I. Introduction

The first section derives the relevance of the research topic, followed by outlining the research gaps and questions. Subsequently, the underlying structure of this thesis as well as its overall research context and design are described. Lastly, the anticipated contributions of this dissertation for research and practice are outlined.

I.1 Motivation

Besides the longstanding tradition of inter-organizational cooperation, competition growth in innovation, time, quality, and costs forces firms to collaborate in inter-organizational networks (Siebert 2003), having led to an increased number and importance of inter-organizational arrangements in the last three decades (Gulati 2007; Ozmel et al. 2013). By both working together and combining resources, firms are able to reduce costs, increase flexibility, obtain competencies and new knowledge, access new resources and markets, and share risks (Sydow 2003). IT plays a critical role in the functioning of inter-organizational networks. In addition to the support of collaboration by improving coordination and communication (Chi and Holsapple 2005), IT also enables completely new types of inter-organizational collaboration, such as platform ecosystems (Ceccagnoli et al. 2012) and virtual organizations (Paul and McDaniel 2004). For example, highly automated logistic networks like United Parcel Service (UPS) (Rai et al. 2006), payment networks such as Visa, Inc. (Markus and Bui 2012), and digital platforms like the “Apple Store” (Grover and Kohli 2012) are not conceivable without the utilization of information and communication technologies. As a result, inter-organizational systems (IOS) can be seen as a key resource in inter-organizational networks.

Investments in IT account for approximately 30 percent of all business investments in companies (Saunders and Brynjolfsson 2016), and a positive trend persists (Kappelman et al. 2016). Financial volumes of IOS, such as supply chain management software, are also on the rise (Forbes 2013). Although firms widely recognize the business value of IT spending, capital investments in IT are clearly seen as riskier than non-IT investments such as R&D investments (Masli et al. 2014). Studies report that up to 50 percent of all IT investments fail to deliver returns (Cognizant 2013), with 45 percent of IT projects running over budget, and 56 percent delivering less value than expected (Bloch et al. 2012). In the context of inter-organizational networks, where collaboration per se is reported to have high failure rates of about 50 percent (BPI Network 2014), these issues are even more critical. Firms aiming to

realize returns from joint IT investments through value co-creation face even more challenges, including shared investments, risk allocation, development of joint capabilities, and providing incentives to cooperating organizations (Grover and Kohli 2012).

The described issues are particularly relevant for the wood industry. During the last years, the importance of processing wood has increasingly been recognized by economic and public sectors (Höglmeier et al. 2017). First, wood serves as a carbon pool and important substitute for fossil-based materials (Werner et al. 2005). For instance, the wood industry contributes to a total saving of 105.5 million tons of CO2 emissions per year due to the usage of wood materials and sink effects of products and forests (Rüter et al. 2011). Accordingly, the utilization of wood is seen as an integral part of the transition to a bio-based economy (Höglmeier et al. 2017; Scarlat et al. 2015), and is also subject to environmental public initiatives, such as the European Resource Efficiency Initiative (Huysman et al. 2015). Second, wood resources can be utilized for a high variety of purposes, such as construction, paper production, or energy consumption, while additionally being used multiple times through recycling and recovery (Mantau 2011), hence increasing their rising economic potential (Ollikainen 2014). The economic importance of the wood sector is further reflected by its accounting for more than one million employees and an annual turnover of about €175 billion (Becher 2016), being one of the largest industries in Germany (Mrosek et al. 2005).

However, due to the limited availability of wood as natural resource, and its increasing use for energy purposes, intensified competition (including rising prices) is observed (Schwarzbauer and Stern 2010). Therefore, cooperating in inter-organizational networks is important for wood processing companies in order to optimize the efficient use of wood materials through cascade utilization (Narodoslawsky 2003; Shahriari et al. 2015). In this context, IOS play an important role. By facilitating the transfer and exploitation of information between companies, these systems contribute to the reduction of uncertainties and the improvement of the utilization of resources (Fröhling et al. 2011; Uusijärvi et al. 2010), thus leading to diverse benefits for companies in this sector (e.g., Appelhanz et al. 2016; Osburg et al. 2016; Taskhiri et al. 2013; Zander 2017). However, the surprisingly low diffusion of IOS in the wood industry (e.g., Arano and Spong 2012; Hewitt et al. 2011; Trang 2015) indicates that organizations in this sector currently do not fully realize the potential benefits, underpinning the need to examine how IT investments pay off in this context. Consequently, the wood industry represents a suitable and relevant case for research on IT-based value co-creation.

The overall aim of this thesis is to contribute to the understanding of how IT creates business value in inter-organizational networks and, therefore, to extend IT business value research (Kohli and Grover 2008; Masli et al. 2011; Melville et al. 2004; Schryen 2010). In particular, this dissertation has three main objectives. First, it aims to resolve contradictory findings in this research field by drawing on reference theories and considering contextual factors to integrate results of previous studies. Second, another goal lies in the explanation of IT-based value co-creation mechanisms, including their key capabilities and interdependencies, by extending the identified reference theories. Third, this thesis aims to offer insights on IT-based value co-creation in the wood industry by adapting the derived theoretical findings to this specific context. The third objective is motivated by the fact that social science research in general (Pawson and Tilley 1997), and more recently IT business value research in particular (Wong et al. 2012), highlight the idea that causal relationships depend on the contextual conditions, e.g., the investigated industry. Moreover, such applied theory research (Robey and Markus 1998; Rosemann and Vessey 2008) increases the practical relevance by adapting an appropriate theory to address a specific problem relevant to practice. As stated above, utilizing renewable resources in inter-organizational networks in the wood industry represents a relevant issue for economy and society. The need for analyzing how inter-organizational IT leads to value in a specific supply chain context is highlighted by Venkatesh (2013, p. 281) who states: “If I had to use one word to describe what symbolizes future of research in this area, it is context.”

I.2 Research Questions

To advance the understanding of how IT business value can be created in inter-organizational networks, this thesis follows a reference theorizing approach (see Section A.I.5). Accordingly, this thesis is structured along three steps, i.e., theory integration, theory extension, and theory adaptation, each addressing a particular research question (RQ). The pursued research approach and the corresponding research questions are shown in Figure A-1.

The first part of this thesis aims to integrate previous research insights to advance the understanding of how inter-organizational networks create value from IT investments. Scholars found that inter-organizational networks mainly strive to achieve two types of business value by utilizing IT resources. First, studies reveal that network partners attempt to realize relational rents from inter-organizational relationships, which ultimately result in organizational performance (Dyer and Singh 1998; Lavie 2006; Prasad et al. 2013). Second, as these studies are criticized for being static and unsuitable for dynamically changing environments (Wade and

Hulland 2004), scholars increasingly highlight the critical role of organizational agility in inter-organizational settings (e.g., Gosain et al. 2004; Liu et al. 2013; Sambamurthy et al. 2003).

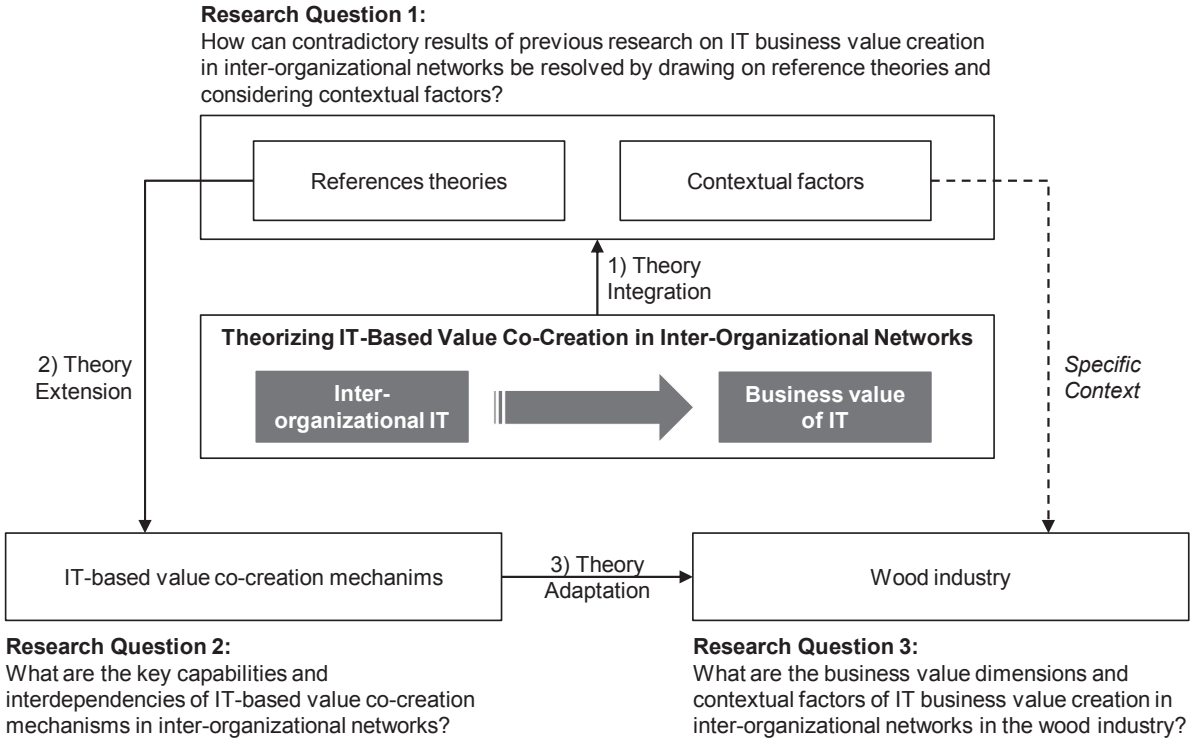

Figure A-1. Research approach and corresponding research questions

Yet, research on IT business value in general and on IT-based value co-creation in particular is characterized by contradictory findings (Brynjolfsson 1993; Sabherwal and Jeyaraj 2015). In contrast to studies that find a positive relationship between IT and business value in this context, some scholars also demonstrate insignificant or even negative impacts of IT on both relational value (e.g., Hyvönen 2007; Saldanha et al. 2013; Truman 2000) and organizational agility (e.g., Gosain et al. 2004; van Oosterhout et al. 2006; Overby et al. 2006). On the one hand, the contradictory findings stem from a missing common theoretical understanding and a highly scattered application of reference theories (Madlberger 2011). On the other hand, contextual factors, such as the type of interfirm relationship and the applied research methodologies, likely affect the impact of IT on business value in inter-organizational settings (Grover and Saeed 2007; Wong et al. 2012). These contradictory findings in the extant literature limit the understanding of how inter-organizational networks create value from IT. Therefore, a first research question is proposed:

> ***RQ 1:*** *How can contradictory results of previous research on IT business value creation in inter-organizational networks be resolved by drawing on reference theories and considering contextual factors?*

In the second part, the goal lies in the extension of the reference theories to gain insights into IT-based value co-creation mechanisms in inter-organizational networks. Researchers typically theorize mechanisms of value co-creation as a capability-building process, resulting in a hierarchy of capabilities in which lower-order capabilities shape the development of higher-order capabilities (Lee et al. 2015; Rai et al. 2006). Following this argument, scholars have empirically demonstrated the positive impact of various inter-organizational IT capabilities, such as IT infrastructure integration, information integration, IT-enabled planning and control, and IT partner support on intermediate factors, e.g., supply chain integration (Rai et al. 2006), process coupling (Saraf et al. 2007), and relational responses (Wang et al. 2013). Moreover, direct impacts on relational value have been found (e.g., Dong et al. 2009; Wong et al. 2012; Zhu and Kraemer 2005).

However, the understanding of how inter-organizational IT capabilities relate to each other, and consequently how the IT-based value co-creation mechanisms can be decomposed, remains underresearched. Although a number of IT capabilities has been found to shape co-created value, their interdependencies in the capability-building process are rarely examined. Moreover, important intra-organizational business value concepts, such as IT alignment (Coltman et al. 2015), are barely considered in inter-organizational settings. This is also highlighted in the MISQ special issue on co-creating IT value, where Grover and Kohli (2012, p. 231) ask researchers to "focus more on interdependencies between the layers" and to "expand the sources of IT-based cocreated value." In information systems (IS) research, this research gap is frequently accompanied by an exogenous treating of the IT artifact and a lack of embedding it into context (Grover and Lyytinen 2015). Therefore, IT-specific phenomena of value co-creation mechanisms remain largely unexplored. These issues limit the understanding of how IT leads to value in inter-organizational networks, leading to the following research question:

> ***RQ 2:*** *What are the key capabilities and interdependencies of IT-based value co-creation mechanisms in inter-organizational networks?*

Finally, the third part aims to instantiate and modify the findings on IT-based value co-creation mechanisms to the specific context of the wood industry. Research on IT business value increasingly highlights the role of both contextual factors (Melville et al. 2004; Wong et al. 2012) and differentiating business value dimensions (Grover and Kohli 2012; Kohli and Grover 2008). In the context of the wood industry, it has been pointed out that the industry is characterized by a low-to-medium degree of IS adoption (Arano and Spong 2012; Hewitt et

al. 2011; Trang 2015). However, studies have shown that IOS can be beneficial for organizations collaborating in the wood industry, for example by reducing costs (Appelhanz et al. 2016), increasing the acceptance of sustainable products (Osburg et al. 2016), and reducing negative environmental impacts (Taskhiri et al. 2013). Moreover, it has been empirically demonstrated that inter-organizational IT capabilities can lead to value for these companies (Zander 2017).

However, the understanding of the IT value creation mechanisms in the wood sector needs to be further extended due to the following special characteristics of the industry: First, the processing of wood is associated with high levels of uncertainties regarding the resource quantity, quality, and availability, resulting in the need to optimize resource efficiency (Daian and Ozarska 2009; Geldermann et al. 2016). Second, organizations in the wood industry represent a special type of inter-organizational networks as they cooperate in supply-chained regional clusters (Kies et al. 2010) and are influenced by a number of industry characteristics (Zander et al. 2015b). Previous research on IT value co-creation has mainly focused on direct economic benefits of IT (Masli et al. 2011), such as supply chain performance (e.g., Chen et al. 2013; Saeed et al. 2011; Wong et al. 2012). However, multiple objectives and criteria regarding the efficiency of renewable resources have to be considered to capture the business value of IS adequately (Zander 2017). Moreover, contextual factors of processing natural resources influence the structures, processes, and technologies in these networks (Narodoslawsky 2003), and hence need to be modeled in this value co-creation process. Therefore, this thesis finally aims to answer the following research question:

> ***RQ 3:*** *What are the business value dimensions and contextual factors of IT business value creation in inter-organizational networks in the wood industry?*

I.3 Structure of the Thesis

As illustrated in Figure A-2 and Table A-1, this thesis is cumulative in nature and consists of three parts, including six interrelated studies. While the first and last part (Part A and Part C) frame and integrate the research findings, the middle part (Part B) comprises the conducted studies in three subsections, each focusing on one of the three research questions presented in Section A.I.2. Three studies have been published in peer reviewed international IS conference proceedings, and three studies are currently under review in renowned IS journals.

Part A ("Foundations") starts with the motivation of the thesis, followed by the central research questions. Next, the research context and the research design as well as the anticipated

contributions are presented. Following this, the subsequent section comprises the theoretical background. Initially, the foundations of inter-organizational networks as a distinct organizational form are provided, followed by the introduction of fundamental concepts of IT-based value-co-creation. The last subsection gives an overview of the wood industry as a specific context.

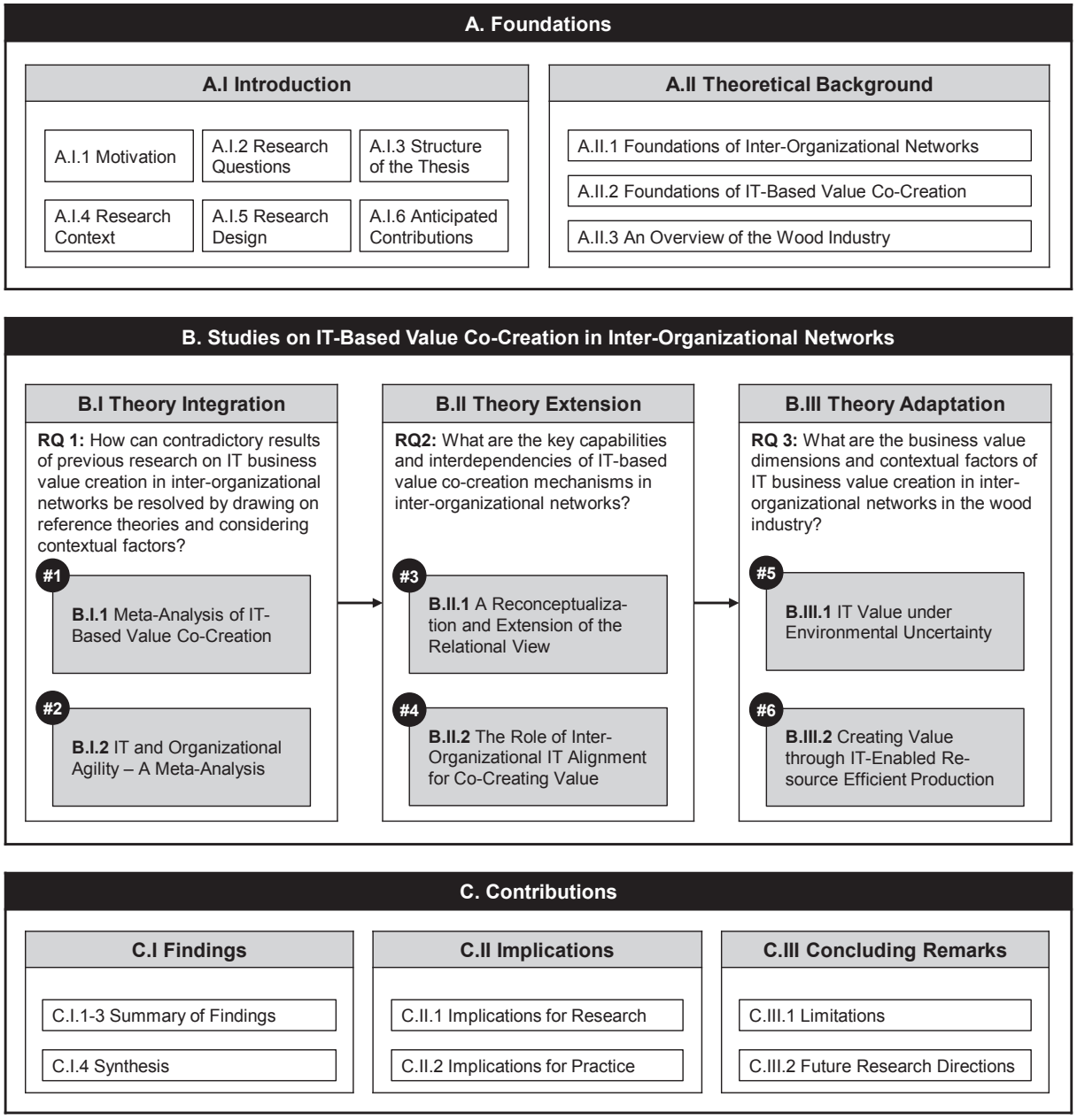

Figure A-2. Overview of the structure of the thesis

Part B ("Studies on IT-Based Value Co-Creation in Inter-Organizational Networks") corresponds to the main body of this cumulative thesis, and includes six studies in three subparts. **Part B.I** aims to address the first research question. The objective is to integrate previous research findings by drawing on reference theories and considering contextual factors to resolve

contradictory findings on relationships between IT and business value that are essential for inter-organizational networks. Both studies conduct a meta-analysis. The first study (#1) investigates the relationship between inter-organizational IT factors and business value while also exploring the role of moderating factors. While the first study does not differentiate between different types of organizational performance, the second study (#2) investigates the relationship between IT and organizational agility as a specific type of business value.

Table A-1. Overview of studies included in the thesis

No	Outlet	Ranking	Status	Section	Core research question
#1	Journal of the Association of Information Systems *	A	Passed 1st round of review	B.I	How can contradictory findings on the relationship between inter-organizational IT factors and business value be resolved?
#2	International Conference on Information Systems 2016	A	Published	B.I	How can contradictory findings on the relationship between IT and organizational agility be resolved?
#3	Information and Organization	B	Submitted	B.II	How can the relational view be reconceptualized and extended when applied to the context of information systems?
#4	Journal of Information Technology	A	2nd round of review	B.II	What is the role of inter-organizational IT alignment as a dynamic capability for co-creating value?
#5	European Conference on Information Systems 2016	B	Published	B.III	How does IT-enabled collaboration lead to supply chain performance under environmental uncertainties in supply chains in the wood industry?
#6	Pacific Asia Conference on Information Systems 2017	C	Published	B.III	How do IT capabilities lead to resource efficient production in supply chains in the wood industry?

Note: The ranking is based on the VHB Jourqual 3 ranking.
** Study #1 has already been published in the Proceedings of the European Conference on Information Systems 2016 (VHB ranking: B) and was nominated for the best paper award.*

Part B.II focusses on the second research question, and extends theoretical findings on IT-based value co-creation mechanisms by explaining the key capabilities and interdependencies in order to capture IT-related phenomena in the context of inter-organizational networks. Both studies target executives in regional networks, and thus a unit of analysis independent from the industrial context. The first study (#3) extends and reconceptualizes the relational view by providing new IT constructs and reconfiguring the underlying logic of this theory. The second study (#4) investigates the role of inter-organizational IT alignment as a dynamic capability and, therefore, as a primary source for co-creating value.

Part B.III addresses the third research question and aims to adapt the theoretical findings on IT-based value co-creation mechanisms to the specific context of the wood industry. Therefore, both studies address organizations in the wood sector. The first study (#5) aims to exam-

ine how IT-enabled collaboration leads to supply chain performance under different dimensions of environmental uncertainties. The second study (#6) sheds light on the business value dimensions of supply chains in the wood industry, and elaborates how dynamic IT capabilities lead to resource efficient production – a construct that has been newly developed for this investigation.

Part C ("Contributions") completes the thesis. As a first step, the findings from the six studies on IT-based value co-creation in inter-organizational networks are reflected and integrated. Synthesizing the findings across all studies, an extended theory on IT business value generation is developed, and a holistic view of reference theorizing is provided. Following this, implications for research and practice are outlined. Finally, the limitations of this thesis are addressed, and an outlook for future research directions is given.

I.4 Research Context

This research is conducted within the context of the Research Training Group (RTG) 1703 "Resource Efficiency in Interorganizational Networks"[1], which focuses on the development of methods for the design and optimization of resource-efficient value networks for renewable raw materials. Its novelty lies in the integration of various disciplines, such as material science, marketing, operations research, and information systems research, to comprehensively analyze effective cascade utilization of inter-organizational networks along the whole supply chain. Accordingly, the RTG is composed of three interrelated topical groups: Material Sciences (A) investigates industrial production processes in the wood industry, Operative Planning (B) focuses on planning algorithms and efficient logistic systems, and Governance (C) examines inter-organizational networks from the perspectives of marketing and information management.

In the context of the RTG 1703 (see Figure A-3), this thesis especially builds on and extends the findings of the studies from Trang (2015) and Zander (2017). Both works found that a number of inter-organizational IT capabilities (e.g., IT integration, knowledge sharing, and IT-enabled collaboration) positively impact business value in the wood industry. Up to now, it has yet remained unclear how these capabilities relate to each other regarding the capability-building process to create business value. Therefore, this thesis aims to integrate and extend reference theories to derive a theoretically founded explanation of the key capabilities and interdependencies of IT-based value co-creation mechanisms. Moreover, these mechanisms are subsequently

[1] The Research Training Group was funded by the German Research Foundation (DFG; Deutsche Forschungsgemeinschaft) from 2012 to 2016.

adapted to the special context of the wood industry. Furthermore, this thesis extends the business value dimensions, which have previously been limited to relational IT value and supply chain performance. Firstly, organizational agility is introduced as a further business value dimension in order to take into account that inter-organizational networks need to respond to dynamically changing environments. Secondly, business value is elaborated in the context of the wood industry by adding resource efficiency as a further outcome dimension.

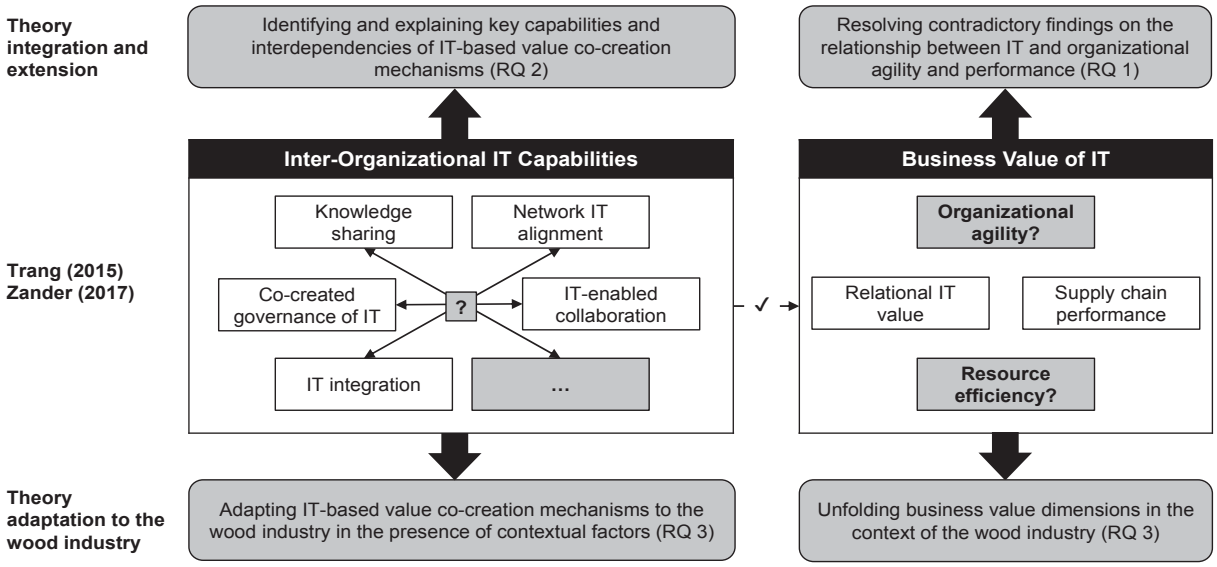

Figure A-3. Relation of the thesis to the findings within the RTG 1703

In accordance with the above, this thesis contributes primarily to the topical group C ("Governance, Coordination and Distribution"). Apart from this main focus, the results are related to other disciplines of the RTG, too. For instance, the assessment of resource efficiency as a business value dimension relates to the characterization of intermediate products from the timber industry. Moreover, the findings are relevant for operative planning, i.e., algorithms for multi-criteria optimization and computer-based production planning in recycling cascades.

I.5 Research Design

This thesis primarily occupies a position in the academic discipline of information systems research, that "focuses on how IT systems are developed and how individuals, groups, organizations, and markets interact with IT" (Sidorova et al. 2008, p. 475). In particular, following Banker and Kauffman (2004), it is positioned within two IS research streams. First, the thesis addresses the stream of *Economics of IS* by examining the impact of IS on business value. Second, since IT capabilities are investigated as mechanisms for value creation, it is also located in the stream of *IS organization and strategy*. Due to the interdisciplinary nature of IS research (Palvia et al. 2004; Wilde and Hess 2007) and the applied reference theorizing ap-