hyundai, Infiniti, Iran Khodro, Iveco, Jaguar, Jeep, Kia, Lada, Lamborghini, Lancia, Land Rover, Lexus, Lifan, Lotus, Maserati, Maybach, Mazda, McLaren, Mercedes-Benz, MG, Mini, Mitsubishi, Morgan, Nissan, Opel, Peugeot, Porsche, Renault, Rolls-Royce, Saab, Seat, Skoda, Smart, Ssangyong, Suzuki, TagAZ, Tata, Toyota, UAZ, Volkswagen, Volvo, Vortex.

to 69 different brands, i.e. car manufacturers and their corresponding corporate groups (35 in total), and to one of three regions (cf. Figure 4-8).

Figure 4-8: Models as sub-elements of the car manufacturers

No.	Model	Brand	Corporate group	Region
M_1	A1	Audi	Volkswagen	Germany
M_2	A1	Audi	Volkswagen	Germany
...	...	...	...	...
M_234	Up 3-Türer	Volkswagen	Volkswagen	Germany
M_235	159 2011	Alfa Romeo	Fiat	Europe
...	...	...	...	...
M_592	Tingo	Vortex	TagAZ	Europe
M_593	Regal	Buick	GM	International
...	...	...	...	...
M_787	Yaris	Toyota	Toyota	International

▶ A data set with **787 different models** assigned to 69 different brands arises

Source: Own illustration.

Information for the **sub-elements** of the suppliers could be collected because from (AUTOMOBIL PRODUKTION, 2013c) the components shown there could be manually taken. As a result, an individual data set for the models as sub-elements of the car manufacturers arises in which 592 different components – represented through a control variable from C_1 to C_592 – are collected (cf. Figure 4-9).

Figure 4-9: Components as sub-elements of the suppliers

Component group	No.	Component	No.
Exhaust systems / Exhaust aftertreatment	I	Exhaust systems	C_1
Exhaust systems / Exhaust aftertreatment	I	Exhaust catalysts	C_2
...	...	...	...
Display and recording instruments	II	Display instruments	C_25
...	...	...	...
Materials	XIX	Textile materials for interior cladding	C_592

▶ Total number of component groups: 19 ▶ Total number of components: 592

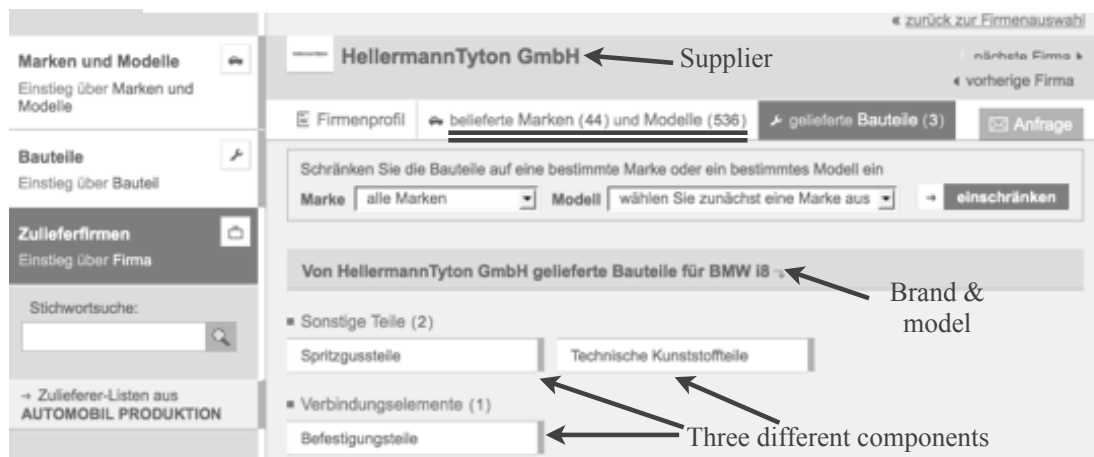
Source: Own illustration.

A **data set for the relations** could be retrieved because the information contained in the supplier data base of (AUTOMOBIL PRODUKTION, 2013c) enabled the collection of the supply relationships. For example, as exemplary illustrated in Figure 4-10 it is shown that a supplier (e.g. *Hellermann Tyton GmbH*) supplies different components (e.g. *Spritzgussteile*, *Technische Kunststoffteile* and

RELATIONS

Befestigungselements) to which brand and model (e.g. *i8* of *BMW*). Hereby, it can also be seen that this supplier supplies to forty-four brands and 536 models in total so that for each brand such a screenshot as shown in Figure 4-10 occurs. Therewith, with the help of all these information of all suppliers a data set or the relations of the supply relationships as illustrated in Figure 4-11 arises.

Figure 4-10: Information of the supplier database



Consequently,

by using a typical supplier it can be seen that this supplier supplies three different components to the model *i8* of the brand *BMW* as well as to 536 models of 44 brands so that the **supply relationships** can be mapped out.

Source: Screenshot taken from (AUTOMOBIL PRODUKTION, 2013c).

As a response to the need for mapping out one form of International Supply Network, the above-shown individual data sets **contribute** to close a gap of knowledge because the supply relationships as the selected type of network could be mapped out so that an empirical data set exists. Hence, this is **limited** with regard to the fact that it cannot be proved if the information contained in the empirical data set are reliable and extensive so that a potential bias in the collected data cannot be excluded.

Figure 4-11: Relations of supply relationships

No.	Supplier	Component	Brand	Models
1	Friedrich Boysen GmbH & Co. KG	Abgasanlagen	Audi	A4, A4 Allroad, A4 Avant (2007), A4 Cabriolet, A4 Limousine (2007), A5, A5 Cabrio, A5 Coupé, A5 Sportback, A5 Sportback 1.8T (06/10), Q5, Q5 (AU416), R8, R8 (AU714), R8 Spyder (04/10), TT (09/10), TT (AU324), TT (AU334), TT Coupé, TT Roadster (2007)
...	...	...	...	...
11848	Schneiderfilz Schneider GmbH & Co. KG	Textilwerkstoffe für Innenraumverkleidungen	Volkswagen	Passat Limousine, Passat Variant, Phaeton, Touareg, Touran
 A data set with 11848 supplier-component-brand-supply relationships -including their models! - arises				

Source: Own illustration.

Consequently, it has been analysed that the empirical data set for the supply relationships of the German automotive industry can be traced back to the developed SEM-approach because individual data sets for the brands and supplier as well as brands and components and their corresponding supply relationships could be collected. Therefore, an empirical data set for the elements and relations of the International Supply Networks of the German automotive industry arises. Hence, the question arises, if this empirical data set allows calculating the complexities.

Conclusions for
the cause-
perspective

Effects-
perspective

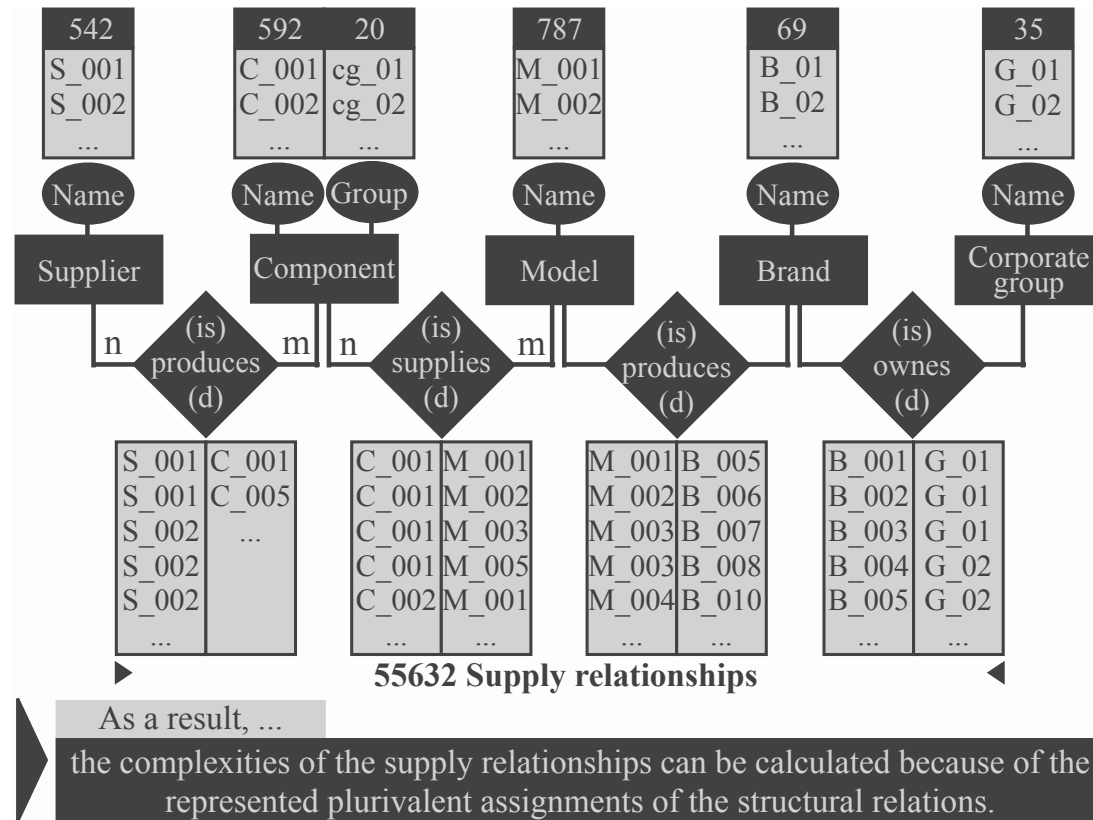
The **effects-perspective** deals with the **aftermaths of this empirical data set** about the supply relationships of the German automotive industry because the question arises about why to use these collected empirical information. Therefore, the analysis of the effects-perspective can be **assigned to the overarching theoretical framework of multivariate statistics** because it shall highlight about how to process these data for enabling a statistical analysis. Because of the plurivalent assignments that were outlined in previous subsection, this analytic consideration has to deal with the characteristic of plurivalent relations e.g. a supplier can supply one or more components to one or more models.

SQL framework

Against this background, it is the **idea** to use the **SQL framework** because according to (Gennick, 2007; Matthiesen & Unterstein, 2003) SQL is characterised as a methodological framework for defining data structures in relational data sets. Because of this it is the **aim** to formally represent (and manipulate) all these plurivalent assignments contained in the empirical data set because of the following reason: If the complexities in and of the supply relationships have to be calculated, then the amount and diversity of the elements and relations have to exist because of the definition of the structural complexity outlined in Section 2.2. Hence, if the amount and diversity of the elements and relations, i.e. the structural relations, have to be considered, then plurivalent assignments have to be figured out because they indicate an amount and diversity of elements relations. Therefore, if the plurivalent assignments can be figured out with the help of the **SQL-framework**, then a calculation of the complexities in and of the supply relationships of the German automotive industry becomes possible. According to (Gennick, 2007; Matthiesen & Unterstein, 2003) the systematic approach of the **SQL-framework** is **based** on the so-called Entity-Relationship-(ER)-diagram **targeted towards** the formalisation of all the contained information from the sources into one data base. Hereby, rectangles represent the objects to be investigated, i.e. the elements, that can be specified through oval forms e.g. through their names or their running variables. The relations between these objects, i.e. elements, are represented through lines with diamond-shaped boxes, e.g. “produces” or “supplies”, for symbolising the relationships. Hereby, the so-called “n-m-notation” indicates a mutual/reciprocal assignment while a “n-1-” respectively “1-m-notation” shows a onesided assignment. Therefore, it is the **central conclusion** that the complexities in and of the supply relationships can be calculated because the empirical data set can be formally represented through the SQL-framework – the supplier, components, models, brands and corporate groups have to be identified as elements that have to be represented through rectangles – containing several “n-m-notations” so that these plurivalent assignments point to the amount and diversity of the elements and relations of the structural complexity (cf.

Figure 4-12). It is the **main contribution** of the **SQL-framework** that with the help of this systematic approach the plurivalent assignments in the empirical data set can be represented through the “n-m-notation” and that big empirical data sets can be structured and processed in a reproducible way while it is the **main limitation** that the **SQL-framework** has to be considered as a language for data bases so that it can only build the prestep for the actual analysis.

Figure 4-12: SQL-framework for the formalisation of the plurivalent assignments



Source: Own illustration.

As a result, the International Supply Network (supply relations) of the German automotive industry can be mapped out because all the relations are systematically arranged with the help of the SQL-formalism so that the complexities in and of the supply relationships of the German automotive industry can be calculated due to the representation of the plurivalent assignments of the structural relations.

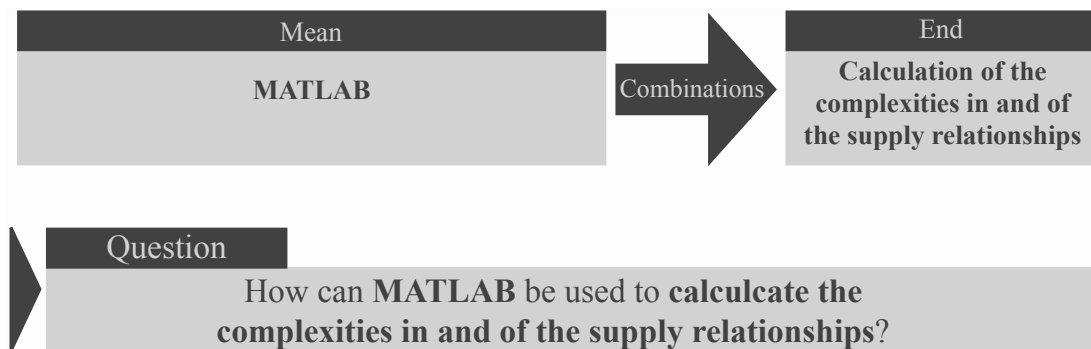
Conclusions for
the effects-
perspective

4.1.3 Pragmatic research task: A MATLAB-cockpit for calculating the complexities in and of the supply relationships

Pragmatic
research task of
Subsection 4.1.3

Because of the **central subject of consideration** of this section, the **end-means combinations** of this subsection are **targeted towards the handling of the empirical data set**. Therewith, the **pragmatic scientific aim** of this subsection consists of identifying a methodological approach as a mean for calculating the complexities in and of the supply relationships (cf. Figure 4-13). In order to do so, the empirical data set has to be transformed into metrical nature.

Figure 4-13: MATLAB for calculating the complexities



Source: Own illustration.

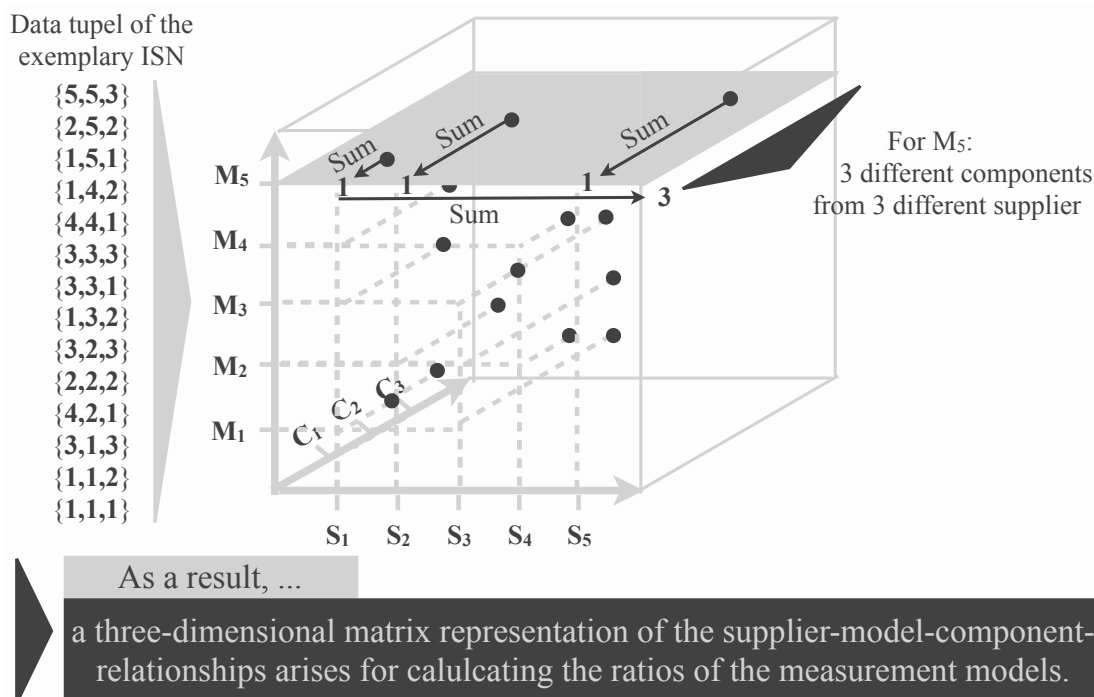
MatLab

MATLAB shall be used as a means towards the above-outlined end because it is considered to be an approach for the usage of automated methods for (the acquisition/collection and) the processing of data so that **MATLAB** can be **assigned into the field of Electronic Data Processing** (EDP; German: EDV). Besides other approaches for the processing of data such as for example SPSS or Excel, MATLAB will be used because of its automatisisation so that the overarching pragmatic scientific aim outlined in Section 1.4 is achieved because it enables an automated processing in the sense of a management cockpit. The **origin** of MATLAB can be traced back to Cleve Moler who developed **MATLAB** (MATrix LABoratory) at the University of New Mexico at the end of the 1970's and who founded with Jack Little and Steve Bangert in 1984 *The MathWorks-Corporation* for making it a commercial product (Beucher, 2006, p. 10). Despite of its further development, **MATLAB** can generally be **classified** as an approach for a numerical calculation with the help of matrices (Beucher, 2006, p. 10 et sqq.).

Because of this it is the **idea** to transform the verbal information contained in the empirical data set into metrical nature with the help of matrices towards the **aim** to

acquire the collected information of the empirical data set into a matrix notation and to calculate the – complexity-based – measures for the first and second measurement models.⁹⁵ This approach is **based** on the **main assumption** that **MATLAB** has a main advantage because while other computeralgebra-programes require complex data formats that generally lead to a complex syntax and complex programmes for the users, **MATLAB** basically just knows in principle one data structure that can work as the basis for all other operation, i.e. the numerical array or the Matrix (Beucher, 2006, p. 10). Therefore, it is the **central conclusion** that **MATLAB** is promising tool because due to the representation of the empirical data with the help of the SQL-framework the information all the information can be collected and processed in the form of a (3-dimensional) matrix-representation as it is illustrated in Figure 4-14. Therewith, by concentrating on the grounding data structure of the matrix the empirical data can be more easily computed (Beucher, 2006, p. 11).

Figure 4-14: Illustration of the 3-dimensional matrix for the MATLAB-cockpit



Source: Own illustration. Points indicate a “1” as an entry for a supply relationship.

The **main contributions** of the **MATLAB**-tool consists, firstly, in the automatisisation because once the programmes in **MATLAB** has been written, they can be used for all other data sets so that a management cockpit in the sense of the overarching pragmatic scientific aim can be achieved. For example, with the help of

⁹⁵ The third measurement model is just collected in metrical form from the business reports.

ten test samples the programmes were proved by comparing their results with the results calculated by hand; secondly, a certain liability can be assumed because the author wrote also his diploma with the help of **MATLAB** so that errors are less likely to occur as by learning a totally new software; thirdly, **MATLAB** is quite capable of being integrated because of its intuitive handling and relatively simple syntax so that it is commonly used and help is easily available. Nevertheless, some **main limitations** exist because **MATLAB** is not freely available and some Toolboxes are expensive while some programme structures are not as fast as other ones and it lags behind the status quo with respect to the support of a multiprocessor computation. As a **result** of the **MATLAB**-approach, five programs occur for calculating the complexities in and of the International Supply Networks.

Program 1

It is the **idea** of the **first program** to save the information of the empirical data set in a so-called csv.-format with the help of excel because this format simplifies the import into MATLAB. This is targeted towards the **aim** to import the data into MATLAB so that the information can be processed. It is **based** on so-called strings for representing the verbal representation into a cell array, i.e. hereby more strings (= elements) can be represented in one cell array for adequately dealing with the plurivalent assignments. As a **result**, the supply relationships of the empirical data set with the categories/columns of supplier, components, brands and models are imported into a matrix structure in MATLAB in the form of a cell array. The code for doing so is represented in Figure 4-15.

Figure 4-15: Code program 1

```
% Program : Step1DataImport.m
% is a program for the import of the empirical data set
%
% Richard Colmorn, 02-01-14
% Copyright (c) 2014 by Richard Colmorn
clear all
close all
clc
tic
% 1. step: Data import
% Import of the individual lists of the supplier,
% components, brands and
% models.
% File --> Import Data: Datensatz/List-Supplier.csv
S = [S1 S2];
% File --> Import Data: Datensatz/List-Components.csv
% File --> Import Data: Datensatz/List-Components-1.csv
% File --> Import Data: Datensatz/List-Components-2.csv
C = [C1 C2];
% File --> Import Data: Datensatz/List-Brands.csv
```

```
% File --> Import Data: Datensatz/List-Brands-1.csv
% File --> Import Data: Datensatz/List-Brands-2.csv
B = [B1 B2];
% File --> Import Data: Datensatz/List-Models.csv
% File --> Import Data: Datensatz/List-Models-1.csv
% File --> Import Data: Datensatz/List-Models-2.csv
M = [M1 M2];
% File --> Import Data: Datensatz/List-
SupplyRelations.csv
% File --> Import Data: Datensatz/List-SupplyRelations-
1.csv
% File --> Import Data: Datensatz/List-SupplyRelations-
2.csv
% File --> Import Data: Datensatz/List-SupplyRelations-
3.csv
% File --> Import Data: Datensatz/List-SupplyRelations-
4.csv
SupplyRelations = [SupplyRelations1 SupplyRelations2
SupplyRelations3 SupplyRelations4];
save Datensatz/Step1DataImport.mat
% Structure:
% B <69x2 cell>
% C <592x2 cell>
% M <787x2 cell>
% S <564x2 cell>
% SupplyRelations <
toc
```

Source: Own programing.

The **second program** follows the **idea** to anonymise the information of the empirical data set so that a name e.g. of the brand “Audi” is only represented through its running variable “B_1” as it was outlined in Figure 4-6 – Figure 4-9. The reason for this is twofold: On the one side, this unique labelling enables a correct processing with MATLAB because in the empirical data set with over 50.000 supply relationships the spelling might and had been different due to misspellings – if the full empirical data set can be translated into the running variables, then it has been taken care of that no misspellings are there so that nothing is in it that does not belong there. Finally, this makes it easier for enabling the cube. On the other side, this procedure shall enable to consider the property rights of the source of the empirical data set so that the plurivalent assignments are conserved because of just a new labelling but the information with the full names are still saved by the source that are reliable to pay money. This is **based** on the approach that every entry of the matrix is gone through and compared with a reference list of (e.g. all the brands) and replaced with the assigned running variable. This has been done a couple of times because it had to be checked if all the strings have been anonymised so that

Program 2

misspellings were manually updated. As **result** of this **second program** – that is depicted in Figure 4-16 –, the supply relationships of the empirical data set are anonymised and represented through their running variable (e.g. the car manufacturer *Audi* is only represented through its running variable *B_1* any longer).

Figure 4-16: Code program 2

```
% Program : Step2Anonymisieren.m
% is a program for the anonymisation of the information
% contained in the empirical data set through running
% variables
%
% Richard Colmorn, 02-01-14
% Copyright (c) 2014 by Richard Colmorn
clear all
close all
clc
tic
load Datensatz/Step1DataImport.mat % Data import from
% the first step
function [SupplyRelations1_Anonym] =
    fAnonymisieren(SupplyRelations1,S)
function [SupplyRelations2_Anonym] =
    fAnonymisieren(SupplyRelations2,C)
function [SupplyRelations3_Anonym] =
    fAnonymisieren(SupplyRelations3,B)
%%% function refers to a subprogram as it follows:
% function [Output] = fAnonymisieren(Input1,Input2)
Output(:,1) = Input1(:,1);
for ii = 1:length(Input1(:,1))
    for j = 1:length(Input2(:,2))
        testvariable = strcmp(Input1(ii,1),Input2(j,2));
        if testvariable == 1
            Output(ii,1) = Input2(j,1);
            ii = ii + 1;
        else
            ii = ii;
        end
    end
end
end
% Structure of the output:
% Output = [Variable_# Name], e.g. [S_1 Name of
% Supplier]
%%%
% SupplyRelations4 needs another approach because of
% its plurivalent fillings in the cell array
SupplyRelations4_Anonym = SupplyRelations4;
for x = 1:length(SupplyRelations4(:,1));
    for y = 1:numEntries(x,1);
        for z = 1:length(M(:,2))
```

```

        testvariable =
            strcmp(SupplyRelations4(x,y),M(z,2));
        if testvariable == 1
            SupplyRelations4_Anonym(x,y) = M(z,1);
        end
    end
end
x
end
save Datensatz/Step2Results.mat
toc

```

Source: Own programing.

It is **idea** of the **third program** to create the three-dimensional cube that has been introduced above because of the **aim** to have a three-dimensional matrix representation of the supply relationships. This approach is **based** on the structure array of MATLAB with which different arrays can be combined to more complex data structures. As a **result**, the information contained in the empirical data set can be transformed into a representation of a three dimensional coordinate system whereby the x-axis represented a supplier (dimension: 564), the y-axis a model (dimensions: 787) and the z-axis a component (dimensions: 592) so that a numerical entry indicates the amount of supply relationships between the corresponding supplier, model and component. The program code is shown in Figure 4-17.

Program 3

Figure 4-17: Code program 3

```

% Program : Step3.m
% is a program for the representing the supplier-
% component-model-relationships through a 3-dimensional
% cube in which a supply relationship (e.g. S_1
% supplies C_4 to M_5) through a 1 elsewhere 0.
%
% Richard Colmorn, 02-01-14
% Copyright (c) 2014 by Richard Colmorn
tic
clear all
close all
load Datensatz/Step2Results.mat
% load Testlauf10/Testlauf10.mat
% load Testlauf9/Testlauf9.mat
% load Testlauf8/Testlauf8.mat
% load Testlauf7/Testlauf7.mat
% load Testlauf6/Testlauf6.mat
% load Testlauf5/Testlauf5.mat
% load Testlauf4/Testlauf4.mat
% load Testlauf3/Testlauf3.mat
% load Testlauf2/Testlauf2.mat

```

```
% load Testlauf/Testlauf.mat
Supplier = SupplyRelations1_Anonym; % or =
SupplyRelations1 in case of TestlaufX
Component = SupplyRelations2_Anonym; % or =
SupplyRelations2 in case of TestlaufX
Brand = SupplyRelations3_Anonym;% or = SupplyRelations3
in case of TestlaufX
Model = SupplyRelations4_Anonym;% or = SupplyRelations4
in case of TestlaufX
% STRUCT creates or converts to structure array. Hereby,
(4-dimensional)
% only labelling without contents (because of "{}").
RelationsStruct =
struct('Supplier',{},'Component',{},'Brand',{},'Model',{
});
N = size(Supplier,1);%N=size(SupplyRelations1_Anonym,1);
% Transformation of running variables into numbers, e.g.
% S_5 --> 5 or M_12 --> 12 because this trick enables a
% simpler calculation.
for kk = 1:N
    RelationsStruct(kk).Supplier =
str2num(regexprep(Supplier{kk},'S_',''));
    %RelationsStruct(kk).Supplier =
str2num(regexprep(SupplyRelations1_Anonym{kk},'S_',''));
    RelationsStruct(kk).Component =
str2num(regexprep(Component{kk},'C_',''));
    %RelationsStruct(kk).Component =
str2num(regexprep(SupplyRelations2_Anonym{kk},'C_',''));
    RelationsStruct(kk).Brand =
str2num(regexprep(Brand{kk},'B_',''));
    %RelationsStruct(kk).Brand =
str2num(regexprep(SupplyRelations3_Anonym{kk},'B_',''));
    % Due to the fact that several models can be stored
in a cell array,
    % another approach is needed
    RelationsStruct(kk).Model = cell2mat(cellfun(@(x)
str2num(regexprep(x,'M_','')),Model(kk,:),'uniformoutput
',false));
    %RelationsStruct(kk).Model = cell2mat(cellfun(@(x)
str2num(regexprep(x,'M_','')),SupplyRelations4_Anonym(kk
,:),'uniformoutput',false));
end
% Determining the maximizing amount of entries
nSupplier = max([RelationsStruct.Supplier]);
nModel = max([RelationsStruct.Model]);
nComponent = max([RelationsStruct.Component]);
% Construction of the cube by creating x-, y- and z-axes
with the length
% of maximum amount of entries. At the beginning, every
entry of the cube
% is filled with zeros.
% Therewith, "SuppModComp" is a tuple for depicting the
```



```

three dimensions,
% whereby brands are neglected.
SuppModComp = false(nSupplier,nModel,nComponent);
for kk=1:N
    subModel = RelationsStruct(kk).Model;
    subSupplier = RelationsStruct(kk).Supplier *
ones(size(subModel));
    subComponent = RelationsStruct(kk).Component *
ones(size(subModel));
    ind =
sub2ind([nSupplier,nModel,nComponent],subSupplier,subModel,subComponent);
    SuppModComp(ind) = true;
end
% With the command „SuppModComp“ it can be shown which
% models are supplied from which suppliers, e.g.
% RelationsStruct([RelationsStruct.Supplier] == 1).Model
clear N ind kk subModel subComponent subSupplier
save Datensatz/ResultsStep3-Latest.mat
% save Testlauf/TestlaufResultsStep3.mat
% save Testlauf2/Testlauf2ResultsStep3.mat
% save Testlauf3/Testlauf3ResultsStep3.mat
% save Testlauf4/Testlauf4ResultsStep3.mat
% save Testlauf5/Testlauf5ResultsStep3.mat
% save Testlauf6/Testlauf6ResultsStep3.mat
% save Testlauf7/Testlauf7ResultsStep3.mat
% save Testlauf8/Testlauf8ResultsStep3.mat
% save Testlauf9/Testlauf9ResultsStep3.mat
% save Testlauf10/Testlauf10ResultsStep3.mat
toc

```

Source: Own programing.

The **fourth programme** expresses the **idea** to compute the equations of the first measurement model because of its **aim** to calculate the complexity measures $enc_A - enc_D$. This approach is **based** on the matrix operations that e.g. the sums over the x-, y- and/or z-axis are representations of logics of the equations. As a **result**, an automatic program occurs as shown in Figure 4-18 with whom it becomes possible to automatically calculate the complexity measures $enc_A - enc_D$ of a given network.

Program 4

Figure 4-18: Code program 4

```

% Program : Step4.m
% is a program for calculating the complexity-measures
% encA - encD
%
% Richard Colmorn, 02-01-14
% Copyright (c) 2014 by Richard Colmorn
tic

```

```

clear all
close all
load Datensatz/ResultsStep3.mat
% load Testlauf/TestlaufResultsStep3.mat
% load Testlauf2/Testlauf2ResultsStep3.mat
% load Testlauf3/Testlauf3ResultsStep3.mat
% load Testlauf4/Testlauf4ResultsStep3.mat
% load Testlauf5/Testlauf5ResultsStep3.mat
% load Testlauf6/Testlauf6ResultsStep3.mat
% load Testlauf7/Testlauf7ResultsStep3.mat
% load Testlauf8/Testlauf8ResultsStep3.mat
% load Testlauf9/Testlauf9ResultsStep3.mat
% load Testlauf10/Testlauf10ResultsStep3.mat
clear Brand Component Model Supplier
SupplyRelations1_Anonym
clear SupplyRelations2_Anonym SupplyRelations3_Anonym
SupplyRelations4_Anonym
clear nComponent nModel nSupplier
load Datensatz/SCBM.mat
%load Testlauf10/BrandModelMatrix.mat
%load Testlauf9/BrandModelMatrix.mat
%load Testlauf8/BrandModelMatrix.mat
%load Testlauf7/BrandModelMatrix.mat
%load Testlauf6/BrandModelMatrix.mat
%load Testlauf5/BrandModelMatrix.mat
%load Testlauf4/BrandModelMatrix.mat
%load Testlauf3/BrandModelMatrix.mat
%load Testlauf2/BrandModelMatrix.mat
%load Testlauf/BrandModelMatrix.mat
% In "SuppModComp" the supply relationships are
% represented as it is illustrated as follows with the
% help of the exemplary ISN (Testsatz):
%SuppModComp(:, :, 1) =
%      1      0      0      0      1
%      0      0      0      0      0
%      0      0      1      0      0
%      0      1      0      1      0
%      0      0      0      0      0
%SuppModComp(:, :, 2) =
%      1      0      1      1      0
%      0      1      0      0      1
%      0      0      0      0      0
%      0      0      0      0      0
%      0      0      0      0      0
%SuppModComp(:, :, 3) =
%      0      0      0      0      0
%      0      0      0      0      0
%      1      1      1      0      0
%      0      0      0      0      0
%      0      0      0      0      1
TotalRelations = sum(SuppModComp(:)) % Total amount of
% supply relationships

```

```

load Datensatz/BrandModelMatrix.mat
% Hereby, the relations between a brand and a model are
% represented through a „1“, e.g. for the exemplary ISN:
% BrandModelMatrix =
% B1-->    [1 1 0 0 0
% B2-->      0 0 1 1 0
% B3-->      0 0 0 0 1];
% BrandModelMatrix = [1 1 0 0 0; 0 0 1 1 0; 0 0 0 0 1];

%%%%%% Calculation of encA
SumOverComponents = sum(SuppModComp(:,:,:),3); % Sum
over z-axis
SumOverComponentsAndSupplier =
sum(SumOverComponents,1); % Amount of
% supply relationships for every model M
hilfsvektor3 =
BrandModelMatrix*SumOverComponentsAndSupplier';
hilfsvektor4 =
sum(logical(BrandModelMatrix*logical(SumOverComponents)'
),2);
encA = hilfsvektor3./hilfsvektor4;
save Datensatz/encA.mat encA

%%%%%% Calculation of encB
% For calculating the amount of the different supplier
% pro model, just a knowledge about an exist relation is
% needed. Due to the fact that in „SumOverComponents“
% the amount of component-relations is summed up, the
% result is logic representation of zeros and ones.
SumSupplierProModel = sum(logical(SumOverComponents),1);
for ii = 1:length(SumSupplierProModel)
    if SumSupplierProModel(1,ii) == 0
        ii
        SumSupplierProModel(1,ii) = 1
    end
end
hilfsvektor1 =
SumOverComponentsAndSupplier./SumSupplierProModel;
hilfsvektor2 = BrandModelMatrix*hilfsvektor1';
encB = hilfsvektor2./sum(BrandModelMatrix,2);
clear ii
save Datensatz/encB.mat encB

%%%%%% Calculation of encC
SupplierBrand = SumOverComponents*BrandModelMatrix';
for uu = 1:size(SuppModComp,3)
    SuppBrandComp(:,:,uu) =
SuppModComp(:,:,uu)*BrandModelMatrix';
end
SumOverModelsAtBrands = sum(SuppBrandComp(:,:,:),2);
for tt = 1:size(SuppBrandComp,1)
    for ss = 1:size(SuppBrandComp,2)

```

```

        for rr = 1:size(SuppBrandComp,3)
            if SuppBrandComp(tt,ss,rr) > 0
                YY(tt,ss,rr) =
SumOverModelsAtBrands(tt,1,rr) -
SuppBrandComp(tt,ss,rr);
            else
                YY(tt,ss,rr) = 0;
            end
        end
    end
end
clear rr
clear ss
clear tt
hilfsvektor7 = sum(sum(YY(:,:,,:),3),1);
hilfsvektor8 = sum(SupplierBrand,1);
encC = hilfsvektor7./hilfsvektor8;
encC = encC';
save Datensatz/encC.mat encC

%%%%% Calculation of encD
SumOverModels = sum(SuppModComp(:,:,:),2);
for tt = 1:size(SuppModComp,1)
    for ss = 1:size(SuppModComp,2)
        for rr = 1:size(SuppModComp,3)
            if SuppModComp(tt,ss,rr) > 0
                XX(tt,ss,rr) = SumOverModels(tt,1,rr) -
SuppModComp(tt,ss,rr);
            else
                XX(tt,ss,rr) = 0;
            end
        end
    end
end
clear rr
clear ss
clear tt
hilfsvektor5 =
sum(sum(XX(:,:,,:),3),1)./SumOverComponentsAndSupplier;
hilfsvektor6 = BrandModelMatrix*hilfsvektor5';
encD = hilfsvektor6./sum(BrandModelMatrix,2);
save Datensatz/encD.mat encD

%%% NORMIERUNG
encA = encA/max(encA);
encB = encB/max(encB);
encC = encC/max(encC);
encD = encD/max(encD);
MMI = [encA encB encC encD];
save Datensatz/MMI.mat MMI

save Datensatz/ResultsStep4.mat

```

```
% save Testlauf/TestlaufResultsStep4.mat
% save Testlauf2/Testlauf2ResultsStep4.mat
% save Testlauf3/Testlauf3ResultsStep4.mat
% save Testlauf4/Testlauf4ResultsStep4.mat
% save Testlauf5/Testlauf5ResultsStep4.mat
% save Testlauf6/Testlauf6ResultsStep4.mat
% save Testlauf7/Testlauf7ResultsStep4.mat
% save Testlauf8/Testlauf8ResultsStep4.mat
% save Testlauf9/Testlauf9ResultsStep4.mat
% save Testlauf10/Testlauf10ResultsStep4.mat
toc
```

Source: Own programing.

The **fifth programme** expresses the **idea** to compute the equations for the second measurement model because of its **aim** to calculate the ego network compositions. It is **based** on the matrix operations that e.g. the sums over the x-, y- and/or z-axis are representations of the logics of the equations. As a **result**, an automatic program occurs as shown in Figure 4-19 with whom it becomes possible to automatically calculate the ego network compositions q_1 & q_2 of a given network.

Program 5

Figure 4-19: Code program 5

```
% Program : Step5
% is a program for calculating the ego network
% compositions
%
% Richard Colmorn, 02-01-14
% Copyright (c) 2014 by Richard Colmorn
tic
clear all
close all
% IMPORT OF THE DATA that is needed
load Datensatz/SuppModComp.mat % <564x787x592 logical>
load Datensatz/BrandModelMatrix.mat % <69x787 double>
%%% SupplierEmployees = List0x2Dsupplier0x2Dqualities; %
<564x1 double>
%%% clear List0x2Dsupplier0x2Dqualities
load Datensatz/SupplierEmployees.mat % <564x1 double>
% SupplierModelMatrix
SumOverComponents = sum(SuppModComp(:,:,:),3); %
<564x787 double>
SupplierModelMatrix = logical(SumOverComponents); %
<564x787 logical>
% It is the idea to figure out how many components are
produced by a
% supplier.
XX = sum(SuppModComp(:,:,:),2); % <564x1x592 double>
for tt = 1:size(XX,1)
    for rr = 1:size(XX,3)
```

```

        SumOverModels(tt,rr) = XX(tt,1,rr);
    end
end
clear XX tt rr
% SumOverModels % <564x1x592 double>
% sum(sum(SumOverModels)) = 66178
SupplierComponentMatrix = logical(SumOverModels); %
<564x787 logical>
% sum(sum(SupplierComponentMatrix)) = 2372
% The vector "ComponentsProSupplier" indicates how many
% components are produced by a supplier
ComponentsProSupplier = sum(SupplierComponentMatrix,2);
for rr = 1:length(ComponentsProSupplier)
    if ComponentsProSupplier(rr) == 0
        ComponentsProSupplier(rr) = 1
    end
end
clear rr
% COMPONENTS PRO EMPLOOYEES
EmployeesProSupplierAndComponent =
SupplierEmployees./ComponentsProSupplier;
% BrandSupplierMatrix
BrandSupplierMatrix =
BrandModelMatrix*SupplierModelMatrix'; % <69x564 double>
BrandQuality1 = BrandSupplierMatrix*SupplierEmployees;
BrandQuality2 =
BrandSupplierMatrix*ComponentsProSupplier;
% <69x1 double> = <69x564 double> * <564x1 double>
% NORMIZATION
q1 = BrandQuality1/max(BrandQuality1);
q2 = BrandQuality2/max(BrandQuality2);
save Datensatz/q1.mat q1
save Datensatz/q2.mat q2
toc

```

Source: Own programing.

Conclusions for
the pragmatic
scientific aim

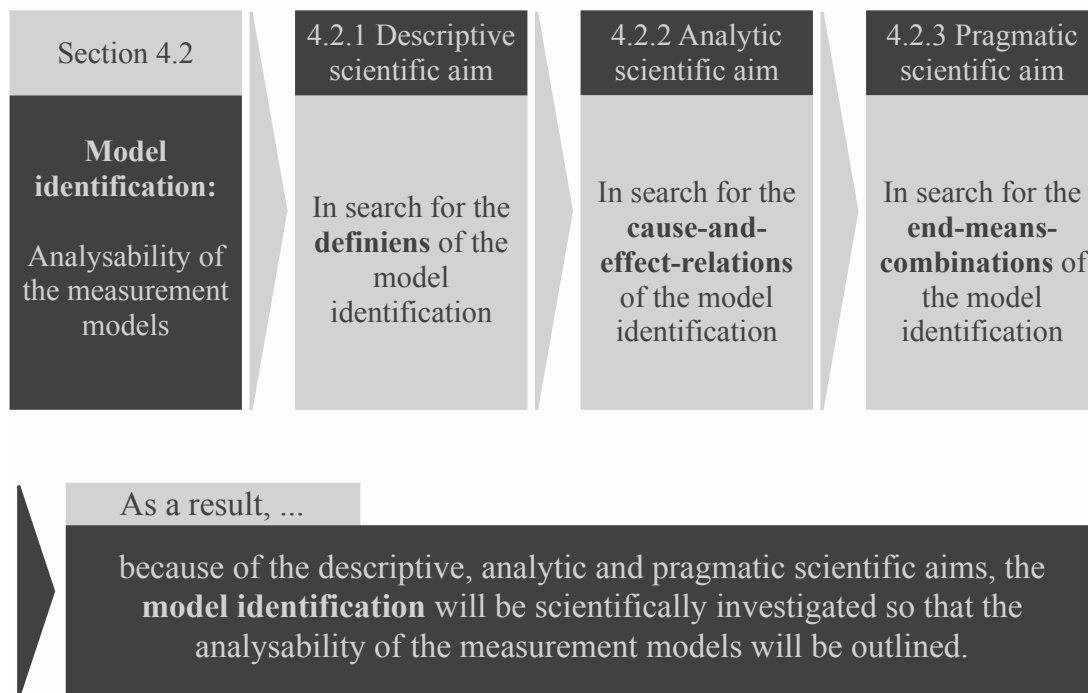
Consequently, the pragmatic scientific aim could be achieved because with the help of **MATLAB** the information contained in the empirical data set could be transformed into metrical nature in the form of a matrix. Therewith, the measurement models for the empirical validation of the developed SEM can be computed.

4.2 Model identification: Analysability of the measurement models

After having introduced the empirical data set that shall be used for the empirical validation of the solution approach, **Section 4.2 aims** at the **model identification** because it has been identified as the first step of the analysis respectively as the fourth step of a complete process of a Structural Equation Model (cf. subsection 3.1.3). Therefore, it has to be depicted what the model identification actually is (subsection 4.2.1) before the empirical data set can be analysed with regard to the identification (subsection 4.2.2). The section will conclude with the pragmatic scientific aim about how to handle it (subsection 4.2.3) (cf. Figure 4-20).

Overview over
Section 4.2

Figure 4-20: Overview over section 4.2



Source: Own illustration.

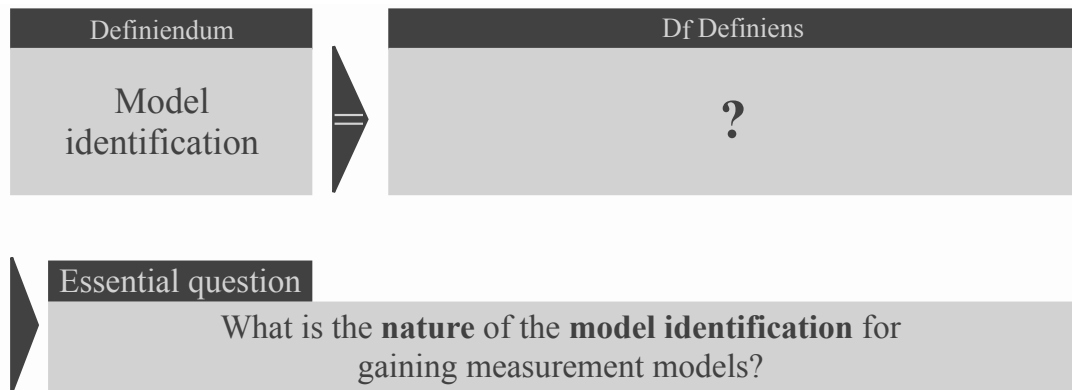
4.2.1 Descriptive research task: What is the model identification?

Descriptive
research task of
Subsection 4.2.1

It is the **descriptive scientific aim** to define what the model identification actually is. For this reason, the **definiens of the model identification is searched for** so that the essential question about its nature can be answered (Figure 4-21).

In search for the
definiens of the
model
identification

Figure 4-21: In search for the definiens of the model identification



Source: Own illustration.

Definiens of the
model
identification

The **definiendum of the model identification** can be **assigned to the field of multivariate statistics** because it was identified as the fourth step of a complete process of Structural Equation Modeling approach. Therewith, it can be **classified** further because it refers to the process of the statistical analysis while the first three steps were characterised as steps for the model development. According to (Raithel, 2009) the **idea** of the **model identification** refers to the so-called problem of identifiability. Hereby, a problem of identifiability exists if the available empirical data are deficient to deliver distinct parameter estimations for the specified model (Raithel, 2009, p. 548). Because of this it is the **aim** of the **model identification** to prove whether the information contained in the empirical data are adequate to “identify” the compiled equations so that the system of equations is uniquely solvable (Backhaus et al., 2011, p. 83). This can be explained with the help of the **basic assumption** that a Structural Equation Model constitutes a system of several equations that is only solvable, if the amount of the equations has at least the size as the amount of the parameters that have to be estimated (Backhaus et al., 2011, p. 83; Raithel, 2009, p. 549). Therewith, it is the **central conclusion** that the amount of the equations always corresponds to the amount of the different elements contained in the model-theoretic matrix of correlations. For example, if n indicator variables are measured, then $n(n+1)/2$ correlation coefficients can be calculated.

Therefore, the **main contribution** consists in formulating the so-called t-rule as a necessary condition for the identifiability whereby t refers to the amount of the parameters to be estimated whereas p and q are for the number of x - and y -variables:

Formula 4-1:
$$t \leq \left(\frac{1}{2}\right) \cdot (p + q) \cdot (p + q + 1)$$

Hence, the **main limitations** exists with regard to the fact that this condition – in general – is not sufficient for proving the identifiability of a model structure with certainty so that more criteria for the provement of the identifiability have to be taken into account. Therefore, no guarantee because further sufficient conditions depending on the approach.

As a result, the model identification can mainly be defined over the well-known t-rule that has to be fulfilled so that the system of equations can be solved.

Conclusions for
the descriptive
scientific aim

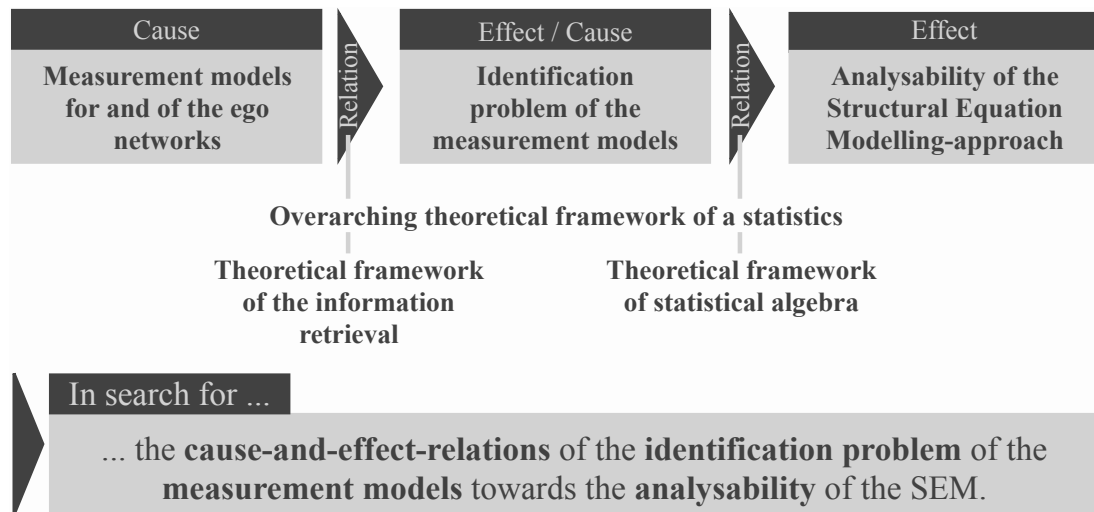
4.2.2 Analytical research task: Cause-and-effect relations of the identifiability of the measurement models for and of the ego networks

Analytic research task of Subsection 4.2.2

It is the **analytic scientific aim** of this subsection to investigate the **cause-and-effects-relations** of the **identification problem** because of the following reasons: As outlined in section 3.5, measurement models for and of the ego networks have to be collected for the solution approach so that the question arises, if these retrieved information for the network structure of the ISN fits to the requirements of the fourth step (**cause-perspective**) while with the help of the framework of statistical algebra an answer to this question has to be found (**effects-perspective**). A need for measurement models leads to the problem of identifiability leading to the consequence of the analysability (or not) for the following procedure.

In search for the cause-and-effect relations of the identification problem

Figure 4-22: In search for the cause-and-effect relations of the identification problem



Source: Own illustration.

Cause-perspective

The **cause-perspective** as being part of multivariate statistics broaches the issue about the effects of the compilation of the measurement models because with the result of previous section it has been analysed that the complexities in and of the International Supply Networks could be calculated so that measurement models can be compiled. Therefore, it is the **idea** of this perspective to present the three measurement models with their corresponding empirical data because herewith it becomes possible to fix the final Structural Equation Model for the empirical validation. This is targeted towards the **aim** to outline which Structural Equation Model has to be tested. Therewith, it can be checked, if with respect to the

requirements of multivariate statistical analysis a statistical test is possible. This outline of the Structural Equation Model containing empirical data for the measurement models is **based** on the calculation of the complexity ratios in the previous subsection on the one side and on the data collection from business reports for the third measurement model on the other side. A measurement model for the latent endogeneous variable of the company success could be compiled as well because with the help of the information contained in the business reports about the EBIT (=earnings before income and taxes) respectively the operative income their values for the $k = 69$ ego networks could be composed. The results are shown in the following Table 20 whereby the currency rates were calculated (cf. the fourth column) with the help of a webpage of (Bundesverband deutscher Banken E.V., 2014). Hereby, it is possible to set back the calculation of the currency rate to the point in time of the financial statements, e.g. the 31st March 2013 for most of the annual reports of the Japanese car manufacturers (-999 refers to the dummy variable for a not-retrievable entry).

No.	Brand	Operating income in Mio.	Currency rate	Operating income in Mio. €	References
B_1	Audi	9.923 €	/	9923	(Volkswagen Aktiengesellschaft, 2013, p. 105) Operatives Ergebnis
B_2	BMW	8.300 €	/	8300	(BMW Group, 2013, pp. 5, 19) EBIT
B_3	Ford	6010 \$	1 \$ = 0,78 €	4688	(Ford Motor Company, 2013, p. 2) Income before income taxe, auto
B_4	Maybach	4.389 €	/	4389	(Daimler AG, 2013, p. 92) EBIT
B_5	Mercedes-Benz	4.389 €	/	4389	(Daimler AG, 2013, p. 92) EBIT
B_6	Mini	8.300 €	/	8300	(BMW Group, 2013, pp. 5, 19) EBIT
B_7	Opel	7116 \$	1 \$ = 0,78 €	5550	(General Motors Company, 2013, p. 28) EBIT
B_8	Porsche	9.923 €	/	9923	(Volkswagen Aktiengesellschaft, 2013, p. 105) Operatives Ergebnis
B_9	Smart	4.389 €	/	4389	(Daimler AG, 2013, p. 92) EBIT
B_10	VW PkW	9.923 €	/	9923	(Volkswagen Aktiengesellschaft, 2013, p. 105) Operatives Ergebnis
B_11	Alfa Romeo	204 €	/	204	(Fiat Group, 2013, p. 14) EBIT
B_12	Aston Martin	6010 \$	1 \$ = 0,78 €	4688	(Ford Motor Company, 2013, p. 2) Income before income taxe, auto
B_13	AvtoZAZ	21811 RUB	1 RUB = 0,025 €	545	(AvtoZAZ Group, 2013, p. 6) Gross profit
B_14	Bentley	9.923 €	/	9923	(Volkswagen Aktiengesellschaft, 2013, p. 105) Operatives Ergebnis
B_15	Bogdan	Not retrievable		-999	
B_16	Bugatti	Not retrievable		-999	Cf. (Volkswagen Aktiengesellschaft, 2013, p. 104)
B_17	Caterham	Not retrievable		-999	
B_18	Citroen	1504 €	/	1504	(PSA Peugeot Citroen, 2013, p. 19) Operating income automotive
B_19	Dacia	122 €	/	122	(Renault, 2013, p. 2) Operating inc.
B_20	Ferrari	204 €	/	204	(Fiat Group, 2013, p. 14) EBIT
B_21	Fiat	204 €	/	204	(Fiat Group, 2013, p. 14) EBIT
B_22	Fisker automotive	Not retrievable		-999	
B_23	GAZ	Not retrievable		-999	
B_24	Iveco	204 €	/	204	(Fiat Group, 2013, p. 14) EBIT
B_25	Jaguar	21805 INR	1 INR = 0,014 €	305	(Tata Group, 2013, p. 1) Gross profit
B_26	Lada	21811 RUB	1 RUB = 0,025 €	545	(AvtoZAZ Group, 2013, p. 6) Gross profit

B_27	Lamborghini	9.923 €	/	9923	(Volkswagen Aktiengesellschaft, 2013, p. 105) Operatives Ergebnis
B_28	Lancia	204 €	/	204	(Fiat Group, 2013, p. 14) EBIT
B_29	Land Rover	21805 INR	1 INR = 0,014 €	305	(Tata Group, 2013, p. 1) Gross profit
B_30	Lotus	Not retrievable		-999	
B_31	Maserati	204 €	/	204	(Fiat Group, 2013, p. 14) EBIT
B_32	McLaren	Not retrievable		-999	
B_33	MG	Not retrievable		-999	
B_34	Morgan	Not retrievable		-999	
B_35	Peugeot	1504 €	/	1504	(PSA Peugeot Citroen, 2013, p. 19) Operating income automotive
B_36	Renault	122 €	/	122	(Renault, 2013, p. 2) Operating inc.
B_37	Rolls-Royce	8.300 €	/	8300	(BMW Group, 2013, pp. 5, 19) "EBIT"
B_38	Saab	Not retrievable		-999	Cf. (Saab Group, 2013)
B_39	Seat	9.923 €	/	9923	(Volkswagen Aktiengesellschaft, 2013, p. 105) "Operatives Ergebnis"
B_40	Skoda	9.923 €	/	9923	(Volkswagen Aktiengesellschaft, 2013, p. 105) "Operatives Ergebnis"
B_41	TagAZ	8436947 KRW	1 KRW = 0,001 €	8437	(Hyundai Motor Group, 2013, p. 6) Operating income
B_42	UAZ	Not retrievable		-999	
B_43	Volvo	2529 CNY	1 CNY = 0,124 €	314	(Geely Automobile Holdings Limited, 2013, p. 002 / 003) Profit before taxes
B_44	Vortex	Not retrievable		-999	
B_45	Buick	7116 \$	1 \$ = 0,78 €	5550	(General Motors Company, 2013, p. 28) EBIT
B_46	BYD	5126 CNY	1 CNY = 0,124 €	636	(BYD Company Limited, 2013, p. 2) Gross profit
B_47	Cadillac	7116 \$	1 \$ = 0,78 €	5550	(General Motors Company, 2013, p. 28) EBIT
B_48	Chery	Not retrievable (cf. Vortex)		-999	
B_49	Chevrolet	7116 \$	1 \$ = 0,78 €	5550	(General Motors Company, 2013, p. 28) EBIT
B_50	Chrysler	3473 €	/	3473	(Fiat Group, 2013, p. 14) EBIT
B_51	Daihatsu	264 \$	1 \$ = 0,78 €	206	(Toyota Motor Company, 2013, p. 21) Operating income automotive
B_52	Dodge	3473 €	/	3473	(Fiat Group, 2013, p. 14) EBIT
B_53	Geely	2529 CNY	1 CNY = 0,124 €	314	(Geely Automobile Holdings Limited, 2013, p. 002 / 003) Profit before taxes
B_54	Great Wall	Not retrievable		-999	
B_55	Honda	544.810 JPY	1 JPY = 0,008 €	4356	(Honda Motor Co., 2013, p. 4) Operating income
B_56	Hyundai	8436947 KRW	1 KRW = 0,001 €	8437	(Hyundai Motor Group, 2013, p. 6) Operating income
B_57	Infiniti	523544 JPY	1 JPY = 0,008 €	4188	(Nissan Motor Company, 2013, p. 7) Operating income
B_58	Iran Khodro	Not retrievable		-999	
B_59	Jeep	3473 €	/	3473	(Fiat Group, 2013, p. 14) EBIT
B_60	Kia	8436947 KRW	1 KRW = 0,001 €	8437	(Hyundai Motor Group, 2013, p. 6) Operating income
B_61	Lexus	264 \$	1 \$ = 0,78 €	206	(Toyota Motor Company, 2013, p. 21) Operating income automotive
B_62	Lifan	Not retrievable		-999	
B_63	Mazda	38718 JPY	1 JPY = 0,008 €	310	(Mazda Motor Corporation, 2013, p. 2)
B_64	Mitsubishi	1029 JPY	1 JPY = 0,008 €	8	(Mitsubishi Corporation, 2013, p. 3) Gross profit
B_65	Nissan	523544 Yen	1 JPY = 0,008 €	4188	(Nissan Motor Company, 2013, p. 7) Operating income
B_66	Ssangyong	Only for 2010 retrievable		-999	
B_67	Suzuki	80389 JPY	1 JPY = 0,008 €	643	(Suzuki Motor Corporation, 2013, p. 4)
B_68	Tata	21805 INR	1 INR = 0,014 €	305	(Tata Group, 2013, p. 1) Gross profit
B_69	Toyota	264 \$	1 \$ = 0,78 €	206	(Toyota Motor Company, 2013, p. 21) Operating income automotive

Table 20: Compilation for the third measurement model (Currency rates were determined from (Bundesverband deutscher Banken E.V., 2014)).

Against this background it can be **concluded** that a Structural Equation Model arises because information for seven measurable indicators and for the 69 ego networks could be collected – in a normalized way (cf. Subsection 4.1.3) – as shown in Figure 4-23. Therefore, if a full model arises, then the question about the identifiability, i.e. if the information contained in the empirical data are sufficient to test the equations, arises. It is the **main contribution** of this consideration to be in accordance with the systematic approach of a complete Structural Equation Modelling-process so that a mental check mark can be made for this step, but this is **limited** through the fact that such a mental check mark has to be connected with the improvement of the t-rule to leading to any clear statement for the further empirical validation. Furthermore, besides the above-mentioned limitations concerning the compilation of the first and second measurement model, the information for the third measurement model are connected with **limitations**, too because e.g. the point in time of the financial statements differ from each other (31st March 2013/31st December 2012) and the ratios differ from each other (e.g. EBIT/operating income/gross profit as well as for the whole group or just for the automotive segment). Because of this it has to be kept in mind that even if these information lead to an identifiability, the validity of the empirical information can only be of limited value. Hence, for the sake of proceeding, we give them a try.

Figure 4-23: Illustration of the – normalised – results for the measurement models

Measurement models:			MM _I				MM _{II}		MM _{III}
k	No.	Brand	enc _A	enc _B	enc _C	enc _D	q _I	q _{II}	EBIT
1	B_1	Audi	0,675	0,531	0,012	0,092	1	0,972	1
2	B_2	BMW	0,878	0,554	0,011	0,076	0,654	0,892	0,834
...	...	...	...	...	...	...	...	...	...
69	B_69	Toyota	0,203	0,336	0,072	0,259	0,070	0,074	0,020

As a result, three measurement models arise, because empirical data could be calculated/collected for the seven indicators and for the $k = 69$ ego networks.

Source: Own illustration.

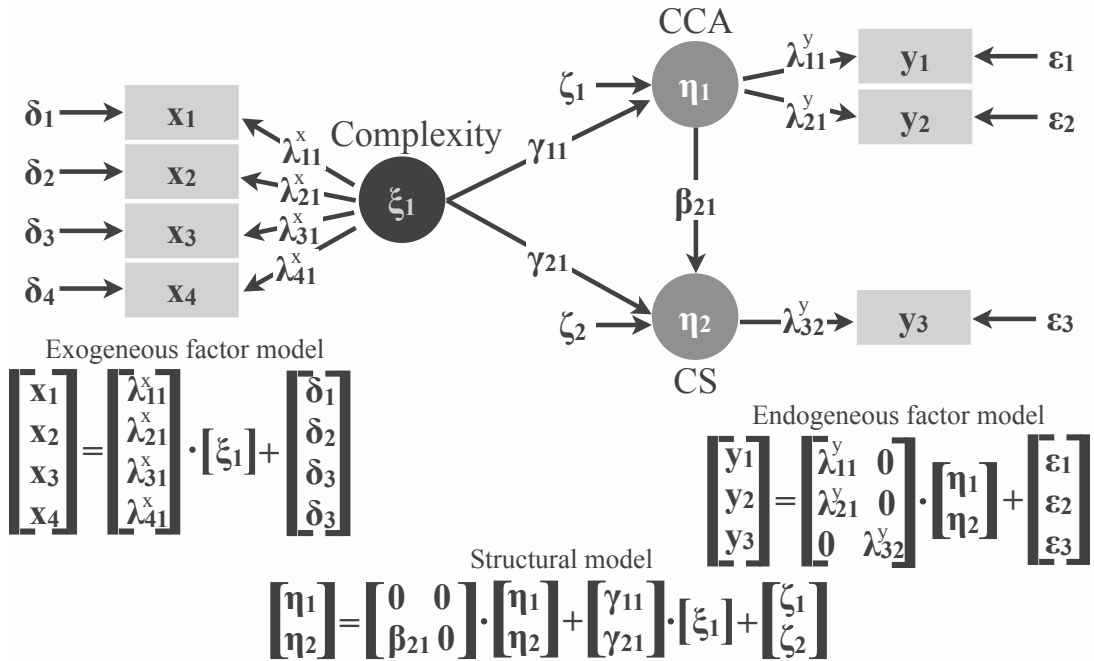
It is the conclusion for the cause-perspective that a full Structural Equation Model arises because empirical information for the three measurement models could be compiled so that the problem of identifiability has to be addressed.

Conclusions for
the cause-
perspective

Effects- perspective

The **effects-perspective** deals with the question, if the effects caused by the identification problem point to an analysability of the measurement models or not. Therefore, it is the **aim** to prove if the hypotheses can be formulated in the form of matrix equations because in this case the full amount of parameters and equations to be estimated can be determined so that the t-rule can be applied (Backhaus et al., 2011, p. 78). This is **based on the assumption** of so-called hybrid models because if Structural Equation Models with latent variables are measured in a reflective way, then no condition exists that has to be necessarily fulfilled for deciding whether a model is identified or not (Raithel, 2009, p. 549). Basically, a hybrid model is identified, if the measurement model and the SEM are identified (cf. the two-step-rule) (Raithel, 2009, p. 549). Additionally, the considerations are grounded on the final path diagram as outlined in Figure 4-24 for determining the equations.

Figure 4-24: Final path diagram for determining the matrix equations



Consequently, ...

the **amount of parameters** that have to be estimated plus the **empirical correlation-values** for the degrees of freedoms can be determined.

Source: Own illustration.

As a **entrail conclusion**, an identifiable system of equation arises because of the followings reasons:

The system of equations consists of the following parameters:

- Structural model: $\beta_{21}, \gamma_{11}, \gamma_{21}, \zeta_1, \zeta_2 = 5$ parameters.

- Measurement model of the latent exogeneous variable: $\lambda_{11}^x, \lambda_{21}^x, \lambda_{31}^x, \lambda_{41}^x, \delta_1, \delta_2, \delta_3, \delta_4 = 8$ parameters.
- Measurement model of the latent exogeneous variable: $\lambda_{11}^y, \lambda_{21}^y, \lambda_{32}^y, \varepsilon_1, \varepsilon_2, \varepsilon_3 = 6$ parameters.
- (If one is willing to include the Psi-Matrix: $\psi_{11}, \psi_{21}, \psi_{22}$ because of the lower triangular (LR-analysis) of the 2x2-matrix concerning the self-interdependencies, then 3 parameters).

By applying the t-rule the 19 (22) parameters are confronted with $0,5 \cdot (4+3) \cdot (4+3+1) = 28$ empirical variance-covariance- respectively correlation values because 4 p -values for the exogeneous and the 3 q -values have been developed and filled with empirical information. Therewith, the degrees of freedom count to $be\ 28 - 19 = 9$ so that the condition concerning the identifiability seems to be fulfilled (cf. (Backhaus et al., 2011, p. 83)). Furthermore, by anticipating the end-means combinations of the next section during the calculation process the matrices were positive-definit and no warning signals were shown. As a result, the **main contribution** towards the analysability arises because with the help of the t-rule it could be analysed that the amount of independent parameters to be estimated is larger than the amount of the non-redundant elements in the empirical covariance-matrix of the observed variables (Raithel, 2009, p. 548). Therewith, the Structural Equation Modeling approach including the empirical information retrieval is just respectively over-identified so that based on the available empirical information the parameters can be estimated in the further steps of the analytical analysis (Backhaus et al., 2011, p. 78; Raithel, 2009, p. 547). Hence, the power of explanation of the statistical analysis is still **limited** because of the limitations of the empirical information retrieval (cf. above) and the t-rule only constitutes a necessary condition that could be refined through further conditions.

The system of equations is identified because with the help of the t-rule it could be analysed that the degrees of freedom are larger than zero. As a result, the analysability of the Structural Equation Modeling approach can be concluded.

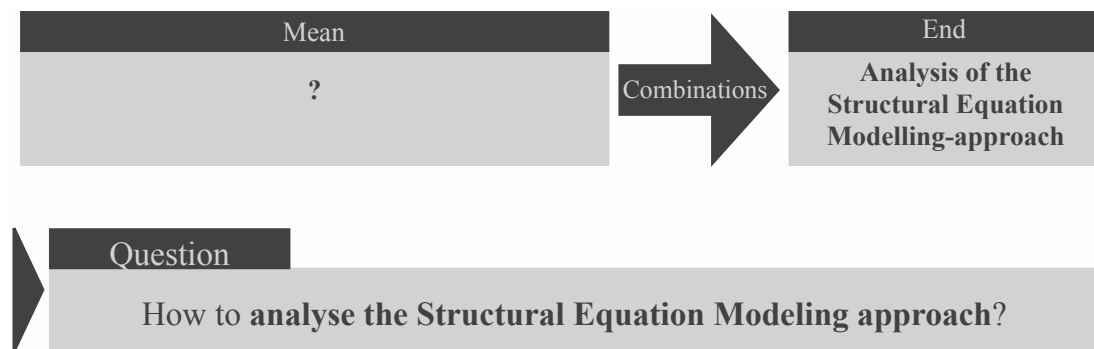
Conclusions for
the effects-
perspective

4.2.3 Pragmatic research task: A Variance-based Structural Equation Modeling approach

Pragmatic
research task of
Subsection 4.2.3

Because of the results of the analytic considerations of the model identification, the **pragmatic scientific aim** of this subsection is targeted towards a methodology for the Structural Equation Modeling approach so that the **end-means combinations for doing so are searched for** (cf. Figure 4-25).

Figure 4-25: In search for the end-means combinations for analysing the SEM



Source: Own illustration.

Variance-based
SEM-approach

Against the background of the **aim** to determine an end-means-combination for analyzing the Structural Equation Modeling approach, it is the **idea** to use a **variance based-approach** that has been **classified** with the covariance-based approach as one of the two main classes of Structural Equation Models because this class is **based** on the statistical approach of the principal component analysis trying to prognose the values of the row data as accurate as possible while covariance-based Structural Equation Models try to approximate the covarianz-matrix (Backhaus et al., 2011, p. 111; Raithel, 2009, p. 543; Schloderer, Ringle, & Sarstedt, 2009, p. 575). In this conjunction, the **variance based-approach** is grounded on the factor-analytical model that can be formalised through the following equations (Schloderer et al., 2009, p. 577).:

Formula 4-2:
$$x_{jh} = \lambda_{jh}^x \cdot \xi_j + \delta_{jh}$$

Formula 4-3:
$$y_{jh} = \lambda_{jh}^y \cdot \eta_j + \varepsilon_{jh}$$

Due to these underlying statistical approaches the variance-based and covariance-based Structural Equation Models (besides further classes that were shortly mentioned in 3.1.1) can be **characterised** in the following way: Covariance-based Structural Equation Models are usually used, if a test of theoretically founded causal hypotheses stands at the core. In contrast, variance-based Structural Equation Models

shall be used, if the collected data shall be reproduced as accurate as possible and if the model development is based on new theories or less consolidated theoretical insights (Backhaus et al., 2011, p. 111). The question why to use a **variance-based Structural Equation Model** shall be used can be answered by considering the **main contributions** of the Partial Least Squares-approach with respect to the research. With regard to the research the Partial Least Squares-approach seems to be more promising because of two main reasons: Firstly, the developed research model including the outlined – potential – causal relations has to be identified as a less consolidated theoretical insight because of the underlying theoretical framework of Econophysics leading to some major simplifications and the lack of research about how to interdisciplinary connect Complexity Science with the Strategic Management. Secondly, the empirical information retrieval has to be identified as less consolidated because of e.g. missing values and a limitation of the available amount of empirical information for the measurement models. Against this background, use a **variance-based approach contributes** because of its less rigid requirements for doing a statistical analysis. But, therewith, a **main limitation** exists with regard to the research because a statistical test of the outlined causal relations cannot be done due to its “reproducible” nature. Therefore, the application of a **variance-based Structural Equation Model** can only point – in case of a positive “confirmation” – to deeper considerations in future research.

A **variance-based** Structural Equation Modeling approach could be identified for the statistical analysis because of its contributions towards the limitations of the research with regard to the theoretical foundation and the empirical information. Therewith, the partial least squares-approach has to be applied.

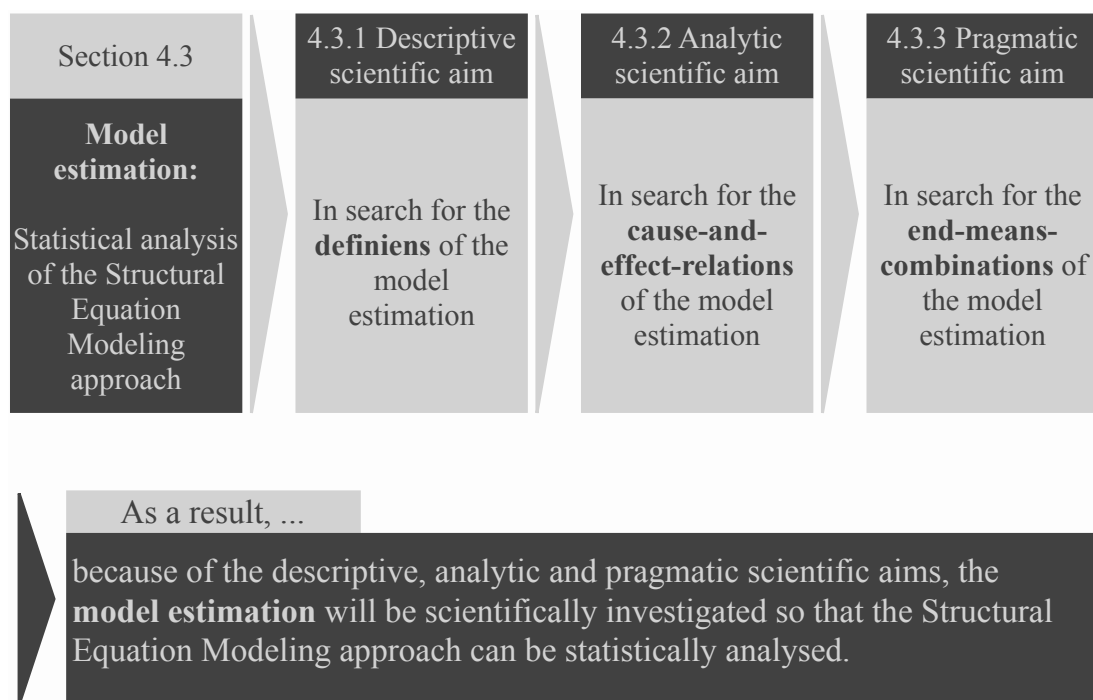
Conclusions for
the pragmatic
scientific aim

4.3 Model estimation: The Partial Least Squares-approach for the statistical analysis of the Structural Equation Model

Overview over
Section 4.3

It is the **aim of Section 4.3** to **estimate** the **model** because with the result of the previous section about the analysability of the measurement models the developed solution approach shall be statistically analysed so that the fifth step of a complete Structural Equation Modeling approach is fulfilled. Therefore, the first subsection shall answer what the model estimation with respect to the Partial Least Squares-approach actually is (Subsection 4.3.1) before it will be analysed from a cause- and an effects-perspective (Subsection 4.3.2). Finally, the section will end with a presentation about the software application for running the statistical analysis (Subsection 4.3.3) (cf. Figure 4-26).

Figure 4-26: Overview over Section 4.3



Source: Own illustration.

4.3.1 Descriptive research task: Depiction of the PLS-algorithm

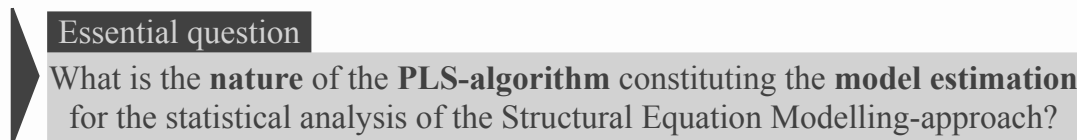
It is the **descriptive scientific aim** of this subsection to **disambiguate the PLS-algorithm** because the PLS-algorithm will constitute the model estimation with regard to a methodological approach for variance-based Structural Equation Models. Therewith, the nature of the PLS-algorithm is searched for (cf. Figure 4-27).

Descriptive research task of Subsection 4.3.1

Figure 4-27: In search of the definiens of the PLS-algorithm



In search of the definiens of the PLS-algorithm



Source: Own illustration.

The **definiendum of the PLS-algorithm** can be **assigned into the field of multivariate statistics**. The reason for this can be seen by considering the **origin** of the **Partial Least Squares (PLS)-algorithm** because Wold who was introduced for the development of variance-based Structural Equation Models in Section 3.1.1 developed the PLS-approach so that the PLS-algorithm is closely related with the field of multivariate statistics. It is the **aim** of the **PLS-algorithm** to generate estimated values for the latent variables because with them it becomes possible to derive statements about the relations between these latent variables respectively their indicators (Schloderer et al., 2009, p. 578). Hereby, it is the **idea** of the **PLS-algorithm** to differentiate between an external estimation and an internal estimation within the model because the estimated values are the result of their relations with the manifest and with the other latent variables so that for every latent variable two different estimated values are determined (Schloderer et al., 2009, p. 578). This differentiation is **based** on a multilevel approach because in the context of the first level the estimated values for the latent variables are iteratively determined whereby each iteration consists of four steps that are summarised according to (Schloderer et al., 2009, pp. 578–579):

Definiens of the PLS-algorithm

- **Step 0:** In the beginning, a first external estimated value for each of the latent variables is initialised (e.g. +1 in SmartPLS, cf. below).

- **Step 1:** For the approximation of the inner values, three different methods exist, i.e. the centroid-approach (correspond to the prefix of the covariance +1 or -1), the factor-weighting-scheme (the covariances are used for all paths) and path-weighting-scheme (for all the paths to follow the factor-weighting-scheme and for the others a multiple regression). Hence, due to the practical results it is accepted that these different methods barely influence the final results so that their selection is of subordinate importance.
- **Step 2:** With the help of the determined path values the scores for the latent variables are determined for the inner approximation and finally standardised, i.e. mean average value = 0, standard deviation = 1.
- **Step 3:** Based on these scores for the latent variables, for approximating the external weights the loads are determined through a simple regression..
- **Step 4:** The external approximation determines new scores for the latent variables that are the result of the weighted sum of the indicators with the determined loads and weights in the sense of a linear combination.
- **Iteration:** The step 1 – 4 are iterated until a certain level of stability of the model is achieved, e.g. the sum of the changes of the weights and loads is lower than 0,001 or a maximum number of iterations is achieved.

The second level aims to calculate the final path coefficients of the structural model through a multiple regression mit the latent exogeneous variables that are used as a regressand while – in the case of reflective indicators – the loads are determined through a simple regression of the latent variables from the step 1 and their corresponding manifest variables. For this reason, the **PLS-algorithm** is **based** on a multilevel approach because the first step aims at the estimation respesively generation for the data of the latent variables while the second step aims to calculate the path coefficients and further results (Schloderer et al., 2009, p. 578). As a **central conclusion**, the – application of the – **PLS-algorithm** results in values for the latent variables as well as for the path coefficients in the structural and measurement models and the loads in the case of a reflective specification (Schloderer et al., 2009, p. 579). Hereby, the loads indicate the degree the conformance of the variance for the corresponding latent variables with their latent construct they are connected with so that the path coefficients indicate the strength of the relationship between the latent variables with a value between -1 and +1 (Schloderer et al., 2009, p. 579). It is the **main contribution** of the **PLS-algorithm** to constitute a helpful alternative to the covariance-based approach Structural Equation Modelling because it requires lesser statistical requirements for the distribution of the raw data in the matrix and for the size of sample so that in combination with the easily available and handable software application of SmartPLS is has an increasing relevance for research

(Schloderer et al., 2009, p. 597). A **main limitation** exists with regard to the evaluation of the results because in contrast with covariance-based Structural Equation Models a global quality criterion for PLS-path models does not exist. Therewith, only quality criteria for the evaluation of partial structures of the model are usually applied so that if the relevant quality criteria are fulfilled in all the parts of the model, then the model is considered to be estimated in total and in a reliable way. Because of this further research of the PLS-algorithm focusses on the development of a global quality criterion, e.g. confirmatory tetrad-Analysis, PLS-multigroup-analysis, the finite mixture PLS-analysis and indexvalue-oriented model evaluation (Schloderer et al., 2009, p. 597).

Consequently, the PLS-algorithm is a method from the field of multivariate statistics for a variance-based Structural Equation Modeling approach comprising the idea to differentiate between an external estimation and an internal estimation within the model. Therewith, variance-based values for the latent variables as well as for the path coefficients in the structural and measurement models and the loads for the reflective specification can be calculated.

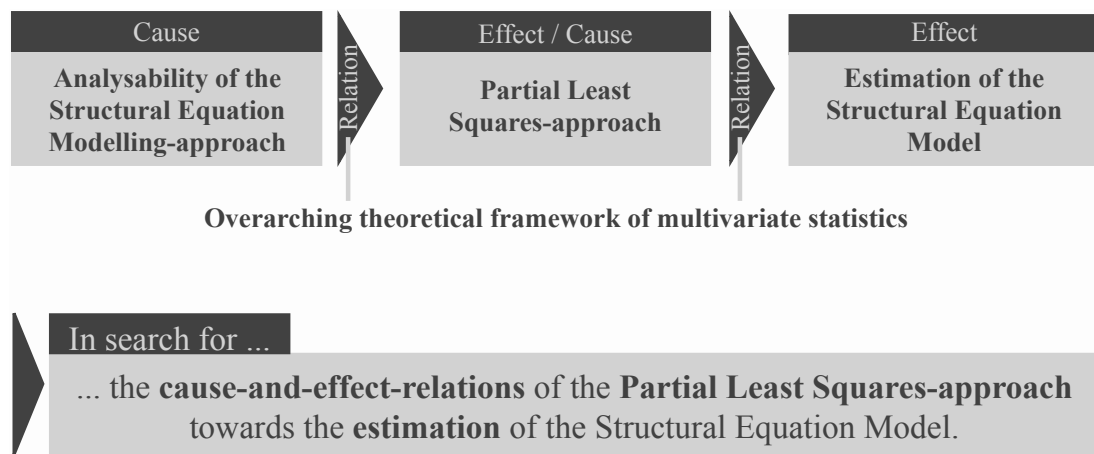
Conclusions for
the descriptive
scientific aim

4.3.2 Analytic research task: In search for the cause-and-effect relations of the PLS-approach

Analytic research
task of
Subsection 4.3.2

To be consistent with the outlined procedures, it is the **analytic scientific aim** of this subsection to investigate the **cause-and-effects-relations** of the **Partial Least Squares-approach** because its usage for the model estimation has to be investigated (cf. Figure 4-28).

Figure 4-28: In search for the cause-and-effect relations of the PLS-approach



Source: Own illustration.

Cause-and-
effects-
perspective of
the PLS-
approach

The analysis of the **cause-and-effect relations for and of the PLS-approach** has already been outlined in Section 3.1 and Subsection 4.3.1 because of the **characterisation** of the **PLS-approach** as a multivariate statistical method for the estimation of Structural Equation Models. Due to this **aim** of a model estimation it is the **idea** to use it because, firstly, the developed research model including the outlined – potential – causal relations has to be identified as a less consolidated theoretical insight due to the underlying theoretical framework of Systems Theory leading to some major simplifications and the lack of research about how to interdisciplinary connect Complexity Science with the Strategic Management. In addition to that, the empirical information retrieval has to be identified as less consolidated because of e.g. missing values and a limitation of the available amount of empirical information for the measurement models. Therefore, the application of the **PLS-approach** leads to the **central conclusion** that an estimation of a variance-based Structural Equation Model containing “weaker” empirical information becomes possible. Because of this it is the **main contribution** that results of the model estimation can be estimated with the help of SmartPLS as shown in Table 21,

but **limitations** exist with regard to the power of explanations regarding the hypotheses of the research model.

PLS Calculation results – Path coefficients			
	Company success	CCA	Structural Complexity
Company success	0	0	0
CCA	0,5618	0	0
Structural Complexity	-0,5801	0,9775	0
PLS Calculation results – Outer loadings			
	Company success	CCA	Structural complexity
cgc	1	0	0
enc _A	0	0	0,2001
enc _B	0	0	0,9954
enc _C	0	0	0,0459
enc _D	0	0	0,9952
q ₁	0	0,4414	0
q ₂	0	0,9727	0
PLS Calculation results – Outer weights			
	Company success	CCA	Structural complexity
cgc	1	0	0
enc _A	0	0	0,0901
enc _B	0	0	0,4937
enc _C	0	0	-0,0123
enc _D	0	0	0,4935
q ₁	0	0,238	0
q ₂	0	0,9201	0
Structural model specification			
	Company success	CCA	Structural Complexity
Company success	0	0	0
CCA	1	0	0
Structural Complexity	1	1	0
PLS Quality criteria – Cross loadings			
	Company success	CCA	Structural complexity
cgc	1	-0,0052	-0,0309
enc _A	0,3687	0,1896	0,2001
enc _B	-0,0588	0,9727	0,9954
enc _C	-0,3828	-0,0365	0,0459
enc _D	-0,0707	0,9721	0,9952
q ₁	0,2439	0,4414	0,2589
q ₂	-0,0688	0,9727	0,9955
PLS Quality criteria – Latent variable correlations			
	Company success	CCA	Structural Complexity
Company success	1	0	0
CCA	-0,0052	1	0
Structural Complexity	-0,0309	0,9775	1
PLS Quality criteria – Total effects			
	Company success	CCA	Structural Complexity
Company success	0	0	0
CCA	0,5618	0	0
Structural Complexity	-0,0309	0,9775	0
PLS Quality criteria - Overview			
	Company success	CCA	Structural Complexity
AVE	1	0,5705	0,5058
Composite reliability	1	0,6995	00,7168
R ²	0,015	0,9555	0
Cronbachs alpha	1	0,3622	0,4081
Communality	1	0,5705	0,5058
Redundancy	-0,3215	0,5131	0

Table 21: Main results of the model estimation with SmartPLS

Consequently because of the nature of research model and the retrieved empirical information the PLS-approach is used leading an estimation of the variance-based Structural Equation Model.

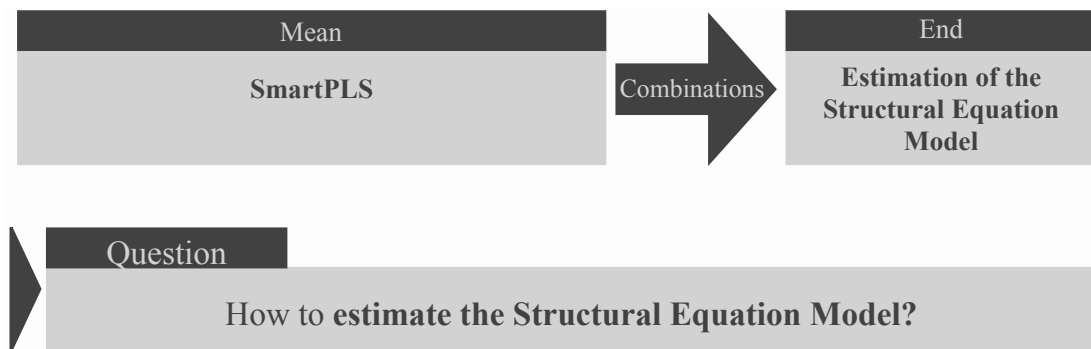
Consequences for the analytic scientific aim

4.3.3 Pragmatic research task: SmartPLS for estimating the Structural Equation Model

Pragmatic
research task of
Subsection 4.3.3

For estimating the model, it is the **pragmatic scientific aim** of this subsection to outline a methodological approach so that the **end-means combinations model estimation and SmartPLS are searched for** (cf. Figure 4-29).

Figure 4-29: Illustration of the pragmatic scientific aim of subsection 4.3.3



Source: Own illustration.

SmartPLS

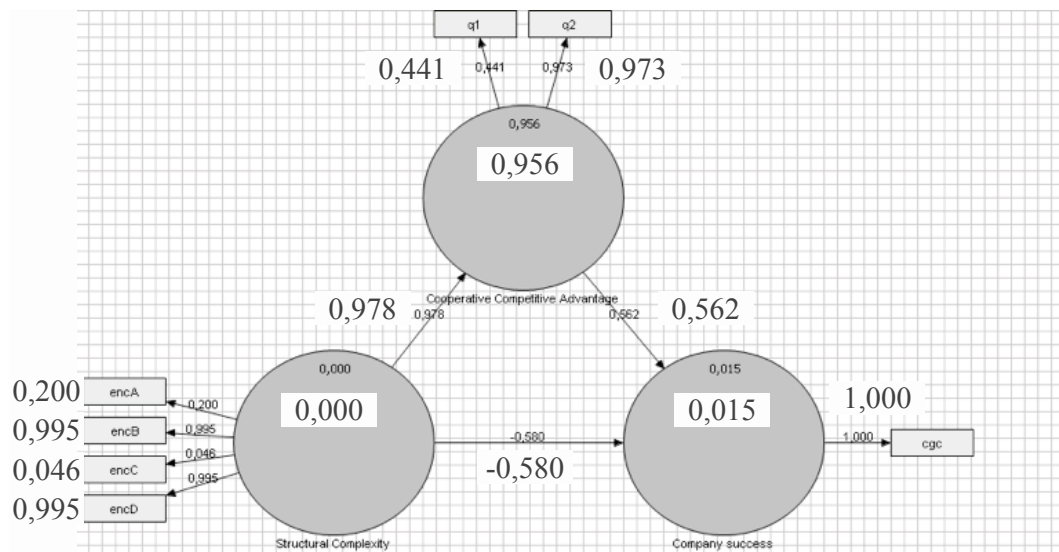
SmartPLS has to be **assigned** to the area of software applications for the analysis of variance-based Structural Equation Models because (Schloderer et al., 2009) mention it as one of several software applications such as e.g. *LVPLS*, *PLS-GUI*, *SPAD-PLS* or *XLSTAT-PLSPM* (Schloderer et al., 2009, p. 586). In comparison with these other software applications **SmartPLS** can be **characterised** as being exempt from charges and user-friendly.⁹⁶ The **aim** of **SmartPLS** is the same as for all the other above-mentioned software applications, i.e. to run the statistical analysis of the Partial Least Squares-approach for a variance-based Structural Equation Model, but it is the **idea** to run the analysis per *Drag&Drop* with the help of a clearly-arranged and an intuitive graphic user interface so that in the appearing graphic interface the data just have to be implemented respectively the settings just have to be adjusted (Schloderer et al., 2009, p. 587). **SmartPLS** is **based** on the programming language of Java, whereby all the common spreadsheets (such as OpenOffice Calc, Microsoft Excel) and statistical programs (such as SPSS, Statistica, MatLab) can be used because of their unique format of *.csv* or *.txt*. (Schloderer et al., 2009, p. 587). Furthermore, with reference to (Schloderer et al., 2009, p. 590) it is **grounded** on the following checklist for the model estimation:

⁹⁶ (Schloderer et al., 2009, p. 587). An extensive comparison of different PLS Path Modelling Software can be found in (Temme, Kreis, & Hildebrandt, 2010).

- **Data preparation:** Missing values are uniquely coded (e.g. with -999) and the data is saved either in a *.txt*- or *.csv*-format.
- **Data import in SmartPLS:** Specification of the code for the missing values in the data-file.
- **Graphical path model:** Circles and isolated constructs are not allowed while each construct is assigned with at least one indicator that can only be used once. Furthermore, the type of reflective or formative specification is selected.
- **Calculation of the paths, loads and weights:** Selection of the Path-weighting-scheme, the amount of iterations and if necessary the handling of the missing parameter value.
- **Interpretation of the outputs and quality criterion** (Part of the model evaluation).
- **Bootstrapping-approach** (Part of the model evaluation): Specification of the amount of Bootstrapping-samples (e.g. 500), cases (sample size) and individual sign changes-option.
- **Blindfolding-Procedure** (Part of the model evaluation): Selection of the constructs to be tested; if Q^2 -value (cross-validated redundancy) > 0 , then relevance of prognosis for the model; Analysis of the relative influences of the exogeneous and endogeneous variables on Q^2 .

As a the **central conclusion**, the application of **SmartPLS** results in a graphical illustration of the results in combination with underlying reports of all the different values because as Figure 4-30 illustrates the values are displayed at their corresponding arrows and constructs. Therewith, the estimation results of the path relations and the stability indices for the constructs can be conducted. Additionally, further output illustrations arise for showing all the other additional analytic results, e.g. in *html*- or *latex*-format (Schloderer et al., 2009, pp. 588–589). Therewith, **SmartPLS contributes** to the search for end-means combinations by offering a easily handable software program for running the variance-based partial least squares approach that is also free of charge and widely accepted because a well established community comprising more than 10.000 active users offers e.g. supports in a forum and several video tutorials so that “robust results” can be estimated for the research (Schloderer et al., 2009, pp. 587, 575, 597). Like with any other software program a **limitation** exists because the correctness of the programming and the implementation of the mathematical equations can only be hardly proved by knowing the underlying language for programming.

Figure 4-30: Path diagram with results



Consequently,

with the help of SmartPLS the Structural Equation Model can be estimated and its results can be graphically illustrated.

Source: Own illustration.

Consequences
for the pragmatic
scientific aim

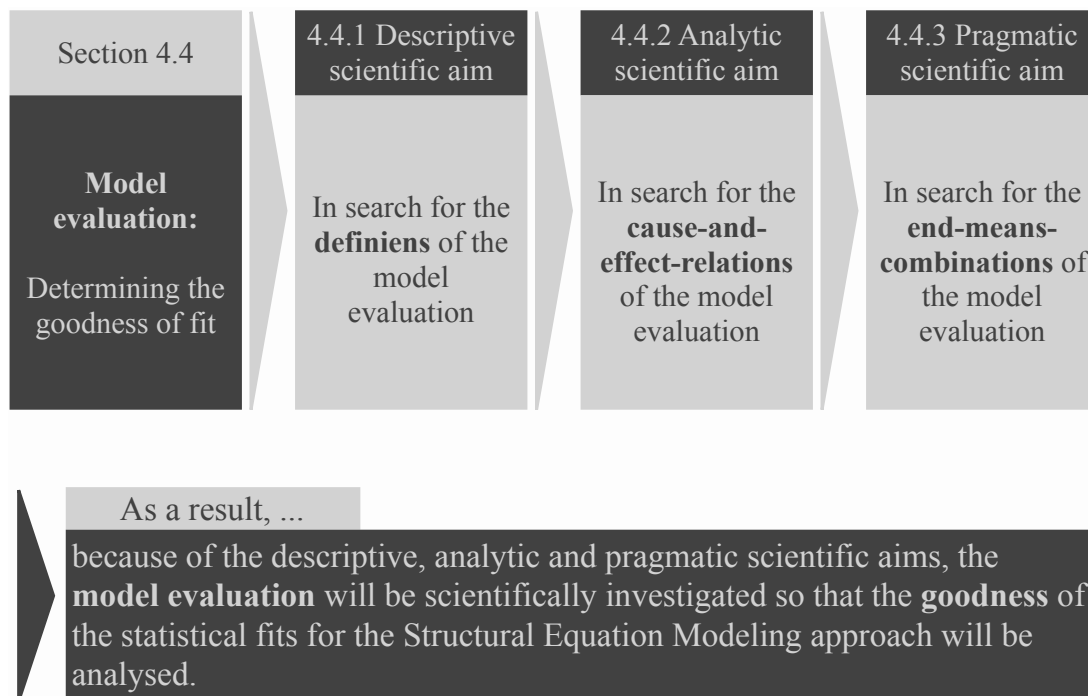
Consequently, SmartPLS constitutes a very helpful computer program for running the model estimation because of its user-friendly design and being exempt from charges so that the statistical analysis could be done.

4.4 Model evaluation: Determining the goodness-of-fit

Because of the model estimation in the previous section, **Section 4.4 aims to evaluate the model** because this has been identified as the next step in a complete Structural Equation Model so that the results of the statistical analysis are investigated. For this, Subsection 4.4.1 will disambiguate the model evaluation before it will stand in the core of the analytic research task of Subsection 4.4.2. Finally, Subsection 4.4.3 will outline the mean for doing the model evaluation (cf. Figure 4-31).

Overview over
Section 4.4

Figure 4-31: Overview over Section 4.4



Source: Own illustration.

4.4.1 Descriptive research task: Depiction of the quality criterion

Descriptive
research task of
Subsection 4.4.1

It is the **descriptive scientific aim** of this subsection to **disambiguate the quality criterion** because they will stand in the centre stage of the cause-and-effect relations for building the corner stone towards a model evaluation. Therewith, the nature of the **quality criterion is searched for** (cf. Figure 4-32).

In search of the
definiens of the
quality criterion

Figure 4-32: In search of the definiens of the quality criterion



Source: Own illustration.

Definiens of the
quality criterion

The **definiendum of the quality criterion** can be **assigned into the field of (multivariate) statistics** (in general) because they are **characterised** as methods for evaluating the objectivity, reliability and validity of a statistical approach that can be **classified** with regard to the statistical method they are used for (Schwaiger & Zimmermann, 2009, pp. 422–423). They comprise the **idea** to determine a quantitative threshold so that the result of the statistical analysis has to fall below or above this quantitative threshold because of the **aim** to conclude whether the statistical effect can be assumed to exist for the whole sample in reality (Schwaiger & Zimmermann, 2009, p. 422). They are **based** on (inference-) statistical tests as instruments for deriving decisions about structural assumptions such as the (non-) effectiveness of influencing factors so that it can be **concluded** that their derived conclusions can only be true with regard to a certain type of probability (Gertheiss & Tutz, 2009, p. 441 et sqq.). This points to the **contribution** of offering a criterion for evaluating a statistical result that is **limited** through its probabilistic nature and its need for several different **quality criteria** (T. A. E. Ebert & Raithel, 2009, pp. 513–514; Gertheiss & Tutz, 2009, p. 441; Schwaiger & Zimmermann, 2009, p. 423).

Consequences

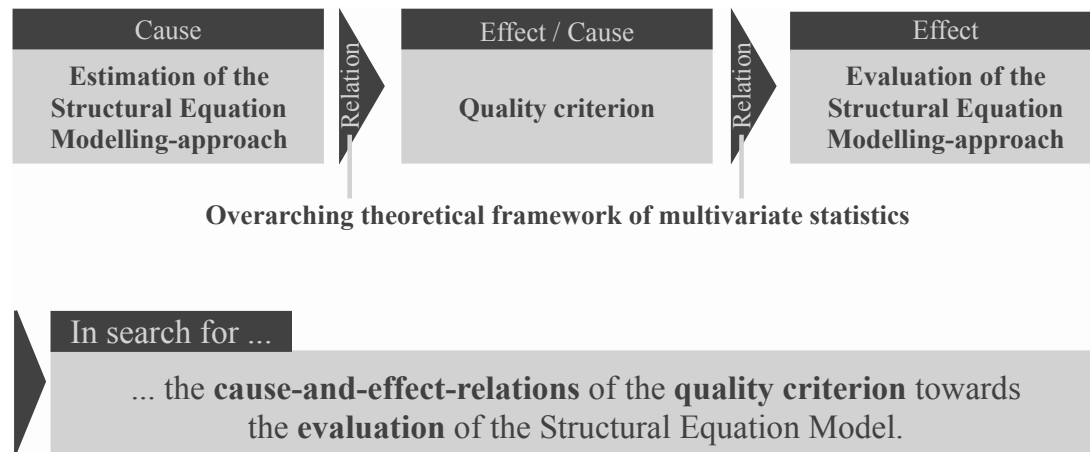
A **quality criterion** is a quantitative threshold for indicating the objectivity, reliability and validity of a statistical result with regard to a certain probability.

4.4.2 Analytic research task: Quality criteria for the model evaluation

It is the **analytic scientific aim** of this subsection to investigate the **cause-and-effect relations of the quality criterion** as shown in Figure 4-33 because they are at the centre stage towards the model evaluation.

Analytic research task of Subsection 4.4.2

Figure 4-33: In search for the cause-and-effect relations of the quality criteria



Source: Own illustration.

With reference to Figure 3-6 the – **cause-and-effect relations** of the – **quality criterion** can be assigned to **multivariate statistics** because the model evaluation is considered to be the sixth step of a complete Structural Equation Modeling approach so that the quality criterion to be used for are part of a multivariate statistical analysis towards the **aim** of evaluating the Structural Equation Model. The reason for this is that with the results of the model estimation in the previous section that were shown in Table 21 **quality criteria** are needed because results of a statistical analysis have generally to be evaluated with regard to their power of explanation (cf. the definiens). Therefore, the **quality criteria** are a direct **effect** of the results of the PLS-approach. Furthermore, in the case of going below or above a certain **quality criterion** the Structural Equation Model can be evaluated with regard to its power of explanation. Therewith, the fulfilments of quality criterion are considered to be a **cause** for a successful evaluation of a Structural Equation Modeling approach. Because of the fact that the PLS-approach was separated into two steps, i.e. an estimation of the external measurement models and then an estimation of the internal path model, it is the **idea** of the **quality criteria** to be used in this conjunction to also separate them into **quality criteria** for the evaluation of (reflective⁹⁷) measurement models and for the evaluation of the inner path model so that two **classes** of **quality criteria** arise

Cause-and-effect relations of the quality criterion

⁹⁷ Due to the fact that only reflective measurement models have been used, the following consideration will only focus on **quality criteria** for the evaluation of reflective measurement models.

(Götz, Liehr-Gobbers, & Krafft, 2010, p. 693; Schloderer et al., 2009, pp. 579, 580–581, 584–586). They are **based on the assumptions** of the PLS-approach concerning the weak assumptions about the distributions of the data sample so that parametric **quality criteria** – as they are used for the covariance-based analysis – cannot be applied (Schloderer et al., 2009, p. 579). For this reason, (Schloderer et al., 2009, p. 579) suggest to apply a catalogue of suitable non-parametric **quality criteria** based on (Chin, 1998, p. 316) that have been developed further by (Diamantopoulos & Winklhofer, 2001) and (Krafft, Götz, & Liehr-Gobbers, 2005) and that take the character of the PLS-approach explicitly into account. In this conjunction, it is commonly **assumed** that a global **quality criterion** for the PLS-approach does not exist, whereby the idea seems to be justified to separately evaluate the measurement models of the latent variable and the inner path model (Schloderer et al., 2009, p. 579). Therefore, it is the **central conclusion** that only if reliable estimations of the latent variables exist, then the evaluation between these latent variables within the path model seems valuable (Schloderer et al., 2009, p. 580). According to (Schloderer et al., 2009, p. 580) the **indicator reliability**, the **construct or factor reliability**, the **average variance extracted (AVE)** and the **discriminant validity** are **quality criteria for the evaluation of reflective measurement models** with regard to the validity and reliability that are known from the factor analysis.

Indicator
reliability

The **aim** of the **indicator reliability** is targeted towards to derive conclusions to what extent a single indicator is fitted to its latent variable (Schloderer et al., 2009, p. 580). The **idea** that at least half of the variance of the indicator should be explained by the construct is **based on the calculation** that on the level of the indicators the reliability is the result of the square of the corresponding factor loading (Götz et al., 2010, pp. 694–695; Schloderer et al., 2009, p. 580). As a **result**, the values are formed in a range between 0 and 1 and it is recommended that the reliability of an indicator should be greater than 0,7 ($=\sqrt{0,5}$) because in this case the loadings significantly differ from zero so that the following **quality criterion** arises:

Formula 4-4: $rel(x_i) \geq 0,7$

$rel(x_i)$: reliability of an indicator x_i .

Construct or
factor reliability

It is the **aim** of the **construct or factor reliability** to determine how well a reflectively specified latent variable is measured through its manifest indicators by following the **idea** to investigate the internal consistency of the combined items (Götz et al., 2010, p. 695; Krafft et al., 2005, p. 74 et sqq.; Schloderer et al., 2009, p. 580).

The **construct or factor reliability** ρ_c is **based** on the following **calculation** (Götz et al., 2010, p. 695; Schloderer et al., 2009, p. 580):

$$\text{Formula 4-5: } \rho_c = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum_i \text{var}(\varepsilon_i)}$$

λ_i : Standardized factor loading between a construct and its indicating variable i .
 $\text{var}(\varepsilon_i)$: The variance of the measurement error is defined by the term $1 - \lambda_i^2$.

As a **result**, ρ_c ranges between 0 and 1 while the following value range is recommended so that an additional **quality criterion** arises (Götz et al., 2010, p. 695; Schloderer et al., 2009, p. 580):

$$\text{Formula 4-6: } \rho_c \geq 0,6.$$

The **average variance extracted (AVE)** **aims** to determine the extend of the variance of the latent variable in relation with a measurement error, whereby it is the **idea** to provide information about how well a latent construct is manifested through the sum of its indicators **based** on the following **calculation** (Götz et al., 2010, p. 696; Schloderer et al., 2009, p. 581):

Average variance
extracted

$$\text{Formula 4-7: } AVE = \frac{\sum_i \lambda_i^2}{\sum_i \lambda_i^2 + \sum_i \text{var}(\varepsilon_i)}$$

The nomenclature is the same as for the construct or factor reliability ρ_c but in this case the factor loadings are squared (Götz et al., 2010, p. 696; Schloderer et al., 2009, p. 581). As a **result**, the values are between 0 and 1 and the following recommendation for the forming of the **AVE** is given (Götz et al., 2010, p. 696; Schloderer et al., 2009, p. 581):

$$\text{Formula 4-8: } AVE \geq 0,5.$$

With reference to (Fornell & Larcker, 1981, p. 46) it is the **idea** to use the **AVE** for the provement of the **discriminant validity** because it is targeted towards the **aim** to determine to which extend the reflectively operationalised latent variable constitutes a self-contained construct (Götz et al., 2010, p. 696; Schloderer et al., 2009, p. 581). It is **based** on the **calculations** of the square roots of the **AVE** and the corresponding correlations as shown in Table 22 so that such a square root should be always bigger as the correlation with another reflectively measured latent construct (Götz et al., 2010, p. 696; Schloderer et al., 2009, p. 581). As a **result**, a fourth **quality criterion** for the reflective measurement models arises as depicted in the following formulation (Schloderer et al., 2009, p. 581):

Discriminant
validity

$$\text{Formula 4-9: } \text{Correlation}(\xi_1, \eta_1) \leq \sqrt{AVE(\xi_1)}$$

$$Correlation(\xi_1, \eta_2) \leq \sqrt{AVE(\xi_1)}$$

$$Correlation(\eta_1, \eta_2) \leq \sqrt{AVE(\eta_1)}$$

	ξ_1 (reflective)	η_1 (reflective)	η_2 (reflective)
ξ_1 (reflective)	$\sqrt{DEV(\xi_1)}$		
η_1 (reflective)	$Correlation(\xi_1, \eta_1)$	$\sqrt{DEV(\eta_1)}$	
η_2 (reflective)	$Correlation(\xi_1, \eta_2)$	$Correlation(\eta_1, \eta_2)$	$\sqrt{DEV(\eta_2)}$

Table 22: Provement of the discriminant validity (Adapted from (Schloderer et al., 2009, p. 581)).

Quality criteria
for the inner path
model

In general, the values for the path coefficients range from -1 to $+1$ because of the standardised correlation coefficients (cf. section 3.1) and (Chin, 1998) approaches to consider a standardized coefficient $\geq |0.2|$ as a significant correlation becoming more significant the close the value comes -1 or $+1$ (Chin, 1998, p. 323). Nevertheless, as **quality criteria for the evaluation of the inner path model** (Schloderer et al., 2009) mention the **coefficient of determination (R^2)**, the **significance of the path coefficients** and the **Stone-Geisser-Criteria Q^2** (Schloderer et al., 2009, p. 584).

R^2

The **aim** of the **coefficient of determination R^2** is targeted towards to evaluate all endogeneous constructs in the model comprising the **idea** to determine to which extend the variance of an endogeneous construct is explained through the exogeneous latent variables (Götz et al., 2010, pp. 701–702; Schloderer et al., 2009, p. 584). It is **based on the calculation** that is known from the regression analysis. In this connection, R^2 is a monotonous transformation of the F-value in which the variance of all residuals are included independently of the effect-size of a regressor so that R^2 is smaller for processes with higher spreading (Harhoff & Wagner, 2009, p. 483). As a **result**, the values are formed in a range between 0 and 1 and the following formings are recommended as a **quality criterion** (Götz et al., 2010, pp. 701–702; Schloderer et al., 2009, p. 584):

Formula 4-10: $R^2 \geq 0,67 \rightarrow \text{substantial}$

$0,33 \leq R^2 \leq 0,67 \rightarrow \text{acceptable}$

$0,19 \leq R^2 \leq 0,33 \rightarrow \text{weak}$

t -values

It is the **idea** of the **significance of the path coefficients** to draw conclusions about the strength of the relations between the latent variables (Schloderer et al., 2009, p. 584). Because of this, it is the **aim** to determine so-called t -values as

statistical measures for stating the probability of error (Gertheiss & Tutz, 2009, pp. 442–444; Schloderer et al., 2009, p. 585). For doing so, it is **based** on the Bootstrapping-approach because statistical information about the distribution of the data sample is missing (Schloderer et al., 2009, p. 584). In this regard, the Bootstrapping-approach aims at calculating mean values and standard deviation for the weights of the model by running m samples of the Bootstrapping-approach in which n cases are randomly sampled for each procedure (Schloderer et al., 2009, pp. 582–583). Based on this, robust confidence intervals can be determined by calculating the mean value and the standard deviation over the m samples and by compiling the quotient of an original value and the standard error for testing the null hypothesis (Schloderer et al., 2009, pp. 582–583). As a **result**, the following recommendation for the forming of the **t-values** is given (Schloderer et al., 2009, p. 585):

Formula 4-11: $t \geq 1,65 \sim \text{Probability of error of } 10\%$

$t \geq 1,96 \sim \text{Probability of error of } 5\%$.

The **effect-size** f^2 follows the **idea** to build up on the prognosis-oriented nature of the PLS-path modelling for deriving quality criterion (Götz et al., 2010, p. 702; Schloderer et al., 2009, p. 585). In this connection, it is the **aim** of the **effect-size** f^2 to determine the strength of the effect of an exogeneous variable on endogeneous latent one (Götz et al., 2010, p. 702; Schloderer et al., 2009, p. 585). This determination is **based** on the following **calculation** where the coefficient of determination of the target construct with the endogeneous latent construct (R^2_{included}) is compared with the one without (R^2_{excluded}) (Götz et al., 2010, p. 702; Schloderer et al., 2009, p. 585):

Formula 4-12: $f^2 = \frac{R^2_{\text{included}} - R^2_{\text{excluded}}}{1 - R^2_{\text{included}}}.$

As a **result** and with regard to the multiple regression analysis, the following recommendations for the formings of the **effect-size** f^2 are given (Götz et al., 2010, p. 702; Schloderer et al., 2009, p. 585):

Formula 4-13: $f^2 \geq 0,35 \rightarrow \text{high}$

$0,15 \leq f^2 \leq 0,35 \rightarrow \text{medium}$

$0,02 \leq R^2 \leq 0,15 \rightarrow \text{low}.$

The **Stone-Geisser-Criteria** Q^2 comprises the **idea** to use a technique for the recovery of data targeted towards the **aim** to determine the relevancy of the prognosis for endogeneous latent variables that are specified through a reflective

f^2

Q^2

measurement model (Schloderer et al., 2009, p. 585). It is **based** on the so-called **blindfolding-procedure** where parts of the empirically collected data are systematically ignored for certain blocks of manifest variables so that these ignored cases can also be estimated with the PLS-approach. This procedure is repeated until all potential cases are ignored and estimated. In this connection, the sum of the squared errors of the estimated values E and of the original values O can be determined by using the distance D between to neglected cases that have to estimated (Schloderer et al., 2009, p. 585). As a result, the following formula of the **Stone-Geisser-Criteria Q^2** arises (Götz et al., 2010, pp. 702–703; Schloderer et al., 2009, pp. 585–586):

$$\text{Formula 4-14: } Q^2 = 1 - \frac{\sum_D E_D}{\sum_D O_D}.$$

As in the case for the f^2 -values, the changes of the Q^2 -values can be used for determining the relative influence of the relations in the structural model on the observed latent endogeneous variable.

$$\text{Formula 4-15: } Q^2 = \frac{Q_{included}^2 - Q_{excluded}^2}{1 - Q_{included}^2}.$$

As a **result** and with regard to the multiple regression analysis, the following recommendations for the formings of the **effect-size Q^2** are given (Schloderer et al., 2009, p. 585):

$$\begin{aligned} \text{Formula 4-16: } Q^2 &\geq 0,35 && \rightarrow \textit{high} \\ 0,15 &\leq Q^2 \leq 0,35 && \rightarrow \textit{medium} \\ 0,02 &\leq Q^2 \leq 0,15 && \rightarrow \textit{low}. \end{aligned}$$

Consequences

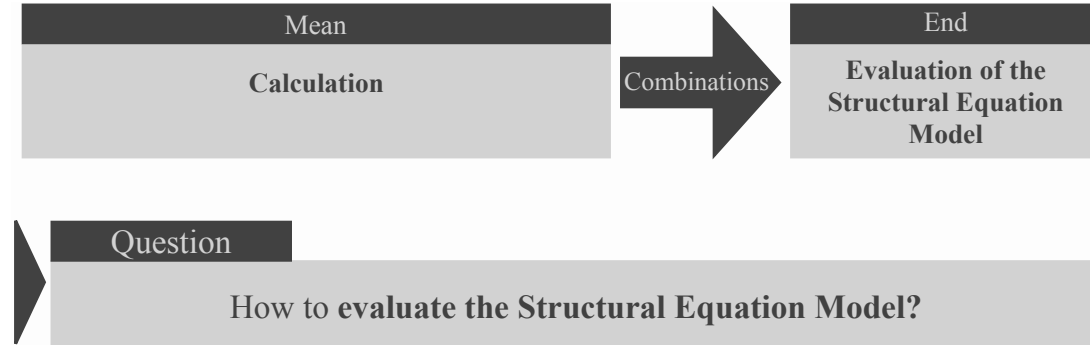
Consequently, because of the quality criteria for the reflective measurement models and the inner path model, the Structural Equation Modeling approach can be evaluated so that statements about the goodness-of-fits can be derived.

4.4.3 Pragmatic research task: SmartPLS for estimating the Structural Equation Model

For estimating the model, it is the **pragmatic scientific aim** of this subsection to outline a methodological approach so that the **end-means combinations model estimation and SmartPLS are searched for** (cf. Figure 4-29).

Pragmatic research task of Subsection 4.3.3

Figure 4-34: In search for the end-means combinations of the model evaluation



Source: Own illustration.

It is the **idea** to **calculate** the above-introduced quality criteria with the help of Formula 4-4 – Formula 4-16 so that it is the **aim** to use the statistical results as outlined in Table 21 for their calculation. In this conjunction, the **calculations** have to be **separated** with respect to the evaluation of the reflective measurement models and the inner path model. Therewith, the following considerations are **based** on the following calculations that are also summarised in Table 23.

Calculation

Formula 4-17:

$$\rho_{SC} = \frac{(0,2001+0,9954+0,0459+0,9952)^2}{(0,2001+0,9954+0,0459+0,9952)^2 + ((1-0,2001^2) + (1-0,9954^2) + (1-0,0459^2) + (1-0,9952^2))}$$

$$\rho_{SC} = \frac{(2,2366)^2}{(2,2366)^2 + (0,9599 + 0,0092 + 0,9979 + 0,0096)} = \frac{5,0024}{5,0024 + 1,9766} = 0,7168$$

Formula 4-18:

$$\rho_{CCA} = \frac{(1,4141)^2}{(1,4141)^2 + (0,8052 + 0,0539)} = \frac{1,9997}{1,9997 + 0,8591} = 0,6995$$

Formula 4-19:

$$AVE_{SC} = \frac{0,2001^2 + 0,9954^2 + 0,0459^2 + 0,9952^2}{0,2001^2 + 0,9954^2 + 0,0459^2 + 0,9952^2 + ((1-0,2001^2) + (1-0,9954^2) + (1-0,0459^2) + (1-0,9952^2))}$$

$$AVE_{SC} = \frac{0,0400 + 0,9908 + 0,0021 + 0,9904}{0,0400 + 0,9908 + 0,0021 + 0,9904 + 1,9766} = \frac{2,0233}{3,9999} = 0,5058$$

Formula 4-20:

$$AVE_{CCA} = \frac{0,4414^2 + 0,9727^2}{0,4414^2 + 0,9727^2 + ((1 - 0,4414^2) + (1 - 0,9727^2))} = \frac{0,1948}{0,1948 + 0,8591} = 0,1848$$

Formula 4-21: $Correlation(\xi_1, \eta_1) \leq \sqrt{AVE(\xi_1)}$

$$0,9775 \not\leq (\sqrt{0,5058} = 0,7112)$$

$$Correlation(\xi_1, \eta_2) \leq \sqrt{AVE(\xi_1)}$$

$$-0,0309 \leq (\sqrt{0,5058} = 0,7112)$$

$$Correlation(\eta_1, \eta_2) \leq \sqrt{AVE(\eta_1)}$$

$$-0,0052 \leq (\sqrt{0,1848} = 0,4298)$$

	Indicator reliability		Construct reliability		Average variance extracted		Discriminant validity	
<i>cgc</i>	$1 \geq 0,7$	✓	$1 \geq 0,6$	✓	$1 \geq 0,5$	✓		
<i>enc_A</i>	$0,2001 \leq 0,7$	x	$0,7168 \geq 0,6$	✓	$0,5058 \geq 0,5$	✓	$0,9775 \geq 0,7112$ & $-0,0309 \leq 0,7112$	x & ✓
<i>enc_B</i>	$0,9954 \geq 0,7$	✓						
<i>enc_C</i>	$0,0459 \leq 0,7$	x						
<i>enc_D</i>	$0,9952 \geq 0,7$	✓						
<i>q_1</i>	$0,4414 \leq 0,7$	x	$0,6995 \geq 0,6$	✓	$0,1848 \geq 0,5$	x	$-0,0052 \leq 0,4298$	✓
<i>q_2</i>	$0,9727 \geq 0,7$	✓						

Table 23: Results of the quality criteria for the reflective measurement models

As a result, the following **conclusions** can be drawn **for the evaluation of the reflective measurement models**. By considering Table 23, it cannot be definitely concluded if the reflective measurement models comprise a sufficient quality because the fulfilment of quality criteria are intermingled. For example, the quality criteria are sometimes fulfilled to a high extent e.g. with regard to the construct reliability but e.g. the indicator reliability was only fulfilled by half of the indicators. In this regard, the quality of the reflective measurement models should only be slightly positively evaluated under conditional acceptance.

The **evaluations for the inner path model** are **based** on the following **calculations**: As a starting point, the values for the inner path coefficients fulfil the first quality criterion because of $|0,5616|_{\text{Company success} - \text{CCA}} \geq 0,2$, $|-0,5801|_{\text{Company success} - \text{Structural complexity}} \geq 0,2$ and $|0,9775|_{\text{Structural complexity} - \text{CCA}} \geq 0,2$.

The t-values were calculated in SmartPLS as shown in Table 24.

	Orginal sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	Standard Error (STERR)	T-Statistics
CCA – Company success	0,561813	0,397658	0,556796	0,556796	1,009012
Structural complexity – Company success	-0,030900	-0,040647	0,218787	0,218787	0,141236
Structural complexity – CCA	0,977512	0,745458	0,581745	0,581745	1,680309

Table 24: Calculation of the t-values with SmartPLS

The effect-size is calculated as it follows:

Formula 4-22:
$$f_{CCA}^2 = \frac{0,9555^2 - 0,015^2}{1 - 0,9555^2} = \frac{0,9130 - 0,00002}{1 - 0,9130} = \frac{0,91298}{0,087} = 10,49$$

Formula 4-23:
$$f_{CCA}^2 = \frac{0,9555^2 - 0,015^2}{1 - 0,9555^2} = \frac{0,9130 - 0,00002}{1 - 0,9130} = \frac{0,91298}{0,087} = 10,49$$

	Company success	CCA	Structural complexity
R ²	0,015 ≤ 0,19	0,9555 ≥ 0,67	n.a.
	Very weak	substantial	n.a.

Table 25: Results of the quality criteria for the inner path model

The **conclusions** towards **for the evaluation of the inner path model** are intermingled, too. The reason for this is that the corresponding evaluation criteria sometimes indicate certain reliability while other criteria are not fulfilled. For this reason, it is the **overall conclusion** that only weak goodness-of-fits so that conclusions have to be handled with care.

Consequently, because of the manual calculation and in combination with the statistical analysis of SmartPLS, the Structural Equation Model has been evaluated. In consequence, only weak goodness-of-fits could be achieved so that generalizing conclusions have to be handled with care.

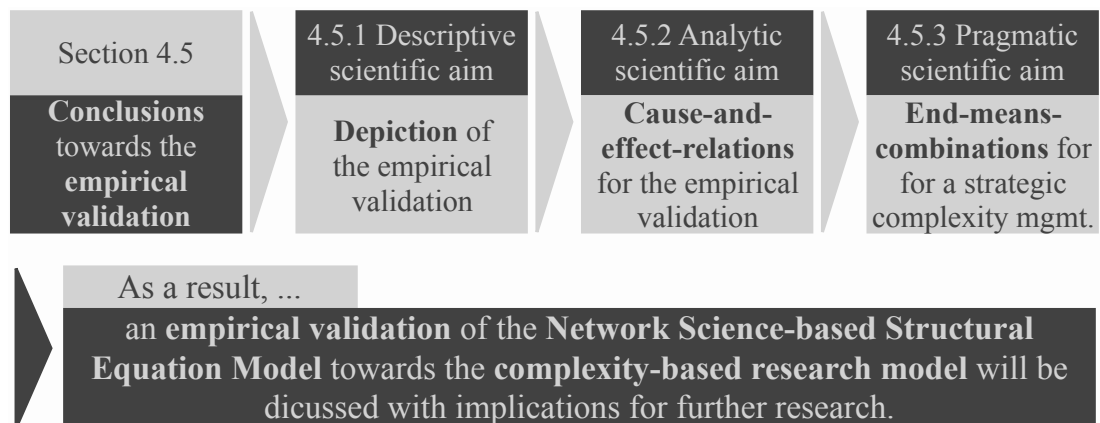
Consequences

4.5 Conclusions towards the empirical validation: Implications for a Strategic Complexity Management

Overview over
Section 4.5

It is the **aim of Section 4.5** to **conclude the results of this fourth chapter** because the result of Chapter 3 was a solution approach that needs an empirical validation. For this reason, the empirical validation will be the third building block after the research model requiring a solution approach. As a result, the section will integrate the findings of the previous sections so that a conclusion towards the implications for a strategic complexity management can be drawn (cf. Figure 4-35).

Figure 4-35: Overview over Section 4.5



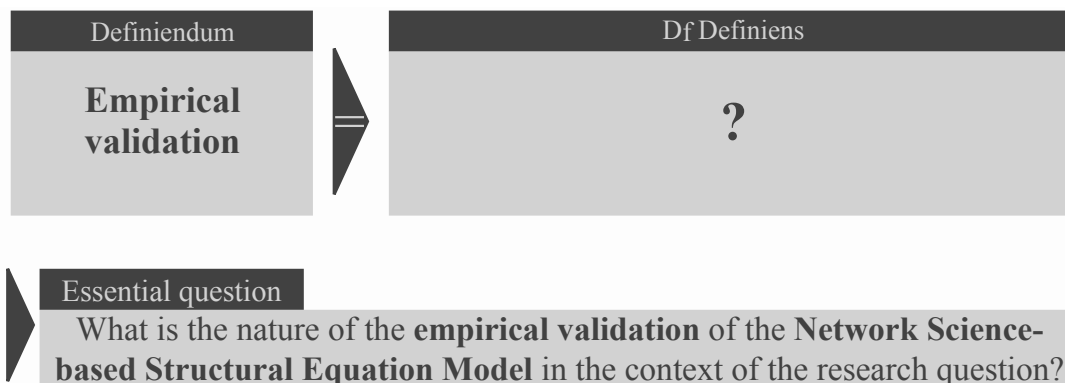
Source: Own illustration.

4.5.1 Descriptive research task: What is the empirical validation?

The **descriptive scientific aim** of this subsection consists of the disambiguation of the **definiendum of the empirical validation** because the underlying understanding of the definiendum of an empirical validation of a Network Science-based Structural Equation Model determines the contributions and limitations with regard to the scientific objectives of this thesis (cf. Figure 4-36).

Descriptive
research task of
Subsection 4.5.1

Figure 4-36: In search for the definiens of the empirical validation



In search for the
definiens of the
empirical
validation

The **definiendum of the empirical validation** has to be **assigned into the field of statistics and philosophy of science** because on the one side Structural Equation Models were defined as a statistical method (Subsection 3.1.3) so that with regard to the methodological scientific position they can be assigned to the quantitative methods (cf. Section 1.5); on the other side, it will be used for the falsification of hypotheses so that it can be assigned to the epistemological scientific position (cf. Section 1.5). Its etymological origin can be traced back to the Latin word *validus* meaning effectual (Duden, 1997, p. 839). In this regard, the **definiendum of the empirical validation** comprises the **idea** to empirically validate the developed solution approach with regard to Popper's falsificationism. Therefore, it is the **aim** to statistically test the power of explanations of the statements derived by the analysis of the Structural Equation Model. Because of the test theoretical nature (cf. Section 3.5.2), it is grounded on the **basic assumption** that causality in a strict scientific sense cannot be confirmed (Cramer & Kamps, 2008). In addition to that, it requires the understanding of science as a system for the creation and confinement of assumptions about cause-and-effect relations (cf. Section 1.5). In this regard, it is the **central conclusion** to consider a validation as a quality criterion for the resilience or reliability of such a scientific statement. In this regard, the **definiendum of the empirical validation** refers to the quality of the operationalisation as well as to the

Definiendum of
the empirical
validation

quality of the scientific statements about hypothesized cause-and-effect relations that shall be tested based on the operationalisation so that two areas of application can be **separated**. Because of this, it is the **main contribution** that scientifically tested statements can be derived with the help of the statistical quality criteria. Hence, it is the **main limitation** that causality cannot be achieved so that – by considering the objectives of this thesis – only evidences towards a theoretical explanation approach can be generated.

Consequences
for the definiens

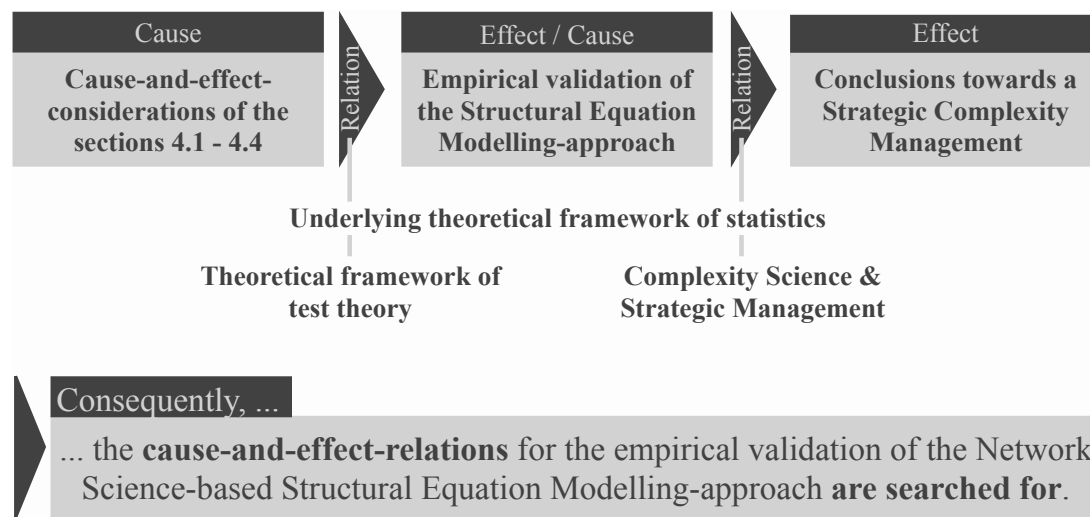
As a result of this fourth chapter, the empirical validation is depicted as a statistical method grounded on Popper's falsificationism for deriving conclusions about the quality or reliability of a scientific statement of cause-and-effect relations with regard to the operationalisation as well as to the power of explanation of the research model.

4.5.2 Analytic research task: Why to do the empirical validation?

It is the **analytic scientific aim** of this subsection to integrate the cause-and-effect considerations of the previous sections because the **cause-and-effect relations of the empirical validation** of the Structural Equation Modeling approach have to be investigated. For this, the cause-perspective will especially focus on the results of the statistical analysis while the effects-perspective will concentrate on the conclusions with regard to the merger of Complexity Science and Strategic Management towards the objectives of the thesis (cf. Figure 4-37).

Analytic research task of Subsection 4.5.2

Figure 4-37: In search for the cause-and-effect relations of the empirical validation



In search for the cause-and-effect relations of the empirical validation

Source: Own illustration.

The **cause-perspective** aims at discussing the results with respect to the falsification of the assumed potential causal relationships of the complexity-based research model. Because of this, the discussion is **based on the statistical results** of the previous section as well as on the **falsifiable hypotheses** that were depicted in Section 3.5.3:

Cause-perspective

H₁: The structural complexity does not positively influence a Cooperative Competitive Advantage.

H₂: The structural complexity does not negatively influence the company success.

H₃: A Cooperative Competitive Advantage does not positively influence the company success.

It is the **idea** to **differentiate** this **discussion** with regard to the direction of the assumed causal relationships as well as to the reliability of the statistical results. For this, the following **central conclusions** can be drawn: The outlined directions of the

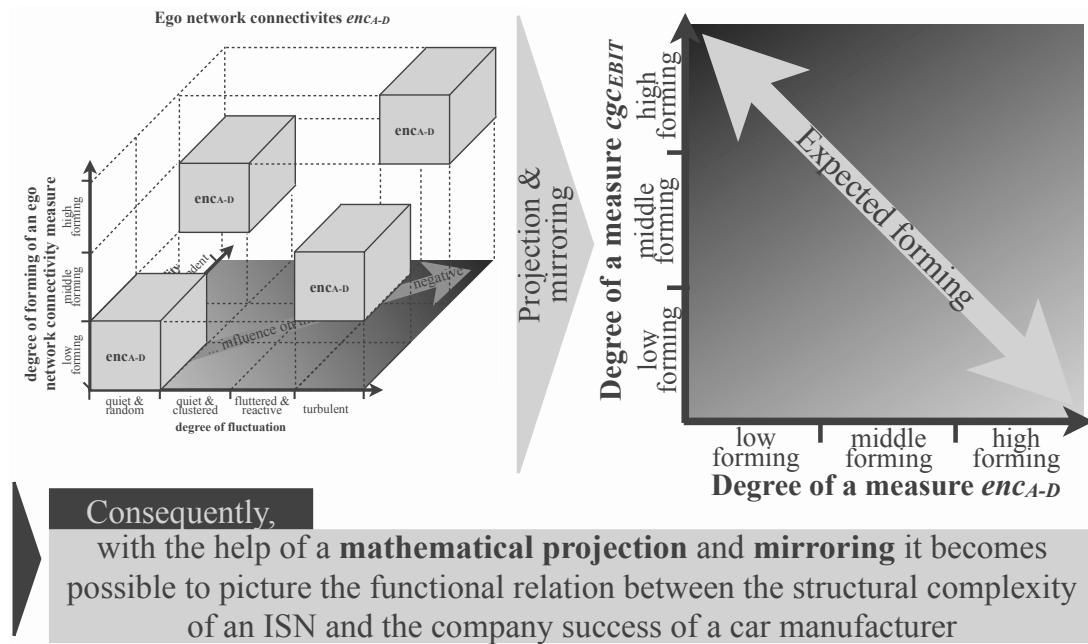
potential causal relations of positive directions between the structural complexity and CCA as well as CCA and the company success and the negative direction between the structural complexity and the company success seem to be confirmed. The reason for this is that the signs of the values of the inner path coefficients are in accordance with the expected directions (cf. $+0,5616_{\text{CCA} - \text{Company success}}$, $+0,9775_{\text{Structural complexity} - \text{CCA}}$ and $-0,5801_{\text{Structural complexity} - \text{Company success}}$). By considering the strength of these path coefficients and the criterion that a path coefficient should be $\geq 0,2$ it can be **concluded** that the outlined directions of the complexity-based research model more or less represent the “reality”. Therefore, the directions seem to be confirmed by trend. Nevertheless, this trend cannot be statistically proved because the assumptions of H_1 , H_2 and H_3 cannot be falsified within a certain level of reliability. The reason for this is that the evaluation of the reflective measurement models showed an intermingled picture because some of the quality criteria indicated a significant goodness-of-fit while others did not. Therefore, it has also to be **concluded** that a falsification of the assumption cannot be achieved in a strict scientific sense. The **main contributions** of these conclusions are that they allow laying the ground for a future research programme because the complexity-based research model seems to represent the real directions of the relationships by trend. Nevertheless, they should be handled with care because the goodness-of-fit of the operationalisation is still unclear.

Consequences
for the cause-
perspective

As a result of this fourth chapter, the falsifiable assumptions of the complexity-based research model could not be statistically falsified because of the intermingled statistical results for the quality criteria. Therefore, the directions of the causal relations are probably only confirmed by trend.

It is the **aim** of the **effects-perspective** to investigate if the results of the empirical validation enable to draw conclusions with regard to the research question and the objective of this thesis. Therewith, these considerations have to be **assigned to Complexity Science and the Strategic Management** because conclusions shall be drawn about the merger of Complexity Science with the Strategic Management. For doing so, it is the **idea** to translate the outlined assumed formings of the structural complexity and the company success (and CCA) that were substantiated with the Resource-Dependence-Approach (and the Relational View) into a potential two-dimensional functional relation. This transformation into a functional relation is **based** on the **mathematical operations or concepts** of the projection and the mirroring. The projection usually refers to the graphical representation of a three-dimensional object into a two-dimensional form in the field of geometry. In this regard, one could just imagine that a light source is standing behind the object so that the resulting shadow constitutes the two dimensional representation. The mirroring just refers to the change of the x- into the y-axis and vice versa so that previous formings are mirrored on the diagonal in the coordinate system. Therewith, it can be **concluded** that functional relation of the formings of profit-based corporate group composition in dependence on the formings of measure for the structural complexity occurs as can be seen in Figure 4-38. It is the **main contribution** of this approach that conclusions for a Strategic Complexity Management can be potentially drawn because it allows to figure the expected forming of the company success in dependence on the structural complexity of an International Supply Networks. These potential conclusions are up to now **limited** with regard to the weak empirical validations and the other outlined limitations such as e.g. that the formings are of relational nature because a normative conclusion would need much deeper research.

Figure 4-38: Graphical representation of the functional relations



Source: Own illustration.

Consequences
for the effects-
perspective

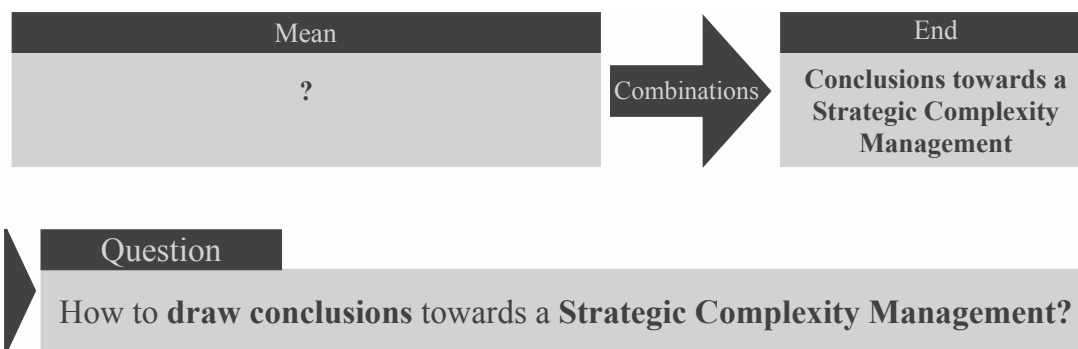
As a result, conclusions towards a Strategic Complexity Management can be potentially drawn because with the help of the mathematical concepts of the projection and mirroring the outlined visualisations of the expected formings can be translated into potential functional relations. Therefore, insights for the overarching objective of this thesis become possible.

4.5.3 Pragmatic research task: How to use the empirical validation?

Due to the fact that the **empirical validation** of the Network Science-based Structural Equation Modeling approach for the complexity-based research model is the subject of consideration of this fourth section, it is the **pragmatic scientific aim** of this subsection to identify a **methodological approach as a mean towards the end of drawing conclusions for a Strategic Complexity Management**. Therewith, it shall become possible to generally derive implications with regard to the research question and the overarching objective the thesis is reliable to (cf. Figure 4-39).

Pragmatic
research task of
Subsection 4.5.3

Figure 4-39: In search for end-means combinations of a Strategic Complexity Mgmt.



Source: Own illustration.

It is the **idea** of this subsection to present a methodological approach for **illustrating a functional relation between the structural complexity and the profit** because of the pragmatic scientific aim. Therefore and by considering the introducing illustration of the research question in **Fehler! Verweisquelle konnte nicht gefunden werden.**, it is the **aim** to graphically represent the formings in the empirical dataset of a profit-value in dependence on a collected value for the structural complexity. This approach is **based on the assumption** of the existence of a functional relation between them that could only be weakly proved in the statistical analysis. Additionally, it is **based** on the following **programme code** in MatLab as shown in Figure 4-40.

Functional
relation between
the structural
complexity and
the profit

Figure 4-40: Code Plotten

```

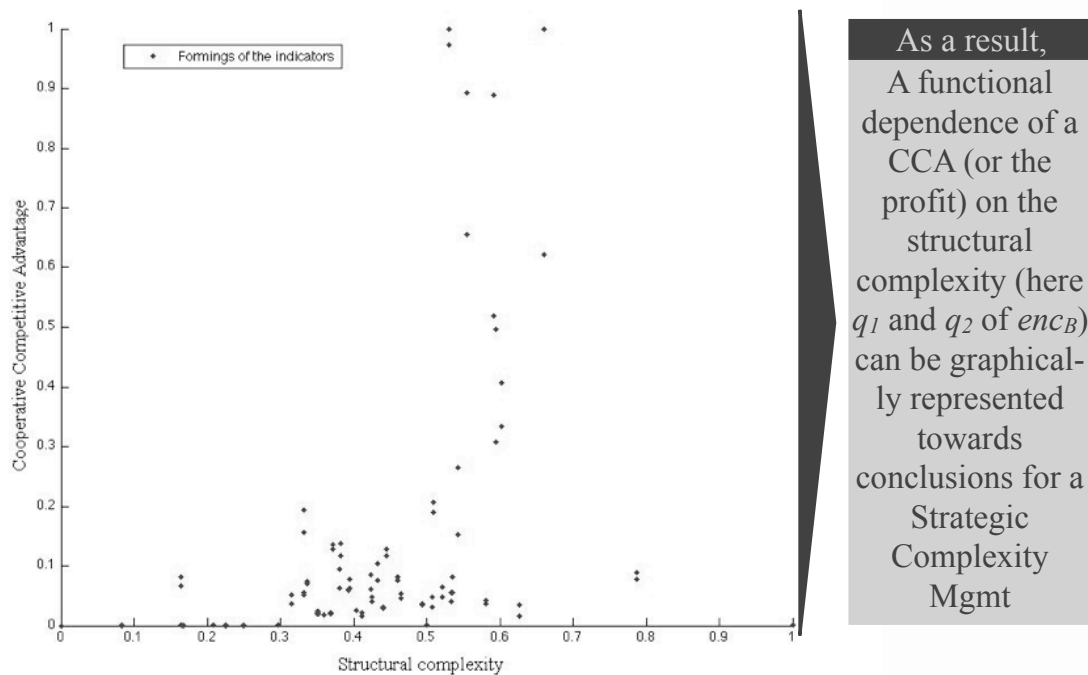
% Program : Plotten.m
%
% Richard Colmorn, 02-01-14
% Copyright (c) 2014 by Richard Colmorn
clear all
close all
load Datensatz/MMI.mat
% load Datensatz/q1.mat
  
```

```
% load Datensatz/q2.mat
% MMII = [q1 q2];
% save Datensatz/MMII.mat MMII
load Datensatz/MMII.mat
load Datensatz/incomes.mat
MMIII = incomes/max(incomes);
enc = 2; % --> Complexity-ratio encB
figure1 = figure('XVisual', '0x24 (TrueColor, depth 24,
RGB mask 0xff0000 0xff00 0x00ff)', 'PaperSize', [20 30],
'Color', [1 1 1]);
axes1 = axes('Parent', figure1);
hold(axes1, 'all');
plot1 =
plot(X1, YMatrix1, 'Parent', axes1, 'Marker', '.', 'LineStyle',
'none');
set(plot1(1), 'DisplayName', 'Formings of the
indicators');
for rr = 1:2
    plot(MMI(:, enc), MMII(:, rr), '.')
end
legend('Formings of the indicators')
axis([0 1 0 1])
xlabel('Structural complexity', 'LineWidth', 1, 'FontSize',
14, 'FontName', 'Times New Roman');
ylabel('Cooperative Competitive Advantage', 'LineWidth',
1, 'FontSize', 14, 'FontName', 'Times New Roman');
legend1 = legend(axes1, 'show');
```

Source: Own programing.

Contributions towards a Strategic Complexity Management can be drawn because as illustrated in Figure 4-41 by using the example of the quality values q_1 and q_2 in dependence on the complexity ratio enc_B the curve progression of a sharpe bell curve could be potentially recognized (and statistically tested through a mathematical fit). Therefore, it could be for example concluded that medium forming of complexity ratio enc_B for the structural complexity should be sought for (in dependence of the relational calculation of all the ratios of similar ISN) so that for example the strategies of the complexity management as outlined in Section 3.2.3 could be deliberately selected. The graphical representations about the functional relation can only be of stylised and therewith illustrative nature because of the **limitations** with regard to the theoretical substantiation of the complexity-based research model, the operationalisation of the Network Science-based measurement models and the information retrieval of the empirical data collection. As a consequence, only the tendencies of potential functional relations can be shown.

Figure 4-41: Exemplary illustration for the plotting of functional relations



Source: Own illustration.

Against this background, strategies for the **complexity management in and of International Supply Networks** can be conceptualised. They follow the **idea** to develop a Portfolio, i.e. a matrix in which the – dynamic and structural – complexities are opposed to the Supply Chain costs in which the required cost niveau of the value creation is mirrored (Meyer, 2007, p. 36). This goes back to the study “Supply Chain Complexity” of the consulting firm PRTM (Meyer, 2007, p. 35). Therefore, it is the **assumption** that the three previously introduced strategies form a building block the complexity management. Because of this idea, it is the **aim** of the **complexity management strategies for International Supply Networks** to select one of the four strategies depending on the forming of the complexity and the costs.

Complexity
management
strategies for ISN

		Supply Chain-costs	
		High	Low
Supply Chain Complexity	Low	A Focus: Efficiency-raising measures	B Focus: Systematic complexity management
	High	C Focus: Reduction of complexity and cost management	D Focus: Active control and reduction of complexity, if possible

Table 26: ISN-Complexity-Strategies (according to (Meyer, 2007, p. 36))

- Focus A: If the ISN has a low complexity but high costs, then the focus lies on

efficiency-raising measures so that cost cutting programs are suggested.

- Focus B: If the ISN has a low complexity and low costs, then the measures are concentrated towards the prevention of costs and complexities.
- Focus C: If the complexity of the ISN is high and the costs are high, then measures shall be taken for reducing complexities that are considered to be sources for costs.
- Focus D: If the complexity is high but the costs within the ISN are low, then the focus lies on measures like the control and reduction of complexities respectively the costs should be passed on the customers.

As a result, it can be **concluded** that with the help of this Portfolio appropriate strategies have to be selected in dependence on the costs and the complexities in and of the ISN. These **complexity management strategies for International Supply Networks** and their separation into these three types of strategies seem to be a common approach because e.g. (Kaluza, Bliem, & Winkler, 2006) develop a similar “complexity strategy matrix” in which “the effort for realisation of integrated SCM” is opposed to “Potential impact of integrated complexity management on SC performance” with negative and positive formings and the entries “reducing complexity”, “avoiding complexity”, “controlling complexity” and “accepting complexity” (Kaluza et al., 2006, p. 7 et sqq.). Due to the fact their conceptualisations are limited with regard to providing measurable and goal-oriented strategies (Kaluza et al., 2006, p. 5), the outcomes of the statistical analysis can theoretically help to connect these strategies with measurable indicators from a multilevel-based perspective.

Conclusions

Consequently, the plotting of potential functional relations between e.g. the formings for a Cooperative Competitive Advantage and complexity-based ratios works as a mean for deriving conclusions towards a Strategic Complexity Management because depending on curve progressions adequate strategies of the complexity management can be selected.

5 Concluding remarks: Setting forth to a Strategic Complexity Management

5.1 Scientific positioning of the PhD Thesis

This **PhD Thesis** has been assigned to the research area of **Systems Management** of Prof. Dr. Michael Hülsmann because it dealt with the Strategic Management for technology-driven value creation networks by concentrating on “new methods and approaches to deal with the adaption to such complex and dynamic structures” (Jacobs University Bremen gGmbH, 2014b). In this conjunction, with respect to the scientific *modus operandi* the **PhD Thesis** can be **classified** as an interdisciplinary thesis because from a Systems Theory-based perspective as the underlying theoretical framework the fields of Strategic Management, Logistics and Supply Chain Management as well as Complexity Science have been addressed so that different disciplines and their way of reasoning had been approached (cf. Section 1.5). It was **based** on the two research questions *What are Cooperative Competitive Advantages and what are the causal relations between an International Supply Network and the company success?* because due to the advantages of cooperation and of specialisation and as a result of a division of work between different autonomously acting organisational units it was **assumed** that not companies but ISN will increasingly compete with each other in the future because restrictions regarding capital, time, resources or competencies of a single company can be conquered so that an ISN can offer more significant products or services for the end-customer. For this reason, it was **assumed** that an ISN – the same as an individual company – aims to gain and maintain a competitive advantage, too, by offering a product or a service for the end-customer that is superior to those of a competitor, that is recognized by the end-customer and that can be adhered long lasting so that – with regard to the advantages of cooperation – an International Supply Network can create a so-called Cooperative Competitive Advantage (cf. **Section 1.1**). Because of this it was the overarching **objective** to develop an explanation approach that is able to explain Cooperative Competitive Advantages as well as the causal relations between an International Supply Network and the company success (cf. **Section 1.4**) because of the theoretical and the practical relevance could identify gaps of knowledge for justifying the relevance of the research questions. The theoretical relevance concluded that an explanatory approach is needed that is able to explain Cooperative Competitive Advantages as well as the causal relations between an International Supply Network and the company success

Scientific
Positioning of
the thesis

because, firstly, CCA have not been extensively analysed and the contribution of the cooperative relations to the competitiveness is unclear. Secondly, the effect of the ISN e.g. on the company success has not been extensively analysed towards an operationalisation and, thirdly, an interdisciplinary and multilevel approach is needed from a systemic perspective for balanced win-win-situation of all companies involved and the whole ISN (cf. **Section 1.2**) could be identified. With regard to the practical relevance of the two research questions it could be assumed be derived that end-means combinations towards the realisation of a competitive advantage of a whole ISN as well as approaches to manage a win-win-situation between the individual and the network level are missing. This can be traced back e.g. to a lack of an operationalisation of the effects of an ISN on the competitiveness that takes both levels explicitly into account (cf. **Section 1.3**). Therefore, it was the **idea** to use the **underlying theoretical framework of Systems Theory** because of the interdisciplinary nature of the topic, the author's qualification in theoretical physics and the focus on the complexities of ISN. Moreover, this approach was in accordance with the epistemological scientific position according to Popper's falsificationism about how to create knowledge, the ontological scientific position according to the course of research of (Chmielewicz, 1979) about how to perceive the subject of scientific consideration and the methodological scientific position with regard to quantitative methods about which instruments to use for gaining knowledge so that the thesis was also reliable to a systematic approach for the scientific *modus operandi* (cf. **Section 1.5**). This systematic, i.e. scientific, procedure was also reflected in the structural proceedings because it followed the pyramid principle according to (Minto, 2005) as an overarching guiding approach as well as a system of objectives connected with the three different levels of the structural proceedings so that – where possible and appropriate – a systematic approach was followed (cf. **Section 1.6**). Against this background and the **characterisation** of the **PhD-thesis** with regard to the application of a methodological procedure motivated from the field of physics the following **central conclusions** can be drawn. Due to the underlying theoretical framework of Systems Theory an abstract approach towards a stylised research model was followed because with reference to (Bar-Yam, 2011) the **main advantage** of the abstract approach of physics consists of the approach that if a stylised model is able – by neglecting so many other theories, factors, methodological approaches – to accurately predict the behaviour of a system, then this abstract and stylised model points to a universal principle so that it seems worthwhile to go into deeper scientific considerations. Therefore, some methodological aspects such as e.g. approaches in the field of social sciences were neglected (cf. **Section 1.5**). But what were the main **results**?

5.2 Summaries: Main findings of the research task

The **main findings** of this **PhD-thesis** can be summarised with regard to the findings of the descriptive, analytic and pragmatic research task for the problem specification, the solution approach and the empirical validation because of the outlined structural proceedings for the level of the sections and subsections. Therefore, the **summaries** for the **2nd**, **3rd** and **4th Chapter** shall be given.

Main findings

At the beginning of **Chapter 2**, the elements and relations of International Supply Networks were considered at first because of the underlying theoretical framework of Systems Theory and the ontological scientific position according to the course of research of (Chmielewicz, 1979) (**Section 2.1**). In this regard, the ISN of the – German – automotive industry were depicted from an stylised perspective, whereby elements constitute organisational units that are connected with each other through horizontal and vertical forms of cooperation targeted towards the function to gain and sustain competitiveness for the value creation of cars (**Subsection 2.1.1**). For the analytic considerations, the scientific discipline of the strategic management offers a theoretical framework for understanding the behaviour of organisations because of the strategic fit pointing to a goal-oriented adjustment of the organisational attributes with changing environmental conditions. Therewith, with respect to the cause-perspective the conclusions could be drawn that due to the requirements of an increased economic globalisation ISN arise because of the advantages due to cooperation and specialisation as a result of the strategies to concentrate on the core competencies. With regard to the effects-perspective of the the conclusion could be drawn that with the help of the strategic success factors a theoretical framework is given for analysing the influence of the characteristics of the ISN to contribute to the competitiveness (**Section 2.1.2**). For the development of an explanation approach implications for a systematic proceeding could be derived. After having identified the elements and relations the characteristics of ISN have to be considered because they allow investigating about how the characteristics of an ISN might affect its function to influence the competitiveness on the individual and the network level. In this regard, a first implication towards the second research question can be drawn because the characteristics of ISN seemed to be the starting point for answering the question about the causal relation between ISN and the company success (**Section 2.1.3**). As a **result of Section 2.1**, the structural relations of the – German – automotive industry were outlined and the first step towards a research model was approached.

Chapter 2

After this, the characteristics of International Supply Networks have been investigated because they are an essential ontological feature of every subject of consideration (**Section 2.2**). For this, complexity was depicted as the characteristic of a system that is determined through the number and diversity of its elements and their relationships with each other and the change of these elements and their relationships over time (**Subsection 2.2.1**). The reason for this perspective was a gap of knowledge about the structural relations in the field of managerial economics because with regard to the consideration of economic network it could be concluded that the interplay between the individual and the network level lacks a theoretical foundation. Therefore, another – interdisciplinary – framework seemed to be more promising that is focussing more on measurable and therewith provable statements about the causal interplay between the individual and the network level. For this, the theoretical framework of Complex Adaptive Systems was used for covering the characteristics of International Supply Networks because the frameworks of the structural complexity and the dynamic complexity including emergent and chaotic phenomena seemed to be promising for covering the characteristics on the individual and the network level. Therewith, the gap of knowledge in the field of managerial economics could be overbeared because of the measurable approaches for explaining and modelling structural complexities from a Systems Theory-based perspective. As a result, it was concluded to investigate whether the system behaviour of the ISN can be somehow connected with the emergent and chaotic complexity (**Subsection 2.2.2**). With regard to the development of the research model it could be derived to consider it as a complexity-based one because the characteristics of ISN could be covered through the framework of the structural complexity while the behaviour of the system, i.e. the ISN, could be theoretically connected with the emergent or chaotic complexity so that positive or negative directions were thinkable (**Subsection 2.2.3**). As a **result of Section 2.2**, the structure and dynamics of Complex Adaptive Systems as characteristics of ISN were outlined.

By considering its definiens, the first function of ISN was considered (**Section 2.3**). At the beginning, a Cooperative Competitive Advantage was assumed to exist if the typical features of a competitive advantage – an important characteristic of a product or a service is superior to those of a competitor, it is recognised by the end-customer and this advantages can be adhered long-lasting – can be traced back to the advantages of cooperation in and of the ISN (**Subsection 2.3.1**). For the analysis of CCA, it was discussed that for explaining the emergence of competitive advantages in general only the Resource-Dependence-Approach and the Relational View would take the network-perspective explicitly into account so that a Resource-based View seems promising. Based on this, it could be derived that the theoretical framework

for explaining cooperation can be connected with the framework of competitive advantages because of their resource-based perspective and their focus on synergetic effects. Therefore, the arise of a Cooperative Competitive Advantage can be assumed in the case of synergetic effects – economies of scope and scale – as a result of cooperation through the structural relations of an International Supply Network. These effects can be covered with the help of the framework of the target areas of logistics because they fit to the features of a competitive advantage. As a result, a potential explanation for Cooperative Competitive Advantages of International Supply Networks has been introduced. Procurement strategies of modular sourcing in combination with the supplier selection supporting a cost leadership could be identified as an end-means combinations for realising and securing a CCA because they are based on the resource-based perspective and the cooperative interplay in and of the ISN so that economics of scale and scope can be achieved as a driver for the competitiveness on the network level (**Subsection 2.3.2**). With regard to the development of the research model a positive causal relation between the structural complexity and the competitiveness on the network and the individual level could be assumed because of the – stylised – considerations with the help of the Relational View and the Supply Chain Valuedriver Decomposition (**Subsection 2.3.3**). As a **result of Section 2.3**, an approach for the competitiveness on the network level has been outlined.

After this, the second function of ISN was considered (**Section 2.4**). To start with, the profit was depicted as a financial measure for the goal-achievement by referring to the benefit, i.e. the overplus. This benefit is usually scored after the costs of the company for the value creation of a product or service (**Subsection 2.4.1**). The theoretical framework of Corporate Finance helped to explain the profit-orientation because the company value refers to the benefit the owner of the company could profit from so that a sustainable increase of the company value in the long run would be an indicator for company's competitiveness. The reason for this was that a maximisation of the profit secures the liquidity and therewith company's survival on the market as well as it serves as an indicator in the financial markets in the competition of potential investments. With the help of the value-based Supply Chain Management in general and with regard to valuedriver in particular it could be concluded that if value is generated for the end customer, then profit is generated for the company in the long run so that its competitiveness is secured (**Subsection 2.4.2**). With regard to the development of the research model a negative causal relation between the structural complexity and the profit can be assumed because of the considerations with the help of the Resource-Dependence-Approach (**Subsection**

2.4.3). As a **result of Section 2.4**, the profit-orientation to the competitiveness on the individual level was outlined as a second function of ISN.

At the end of the second chapter, conclusions were drawn towards a research model (**Section 2.5**). At first, a research model was defined as an idealistic formal representation of the reality where potential relationships between constructs of interest are represented through – positive or negative – substantial hypotheses (**Subsection 2.5.1**). With regard to the overarching objective a complexity-based research model was developed about how the structural complexities might affect the competitiveness on the network and the individual level. In this conjunction, it was approached to consider the whole causal model as a Cooperative Competitive Advantage because of explicitly consider the effects of the characteristics of an ISN from a multilevel perspective so that a CCA can be clearly separated from a competitive advantage (**Subsection 2.5.2**). In order to derive conclusions for the following proceedings, the research model could be extended about a need of research to test the causal relations between the structural complexity as a characteristic of an ISN and its functions towards the profit-orientation and the CCA through falsifiable and therefore measurable hypotheses (**Subsection 2.5.3**). **Consequently**, a complexity-based research model as a first step of the explanation approach could be developed so that a need of a measurement approach in the next step arose.

Chapter 3

At the beginning of **Chapter 3**, Structural Equation Models were introduced as the proposed solution approach (Section 3.1). Structural Equation Models were depicted as a class of statistical methods consisting of a structural model with latent, i.e. non-observable, and measurement models with manifest, i.e. measurable, variables that are able to test causal relationships by proving if content-based postulated hypotheses cannot be rejected statistically (**Subsection 3.1.1**). It could be analysed that Structural Equation Models are a promising solution approach because their nature as a multivariate statistical method fits to the features of the research model. In combination with the framework of Network Science, it could be investigated the potential measuring of the structural complexity in and of ISN (**Subsection 3.1.2**). The procedure for developing a Structural Equation Model could be identified because of the 1st, 2nd and 3rd steps of the recommended framework and because of the approach of Network Science-based measurement models. Therewith, a systematic methodological approach for the solution approach was found (**Subsection 3.1.3**).

Because of this, the first measurement model was developed (**Section 3.2**). To do so, the ego network connectivities of $enc_A - enc_D$ were identified as measures for the structural complexity in an of International Supply Network because of indicating

the amount and diversity of elements and relations (**Subsection 3.2.1**). With regard to cause-perspective of the analytic scientific aim it could be shown that the ego network connectivities of $enc_A - enc_D$ are able to represent the structural complexity because the shown ratios in the equations could be traced back to indicating the amount and or diversity of the elements and relationships so that they could be grounded on the outcomes of Complexity Science in Section 2.2. With regard to the effects-perspective it has been argued that the ego network connectivities of $enc_A - enc_D$ do reflect the structural complexity because it has been argued that the latent variable has to be considered as a causing factor standing behind the indicating measurable variables so that they are the result and therefore of reflective nature (**Subsection 3.2.2**). For getting a measurement model, the ego network connectivities of $enc_A - enc_D$ could be assigned to the LISREL-notation in a reflective way (**Subsection 3.2.3**). As a **result**, it was concluded that the ego network connectivities reflect the latent exogeneous variable of the structural complexity.

For the second measurement model (**Section 3.3**), the ego network composition q was classified as an abstract measure from Network Science for the logistic target area of quality expressed through the mathematical equation Formula 3-12 in which the attributes a can refer to the number of employees and the number of supplying components as indicators for different characteristics of the cooperating suppliers (**Subsection 3.3.1**). For the cause-perspective, the ego network compositions were understood as the result of the need for the operationalisation of Cooperative Competitive Advantages because it seemed to allow a theoretical substantiation with the help of the Resource-based View. Therefore, by following the approach of Systems Theory a measurement model could be developed. With regard to the effects-perspective it has been argued that the ego network composition of $q_{1,2,3}$ reflect a Cooperative Competitive Advantage because it has been argued that despite of their methodological limitations the latent variable has to be considered as a causing factor standing behind the measurable indicators (**Subsection 3.3.2**). For the pragmatic scientific aim, a measurement model for the latent endogeneous variable of the CCA could be developed because the ego network compositions $q_{1,2,3}$ could be transferred to the LISREL-notation so that CCA are operationalised and specified through measureable indicators and mathematical equations as a mean towards the end of a measurement model (**Subsection 3.3.3**). As a **result**, the ego network composition reflects the endogeneous variable.

For the development of the third measurement model (**Section 3.4**), the ego composition e_k for the corporate group k was classified as an abstract measure from Network Science that was defined through the mathematical equations of Formula 3-13 – Formula 3-15 in which the vector entries are filled with the EBIT of a

corporate group from the value-based management (**Subsection 3.4.1**). It was argued that this profit-based corporate group composition can be used – despite of its methodological limitations – for measuring the company value because of the framework of the value-based SCM by using the cause-and-effect relations about the value contribution of the target areas of logistics to the Economic Value Added according to (Sennheiser & Schnetzler, 2008). In this conjunction, the outlined profit-based corporate group composition reflects the latent endogeneous variable of the company success because it could be argued that it is standing as a causing factor behind the observable indicators. Therefore, a measurement model arises (**Subsection 3.4.2**). Consequently, with the help of the SEM-framework a measurement model for the latent endogeneous variable of the company success arose that was operationalised and specified through measureable indicators and mathematical equations (**Subsection 3.4.3**) so that, as a **result**, a profit-based corporate group composition for reflecting the latent endogeneous variable had been developed.

At the end of the third chapter, conclusions were drawn about the solution approach (**Section 3.5**). For this, the essential nature of the solution approach was depicted as a Network Science-based Structural Equation Model being classified as a multivariate statistical method for proving if the causal relations of the research model cannot be rejected statistically (**Subsection 3.5.1**). With regard to the cause-perspective the Network Science-based measurement models seemed to be a promising response to the outlined complexity-based research model because the measures for the structural complexity could be connected with the Resource-Dependence-Approach and the Relational View so that the potential – negative and positive – causal relation of the structural complexity with the company success and CCA could be theoretically grounded. With regard to the effects-perspective Structural Equation Models were able to give strong indications towards causality because of their statistical analysis of correlations. Therefore, this methodological approach seemed to be able to statistically prove the outlined potential causal relations of the complexity-based research model (**Subsection 3.5.2**). For the pragmatic scientific aim, a solution approach could be developed because the final system of equations represented a completely specified Network Science-based Structural Equation Modeling approach (**Subsection 3.5.3**). Therefore, the need to empirically validate its outlined relations through the analysis of statistical covariances arose. As a **result**, a Network Science-based Structural Equation Modeling approach has been outlined as a response to the complexity-based research model.

For the empirical validation of this solution approach in **Chapter 4**, the empirical data set was introduced at first (**Section 4.1**). In this connection, the empirical data set could be defined as secondary data from a content analysis for the supply relationships of the German automotive industry in which 69 brands, 787 car models, 564 suppliers and 592 components are contained that are related with each other through plurivalent assignments of the supply relationships (**Subsection 4.1.1**). Furthermore, it had been analysed that the empirical data set for the supply relationships of the German automotive industry could be traced back to the developed SEM-approach because individual data sets for the brands and supplier as well as brands and components and their corresponding supply relationships could be collected. Therefore, an empirical data set for the elements and relations of the International Supply Networks of the German automotive industry arose. For figuring out if this empirical data set allows the calculation of the structural complexities, the International Supply Network (supply relations) of the German automotive industry could be mapped out because all the relations were systematically arranged with the help of the SQL-formalism so that the complexities in and of the supply relationships of the German automotive industry could be calculated (**Subsection 4.1.2**). Finally, the pragmatic scientific aim could be achieved because with the help of the MATLAB-approach the information contained in the empirical data set could be transformed into metrical nature in the form of a matrix. Therewith, the measurement models for the empirical validation of the developed solution approach can be calculated (**Subsection 4.1.3**). As a **result** of this section, it could be outlined that the complexities in and of the supply relationships of the German automotive industry had been mapped out.

Because of this, the model identification could be approached as the next step of a complete Structural Equation Modelling process (**Section 4.2**) that was mainly defined over the well-known t-rule that has to be fulfilled so that a system of equations can be solved (**Subsection 4.2.1**). It was the conclusion for the cause-perspective that a full Structural Equation Model arose because empirical information for the three measurement models could be compiled so that the problem of identifiability could be addressed. For this, the system of equations were identified because with the help of the t-rule it could be analysed that the degrees of freedom were larger than zero so that the analysability of the Structural Equation Modeling approach could be concluded (**Subsection 4.2.2**). A variance-based Structural Equation Modeling approach could be identified for the statistical analysis because of its contributions towards the limitations of the research with regard to the theoretical foundation and the empirical information. Therewith, the partial least

squares-approach could be applied (**Subsection 4.2.3**). As a **result**, the analysability of the measurement models was outlined.

With the help of these outcomes, the model could be estimated in the next step (**Section 4.3**). For doing so, the PLS-algorithm was depicted as a method from the field of multivariate statistics for a variance-based Structural Equation Modeling approach comprising the idea to differentiate between an external estimation and an internal estimation within the model. Therewith, variance-based values for the latent variables as well as for the path coefficients in the structural and measurement models and the loads for the reflective specification could be calculated (**Subsection 4.3.1**). Because of the nature of the research model and the retrieved empirical information, it was investigated that the PLS-approach could be used for an estimation of the variance-based Structural Equation Model (**Subsection 4.3.2**). In order to execute such a model estimation, SmartPLS was introduced that constitutes a very helpful computer program for running the model estimation because of its user-friendly design and being exempt from charges so that the statistical analysis could be done (**Subsection 4.3.3**). As a **result**, the Partial Least Squares-approach for the statistical analysis of the Structural Equation Model could be outlined.

In this regard, the results of the estimated parameters were evaluated in the next step (**Section 4.4**). With the depiction of a quality criterion as a quantitative threshold for indicating the objectivity, reliability and validity of a statistical result with regard to a certain probability (**Subsection 4.4.1**), it could be argued that the Structural Equation Modeling approach can be statistically evaluated because of the quality criteria for the reflective measurement models and the inner path model so that statements about the goodness-of-fits can be derived (**Subsection 4.4.2**). Therefore, because of the manual calculation and in combination with the statistical analysis of SmartPLS, the Structural Equation Model could be evaluated wherein only weak goodness-of-fits could be concluded so that generalizing conclusions should be handled with care (**Subsection 4.4.3**). As a **result**, the goodness-of-fit of the Structural Equation Modeling approach could be determined.

At the end of the fourth chapter, conclusions about the empirical validation were drawn (**Section 4.5**). In this connection, an empirical validation was depicted as a statistical method grounded on Popper's falsificationism for deriving conclusions about the quality or reliability of a scientific statement of cause-and-effect relations with regard to the operationalisation as well as to the power of explanation of the research model (**Subsection 4.5.1**). Against this background, it could be argued that the complexity-based research model could only be weakly validated because the falsification of the derived assumptions could not be rejected with regard to a statistical reliability. For this, some implications could be discussed for the Strategic

Complexity Management because of “stronger” statistical results for the causal relation between the structural complexity and CCA (**Subsection 4.5.2**). In order to use these indications, the plotting of – potential – functional relations between e.g. the formings for a Cooperative Competitive Advantage and complexity-based ratios worked as a mean for deriving conclusions towards a Strategic Complexity Management because depending on curve progressions adequate strategies of the complexity management can theoretically be selected (**Subsection 4.5.3**). As a **result**, implicatons for a Strategic Complexity Management could be drawn but what are the contributions and limitations of these findings with regard to the two research questions and the overarching objective?

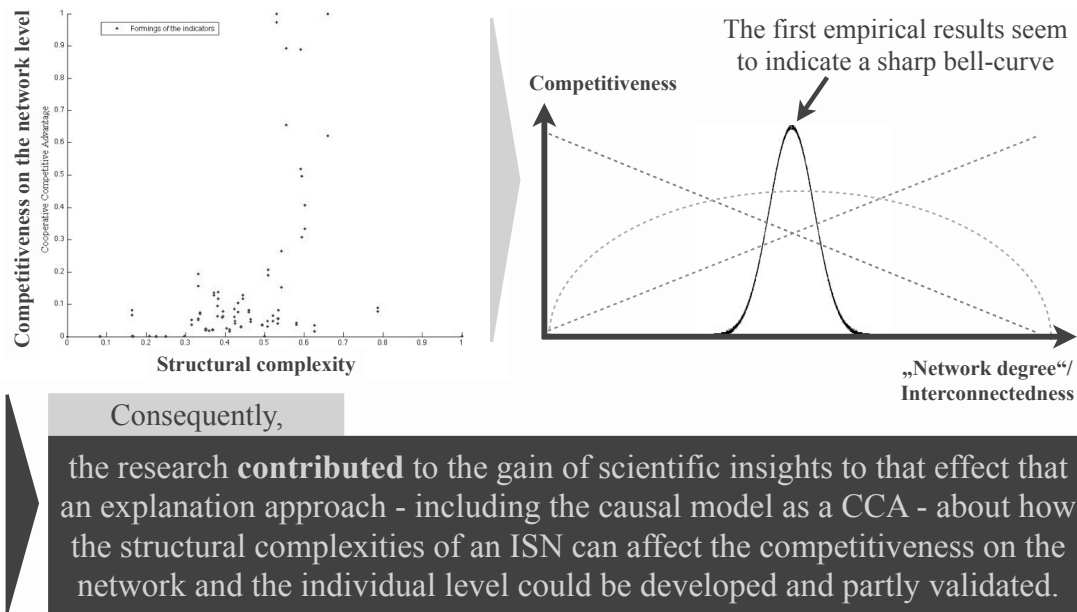
5.3 Contributions: Scientific insights for a Strategic Complexity Management

Scientific insights

The **scientific insights** can be generally **assigned to the scientific progress** because results for answering the relevant and current scientific research questions could be achieved with the help of an interdisciplinary scientific approach. Therewith, the results can be **characterised** as a theory-generating approach because a system of causal assumptions for future research had been generated that were validated to a limited extend through first empirical results. In this conjunction, the **scientific insights** can be **classified** with regard to the question whether contributions towards the explanation of cause-and-effect relations (theory) or if contributions about the end-means combinations (technology) through the first empirical results could be achieved. Against this background, targeted towards the **aim** of figuring out the contributions of the above-introduced main findings it is the **idea** to refer to the illustration of the research question in Figure 5-1 because herewith it is possible to imply the theoretical as well as the pragmatic contributions in a stylised and therewith understandable way. This approach is **based** on the following **assumptions**: Firstly, a two-dimensional graphical illustration of the effects of the complexities on the competitiveness on the network level is **grounded** on the computational effects in which the company success was included so that a two-dimensional representation is a strong simplification of a three-dimensional determination. Secondly, these **scientific insights** are **grounded** on the contributions AND limitations in the individual subsections with regard to the theoretical, methodological and pragmatic results. In **consequence**, this PhD-Thesis achieved **scientific insights** because a causal model about the effects of the structural complexities in and of the International Supply Networks of the German automotive industry on the competitiveness on the network level and on the competitiveness on the individual level could be developed and partly validated in a first step (cf. Figure 5-1). More specifically, the research **contributed** with regard to the **scientific modus operandi** because the development of the complexity-based research model was grounded on the underlying theoretical framework of Systems Theory so that **insights** about an interdisciplinary scientific proceeding for combining Complexity Science with the Strategic Management could be achieved. In this connection, a contribution towards the **methodological modus operandi** was achieved because approaches for an operationalisation of the constructs of CCA and the structural complexity – not only for the logistics and Supply Chain Management but also for the Strategic Management – had been developed so that these operationalisations may be used in different settings. Additionally, a gap of knowledge could be bridged

through the **empirical data collection** about the supply relationships in the German automotive industry because their maps cannot be found in the scientific literature (Cf. Section 4.1). Finally, the research **contributed** to a **potential application** in the industry because with the results it becomes inherently possible to derive – complexity-based – strategies for gaining an intended forming of the complexity of an ISN so that practical implications e.g. for the Strategic Network Management in the automotive industry can be potentially derived.

Figure 5-1: Contributions for the gain of scientific insights



Source: Own illustration.

As a result, the research contributed to the gain of scientific insights to that effect that an explanation approach could be developed that is able to explain Cooperative Competitive Advantages as well as the causal relations between an International Supply Network and the company success. Hereby, a Cooperative Competitive Advantage was approached as the causal model of assumed causal relations about how the structural complexities in and of an ISN can affect the competitiveness on the network and the individual level so that the causal relations between the – characteristics of – an ISN and the company success was considered directly and indirectly. This complexity-based research model could be operationalised with the help of a Network Science-based Structural Equation Model in which a methodological aspect has to be distinguished from a content-oriented one because the ratios e.g. the EBIT are just potential applications. By considering the empirical validation the research contributed also with regard to the scientific modus operandi as well as the methodological procedure towards a Strategic Complexity Management. But what are the limitations?

Conclusions

5.4 Limitations: Weaknesses of the theoretical, methodological, empirical and practical contributions

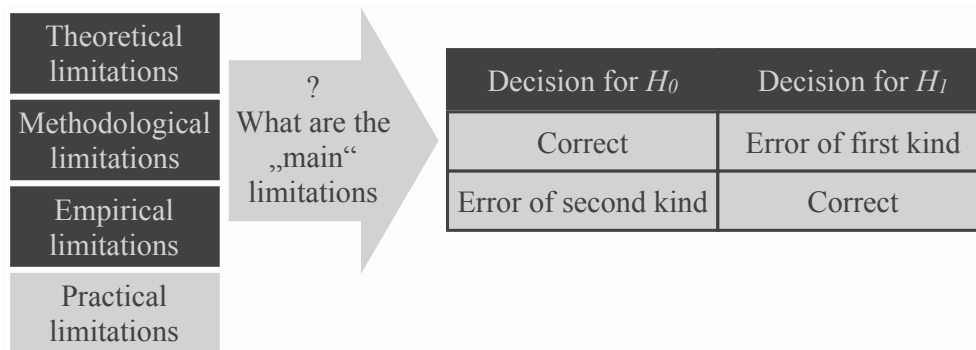
Limitations

For adequately discussing the results of this research, the **limitations** of the above-introduced contributions have to be addressed, too, because they are connected with some significant weaknesses. These weaknesses are **based on the limitations** that were discussed in the subsections of Chapter 2, 3 and 4. Because of the **aim** to critically discuss these **limitations**, they can be **classified** with regard to the **limitations of the theoretical, limitations of the methodological, limitations of the empirical** and the **limitations of the practical contributions**. In this regard, it is the **idea** to illustrate these limitations and their potentials effects with the help of the statistical framework of the error of first and second kind. The error of first and second kind refers to a statistical test problem of H_0 against H_1 where the following errors can occur:

- Error of first kind if the null hypothesis is rejected despite of the fact that it is true.
- Error of second kind if the null hypothesis is accepted despite of the fact that it is false (Gertheiss & Tutz, 2009, pp. 444–445).

Despite of the fact that statistical tests had been applied as quality criteria for evaluating the goodness-of-fit, it cannot be clearly stated which of the above-mentioned **limitations** is mainly responsible with regard to the power of explanations. For example, it might be possible that e.g. the complexity-based research model “precisely represents” the nature but the operationalisation of the latent constructs was insufficient. In contrast, it might be thinkable that these Network Science-based operationalisations and the empirical data collection might be a “very good” approach but the stylised approach of Systems Theory led to a neglect of many theoretical frameworks from the field of Strategic Management so that this abstract procedure motivated from the interdisciplinary approach is insufficient. Therefore, with regard to the **limitations** it is the **central conclusion** that it cannot be clearly determined which of the areas of the theoretical, methodological and empirical limitations constitutes the major limitation of this research. As a consequence, it seems to be worthwhile to widen and/or deepen each of these areas for improving the statements of the empirical validation. For example, the complexity-based research model could be reasoned in more detail by including further theoretical approaches or latent constructs or it is possible to keep this state of the complexity-based research model by focusing on a more sophisticated operationalisation through an increase of the amount of manifest variables.

Figure 5-2: Error of first and second kind for illustrating the limitations



Consequently,
for determining which of the theoretical, methodological and empirical limitations is of major importance a deepening and/or widening of each of these categories seems worthwhile.

Source: Own illustration.

As a result, because of the weaknesses of the theoretical, methodological and empirical approaches, the above-introduced contributions are connected with significant limitations. Therewith, a deepening and/or widening in each of the areas seem worthwhile for figuring out the main limitation of this research. This points to future research.

Conclusions

5.5 Future research: Cornerstones towards a research programme

Future research

As a result, it is the **idea** to tie up with the considerations of the contributions and limitations of this research because of the **aim** to derive implications for future research. Therewith, it can be derived that future research should focus on a deepening and widening of the research with respect to the theoretical, methodological and empirical aspects. This is **based on the approach** of the underlying theoretical framework of Systems Theory because it focussed on the development of an abstract or stylised model through the process of simplification so that a lot of aspects of the state of research were neglected. Due to the fact that this stylised approach was able to mirror some phenomena of the “reality” it seems promising to consecutively improve the explanation approach with regard to the complexity-based research model, the Network Science-based Structural Equation Model and the empirical validation. Because of this, it is the **central conclusion** to improve the complexity-based research model step-wise by including more and deeper theoretical, methodological and empirical insights from the field of Strategic Management and Complexity Science so that the research can be grounded bit by bit.

Conclusions

Consequently, because of the contributions and limitations of this research, future research should focus on a deepening and widening of the research with respect to the theoretical, methodological and empirical aspects. Therefore, this thesis should be understood as an important step towards a future research program.

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Affidavit

Herewith I declare that I have written the present thesis on my own and without the use of other than the indicated support. Passages that I have adopted whether in sense or literally from other published or non- published works, have been marked as such.

The present thesis has, in the same or in similar form, never been handed in to another board of examination.

7th August 2014

Place/Date



Signature