Why Do Complementors Participate? An Analysis of Partnership Networks in the Enterprise Software Industry

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***Abstract*—In the enterprise software industry, large providers (hubs) are fostering partner networks with smaller companies (spokes) that complement their platforms. This study takes the perspective of these spokes and seeks to understand their motivation to partner. It is the first to simultaneously examine two theoretical perspectives that help explain partnership formation. The input-oriented perspective holds that organizations enter inter-firm arrangements in order to access external resources and capabilities. The output-oriented perspective posits that the complementarity of the partners' products influences the benefits obtained from a partnership. In order to examine the relevancy and possible interaction of these two perspectives, a multiple-case study is conducted. Qualitative data from 17 spoke organizations is gathered and thoroughly analyzed. The study confirms that the hub's reputation and its capability to provide integrated systems are generally important reasons for partnering. However, the extent to which the hub's innovativeness and its commercial capital motivate spokes to partner varies substantially. The key finding of this study is that these variations can be explained by differences in the level of product complementarity. This leads to the conclusion that there is a widely neglected interaction effect between the input- and output-oriented perspectives in explaining the formation of hub-and-spoke partnerships.**

***Index Terms*—Complementarity, dynamic capabilities, enterprise software industry, independent software vendors (ISV), partnership networks, resource-based view, small- and medium-sized enterprises (SME).**

I. Introduction

ENTERPRISE application software (EAS) providers develop and offer solutions that range from components and modules that support particular business functions to cross-functional or inter-organizational enterprise systems that are integrated through comprehensive middleware [1]. In the early days of computing, these systems were mostly custom-developed in a make-to-order fashion. In the 1970s, standardized monolithic solutions emerged that covered the majority of business requirements of a variety of customers and hence became state of the art during the 1980s and 1990s [2]. The emergence of these systems turned the formerly diverse industry into an oligopolistic structure with a few dominating system vendors producing best practice solutions for different industries [1], [2].

In recent years, however, established vendors have tried to reduce system costs and complexity by designing the formerly integrated EAS in a more modular way [3]–[7]. This tendency toward disintegration has been facilitated by the emergence of new standards and middleware concepts, such as service-oriented architectures (SOA) that support a modular system design [8]. From a theoretical point of view, the tendency toward disintegrated systems should be reflected by a higher degree of organizational modularity and flexibility [9], [10]. However, in spite of a higher inter-organizational division of labor in the EAS industry, a seamless coordination between different organizations and a friction-free mixing and matching of software components from different vendors is still an elusive ideal. Instead, partnership networks have emerged in which companies of the EAS industry cooperate based on mutual agreements [11]. Within these partnership networks, a limited number of large organizations, often referred to as hubs, platform leaders, or keystones [12], [13], provide the systems' architecture as well as generic core functionalities, while smaller independent software vendors (ISVs), often referred to as complementors, spokes, or niche players, build their solutions on top of and complement these platforms [13]–[16]. These partnership networks may be described as loosely-coupled systems [17], where the participants are neither linked by capital (e.g., joint ventures) nor through joint efforts in specific projects or business areas (e.g., strategic alliances), but rather by more general agreements usually based on certifications of the other party's products or resources [18]–[20].

Previous contributions on hub-and-spoke partnership networks have mostly focused on the platform vendor, i.e., the hubs [13], [21]. It has been argued that hubs benefit from partnering with a large number of spokes due to the existence of two-sided network effects [22]. The software platform of a hub becomes more valuable if a greater number of compatible products exist, possibly turning the solution of the winner in this system competition into a de facto standard [23]. Thus, the attractiveness of taking on the role of a strategic center increases with the growth of the network [24], [25]. Previous literature has argued that the selection of appropriate partner firms is crucial for the success of hub organizations [24], implicitly assuming that potential partners are willing to enter collaborations. Yet, a clear understanding of what motivates complementors to

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participate in a certified partnership with a platform vendor is still missing. In fact, previous research has argued that there is "evidence that inter-organizational collaborations are more likely if partners have similar status and power" [26, p. 804], a scenario that can rarely be found in the EAS industry. Therefore, this study raises the following research question:

> *Why do complementor organizations within the enterprise software industry participate in hub-and-spoke networks?*

In answering this research question, this study is the first that integrates two theoretical perspectives that previous research has applied separately. The first one is widely accepted in the literature on inter-firm partnership arrangements. According to this perspective, organizations form partnerships in order to gain access to external resources and capabilities. The second perspective is less established. It draws on recent work regarding product-level complementarities between the solutions provided by (potential) partners and holds that the benefits from partnering are influenced by output-oriented complementarities. Both streams have not been investigated conclusively in the specific context of hub-and-spoke structures in the enterprise software industry. In particular, no effort has been made to integrate both streams. Therefore, it is intriguing to examine how both the input- and output-oriented perspectives interact in explaining why complementors participate in hub-and-spoke networks.

From a methodological point of view, this study represents a positivist exploratory multiple-case study [27]. It is positivist in that a set of key resources and capabilities, as well as product structures are identified *a priori* as a theoretical basis to guide the gathering and analysis of empirical data. It is exploratory in that the interaction of the input- and the output-oriented perspectives in explaining partnership formation is yet to be elaborated. In line with the theory emergent character of the study, a qualitative approach was favored. Data were gathered through expert interviews and secondary sources from a limited number of spoke companies (i.e., complementors) that participate in one of the partnership networks established by two different hub organizations. The objective was to thoroughly understand the spokes' partnership motivation in retrospective and to match these motivations with the input- and output-oriented perspectives, as previously theorized.

The paper is structured as follows: The next two sections provide an overview of extant literature, as well as the theoretical foundation of the study. Subsequently, the research design is developed and the empirical findings are presented. Finally, the theoretical contribution and managerial implications, as well as the study's limitations and opportunities for future research are discussed.

II. Literature Review

Previous work on the antecedents of partnership formation in the software industry has argued that firms enter inter-organizational arrangements to obtain access to external resources [28], [29]. This resource-based view is based on the assumption that firms represent bundles of resources and capabilities that are heterogeneously distributed across organizational actors [30]–[35]. Accordingly, based on this input-oriented perspective, organizations form partnerships in order to gain access to resources and capabilities that they lack, but which the partner possesses [29], [36], [37]. In particular, organizations are assumed to partner in order to obtain access to another firm's dynamic capabilities, as these capabilities are often difficult and costly to create [35]. Dynamic capabilities refer to "a firm's capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end" [38, p. 35]. Getting access to such dynamic capabilities of partner firms is particularly valuable in dynamic business contexts, like the EAS industry [39]. However, what are the relevant dynamic capabilities in the EAS industry? A few studies have shed some light on this question. For example, Huang *et al.* [18] studied the determinants of ISVs' decision to join the software ecosystems (i.e., networks) of platform owners. The study showed that spokes partner with a platform vendor if the spokes possess high downstream marketing capabilities and if they are able to protect their innovations through property rights. However, little insight was provided on the capabilities of the hub that attract the spokes to partner.

In another study, Mathiassen and Vainio [40] proposed a sense-and-response framework to understand and actively manage the dynamic capabilities of small software firms. Among other results, the authors concluded that small software firms should cultivate external relationships. Along with highlighting the need to closely interact with customers, it was argued that small software firms often depend on "one or a few large powerful players" [40]. However, this leaves open the question on why these powerful players should be a source of valuable resources and capabilities for the smaller firms.

Chellappa and Saraf [41] studied the structure and success of inter-firm networks in the enterprise software industry by applying social network analysis. The authors built their analysis on resource-based reasoning, assuming that software firms "gain access to social and technical resources through their ties" with partner firms [41, p. 3]. This was found to be particularly true for small software firms. Yet, the authors did not explicitly account for the specific structure of hub-and-spoke networks. Moreover, the paper did not investigate in detail what these "social and technical resources" are.

Besides this input-oriented perspective on partnership formation in the EAS industry, there is an emergent stream that examines partnerships in the EAS industry from an output-oriented perspective. This perspective is based on the theory of complementarities, which studies the superadditive value of combining activities [42]. It has been suggested that the success of inter-firm arrangements within the software industry is influenced by the degree of product complementarity that exists between the partnering firms [43], [44]. In this context, complementarity has been defined as the relative distance within a layered software architecture [45]. It was found that partnerships between software firms are particularly successful if complementarity is low, i.e., if the partners reside on the same or adjacent layers in the software stack [44].

Given that product-level complementarity influences partnership success, it is likely to also play an important role when it

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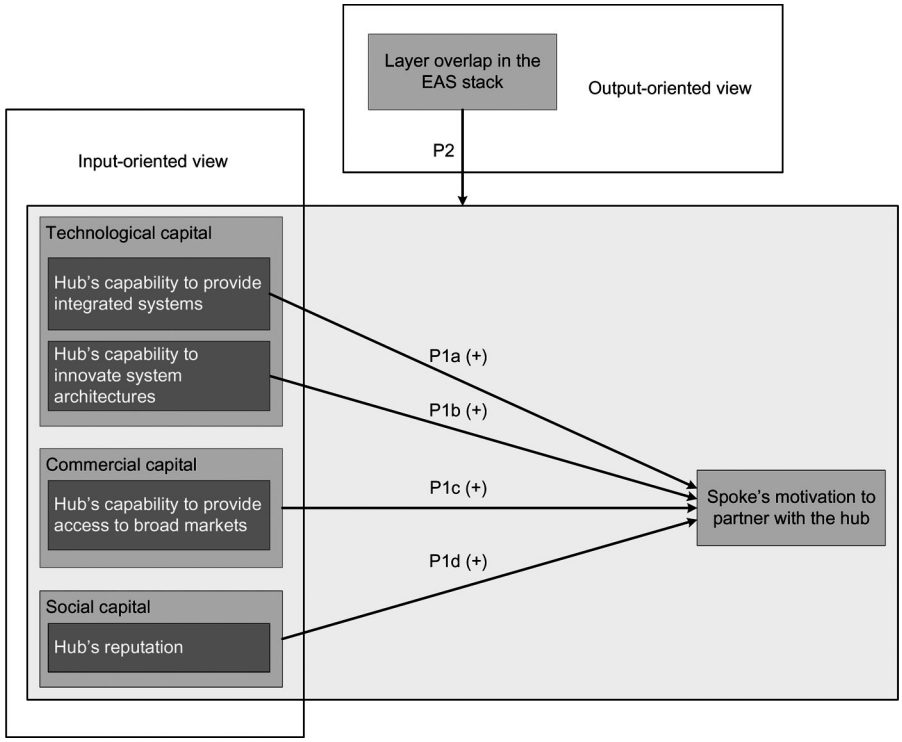

Fig. 1. Spokes' motivation to participate in hub-and-spoke networks in the EAS industry.

comes to a spoke's decision to partner with a platform vendor. However, the results from previous research show inconsistencies regarding the question of how product-level complementarities influence the decision to participate in partnerships. While the results of Gao and Iyer [44] suggest that small software firms would enter partnerships with firms that show a low level of product complementarity, Huang et al. [18] found that low product complementarity (i.e., competing products) discourages partnering. In turn, Chellappa and Saraf [41] found that software firms may benefit from partnerships both with competitors as well as with firms that provide complementary solutions.

To sum up, results regarding the relevancy of the input-oriented (i.e., resource-based) perspective in explaining partnership formation are generally consistent. However, there is little knowledge about the actual types of hub resources and capabilities that motivate the spoke to partner within the context of the EAS industry. Findings from the output-oriented perspective, i.e., the role of product complementarities, in explaining partnership formation and success are rather inconsistent. In particular, there is little knowledge about the combined effect of the two perspectives, i.e., whether there is a possible interaction between them. Against this backdrop, the purpose of this study is (1) to extend the resource-oriented perspective by elaborating a key set of hub resources and capabilities that attract spokes to partner with a hub, and (2) to examine how a combination of the input- and output-oriented (i.e., product-based) perspectives can help explain partnership formation in the EAS industry [46].

III. Theoretical Foundation

Using the previous literature review as our background, we develop a theoretical framework on partnership formation in hub-and-spoke networks. The framework takes the perspective of spoke organizations and covers both the input- and the output-oriented theoretical perspectives identified in the literature review. Fig. 1 summarizes the resulting framework.

A. Input-Oriented Perspective: External Resources and Capabilities

One of the key challenges of the input-oriented perspective is to identify those resources and capabilities of hub organizations that motivate spokes to enter partnerships with a platform leader (i.e., hub). To this end, we draw on the literature on inter-firm linkages that categorized resources and capabilities into three broad categories: technological, commercial, and social capital [37]. These three concepts were found to be of high relevancy for explaining inter-firm linkages in many domains, particularly in high-tech industries, such as the EAS industry [47]. Moreover, they provide an overall umbrella to capture those external resources and capabilities that were found to be primary motives for participating in partnerships in the software industry [18], [40], [41].

Technological Capital: Spokes may partner with hub organizations in order to get access to technological capital. The hub's technological capital can be separated into two sub-dimensions: the hub's current ability to provide integrated systems and its future-directed capability to innovate these systems [47].

Spoke organizations may benefit from the hub's current ability to provide integrated systems for various reasons. Most often, the EAS products and solutions offered by small vendors only cover a small fraction of the information system needs of their customers. In fact, the spokes' solutions are frequently of

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little value without being compatible with other components or modules, as well as with the underlying architecture of the entire information system of the customer. Given that a significant portion of the core functionality and architecture is provided by hub organizations, it is important for spokes to connect to the system offered by a hub [2]. The hub possesses the capability to provide integrated systems stemming from its historically grown, profound understanding of cross-functional business processes, as well as various underlying technological disciplines. It is the hub's core competency to understand the system in its entirety, including its relevant functional parameters, its underlying technology, and its architecture, i.e., the interfaces that exist between its various components [14]. Large enterprise resource planning (ERP) providers are typical examples of such hubs. Their huge success is essentially built on their ability to provide integrated systems that cover and link the core business functions that organizations need [1].

Similarly, the original equipment manufacturers (OEMs) in the automotive industry serve as platform leaders. Smaller partner firms are keen on building knowledge-sharing networks with these OEMs in order to benefit from their knowledge about production processes and product design [34], [48]. Hence in the EAS industry, by becoming a certified partner of a hub organization, small spoke companies may get access to valuable knowledge about the functionalities and interfaces of their larger partner's systems, i.e., to the hub's capability to provide integrated systems [49]. This is deemed necessary for the spokes to ensure inter-operability and co-value of their solutions with those of the hub. Accordingly, we propose the following:

> *Proposition 1a: Small software producers (spokes) are motivated to partner with a large EAS provider (hub) because of its capability to provide integrated systems.*

Getting access to the hub's capability to provide integrated systems allows spoke organizations to exploit the potential of their own solutions to contribute to the hub's system. This rather short-term-oriented perspective has also been referred to as "synchronic" systems integration capability, which describes the ability to exploit current resources to design the product concept, decompose it into modules, coordinate the network of suppliers, and then recompose the product within a given architecture [14]. Beyond exploitation, however, continuous exploration of new potentials is also important for spoke organizations. This long-term ability to change systems incrementally or radically has been referred to as "diachronic" systems integration capability [14]. These diachronic capabilities are closely linked to the concept of innovativeness that constitutes one of the key dynamic capabilities of small software firms [40]. However, how should a spoke benefit from the hub's ability to innovate? In order to answer this question, it is instructive to distinguish between modular (i.e., component) and system innovations [50]. While modular innovations accrue within the boundaries of a component, system innovations affect the general structure by which the components are bound together to form a coherent whole. For example, the emergence of SOAs is an important system innovation in the EAS industry because it provides a new way to build modular and flexible systems based on software components.

Establishing such system innovations requires the ability to understand interdependencies between different components as well as the functionality of the entire system [50]. In other words, these system innovations are not confined to the narrowly circumscribed components in which the spokes specialize. Thus, it can be assumed that small vendors face difficulties in innovating at the system level. In contrast, in order to stay competitive in the system competition with rival vendors, hub organizations have to continuously improve the overall system. For instance, many hubs have built their own SOA standard. Spokes are forced to keep up with the hub's system innovations. i.e., they need to get access to the hub's latest knowledge on system innovations in order to adapt or rebuild their solutions accordingly. This knowledge access may be achieved by partnering with a hub. Accordingly, we propose the following:

> *Proposition 1b: Small software producers (spokes) are motivated to partner with a large EAS provider (hub) because of its capability to innovate system architectures.*

Commercial Capital: Commercial capital has been defined as an organization's "manufacturing and marketing capabilities, and assets such as manufacturing facilities and service and distribution networks" [37, p. 320]. In the case of the EAS industry, manufacturing assets and capabilities are of minor importance. Once developed, the marginal cost for producing additional entities of the software product is close to zero, given that the software can simply be copied on DVDs or distributed through communication networks [23]. Accordingly, we focus on the hubs' marketing capabilities as well as service and distribution networks as key sources of commercial capital.

As small and innovative companies are limited in their ability to make large investments into marketing activities and to build up distribution networks, they may strongly benefit from partnerships with large hub organizations [51]. These hubs are usually global players with very sophisticated marketing and distribution capabilities. Getting access to the hub's commercial capital may enable the spoke to substantially increase the visibility and the availability of its products among a large number of potential customers [36], [37], [47]. For example, partnering was found to be a viable strategy to enter foreign markets [52]–[54]. The scope of the hub organization's marketing support may range from a simple communication of the partnership with the spoke to the actual recommendation of the spoke's solutions. Hence, the following proposition is put forth:

> *Proposition 1c: Small software producers (spokes) are motivated to partner with a large EAS provider (hub) because of its capability to address broad markets.*

Social Capital: In the context of this study, social capital refers to the reputation of a firm in the market that is often closely aligned with the brand name of a firm [37]. Small and recently founded companies often face the challenge that they are unknown in the market and that potential customers are doubtful about the quality and reliability of their products and services. Signaling trustworthiness is of special importance in

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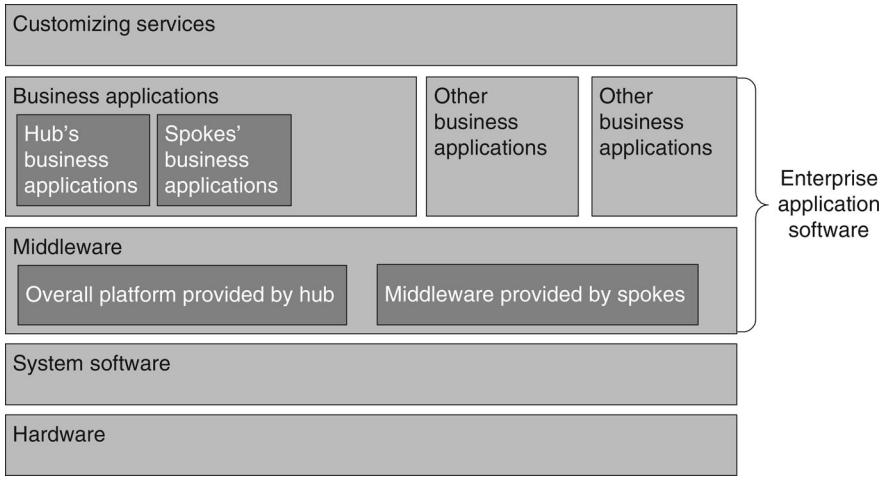

Fig. 2. Layered stack model of EAS (based on [45]).

the EAS industry since the quality of software as well as the knowledge and experience with regard to business processes are difficult to assess in advance [20], [55]. The reputation of large system providers may help small vendors overcome this problem. Through a partnership with a hub and the associated official certification of the spokes' resources or products by the hub, small companies can increase the level of trust in their solutions and signal sustainability [19], [20], [37]. Prominently positioning the brand name of a hub organization within its own marketing efforts, therefore, helps spoke organizations signal their trustworthiness to potential customers. This leads to the following proposition:

Proposition 1d: Small software producers (spokes) are motivated to partner with a large EAS provider (hub) because of its high reputation in the market.

B. Output-Oriented Perspective: Product-Level Complementarity

While most of the extant literature has focused on external resources and capabilities as key determinants of inter-firm partnerships, recent contributions have studied the role of product-level complementarity in inter-firm arrangements in the software industry. Drawing on Gao and Iyer [43], [44], we define product-level complementarity as the relative distance of two products within a layered software stack model [4], [45]. Within this software stack model, enterprise software is assumed to comprise both the business application layer and the middleware layer, which, in turn, build on lower layers like system software and hardware (see Fig. 2).

The question raised is whether the level of complementarity per se (i.e., the level of distance in the software stack) determines partnership formation. Previous literature on inter-firm linkages in the software industry provided rather inconsistent results regarding the benefits obtained from different levels of complementarity between the products of partners (i.e., different levels of distance in the software stack model). These inconsistencies speak against a direct impact of product complementarity on partnership formation. At the same time, however, the particular hub resources and capabilities proposed earlier may not play the same role for partnership motivation in each hub-and-spoke relationship. It is, therefore, intriguing to examine whether interaction effects exist between product complementarity and the impact of particular resources and capabilities of the hub. Rather than affecting the motivation to partner directly, the degree of product level complementarity may change the extent to which certain resources and capabilities are driving partnership motivation. Thus, in line with the exploratory nature of studying such combined effects, the following proposition is put forth:

Proposition 2: The level of product complementarity interacts with the extent to which particular resources and capabilities of the hub motivate the spoke to participate in a hub-and-spoke network.

IV. Research Design

A. Methodology

For scrutinizing and refining the theoretical framework, a multiple-case study approach was chosen [27], [56]–[58]. This approach is particularly appropriate for answering research questions of how and why, such as why spoke organizations participate in hub-and-spoke networks in the EAS industry [57], [59].

Qualitative research is well-suited for exploring new theoretical relationships, like the proposed interaction effect between the input- and output-oriented factors (see P2) [60]. The qualitative case study allowed us to consider the context of particular hub-and-spoke relationships in detail, for example, by examining the technological interfaces that existed between the products of hub and spoke, as well as the inter-personal relationships between the partnering firms' employees [56]. This contextual background was particularly important to understand why spokes seek to get access to particular hub resources and capabilities. Moreover, it enabled us to grasp in retrospective how the perceptions of the spokes about particular hub resources and capabilities have changed over time, possibly in combination with changes in the product portfolios of hub and spoke. Thereby, we were able to better understand the combined impact of external resources and product-level complementarities on partnership motivation.

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Besides illustrating the proposed theoretical relationship through contextually enriched case data, the qualitative data were coded along the theoretical dimensions. The goal of this coding was to provide a quantitative assessment of the impact of particular hub resources and capabilities, as well as to examine the proposed combined impact of the input-oriented factors and the level of product complementarity (see also [61]). With regard to the impact of particular resources and capabilities (P1 a-d), a quantitative assessment was used to back up the qualitative results.

> "Doing qualitative analysis of all data with the aid of numbers is a good way of testing for possible bias, and seeing how robust our insights are" [56, p. 254].

Regarding our proposed interaction effect (P2), quantitative assessment was used for pattern discovery, which was then followed by an illustration of the interaction through enriched case descriptions.

> "In qualitative research numbers tend to get ignored. [. . .] However, a lot of counting goes on in the background when judgments of qualities are being made. When we identify a theme or pattern, we are isolating something that (a) happens a number of times and (b) consistently happens in a specific way" [56, p. 253].

B. Data Collection

Since this study aimed at answering the research question of why spokes participate in partnerships with a hub, the unit of analysis was the particular relationship between a hub and a spoke organization. In order to apply replication logic in analyzing the data, several of these dyadic relationships were examined in depth, each representing a single case. The cases were drawn from two different hub-and-spoke networks in order to further increase the generalizability of the findings [57]. By examining multiple spoke organizations in two different networks, it was ensured that enough variation existed in the variables of interest, particularly in the level of product complementarity between the solutions of hub and spoke [57].

The two hub organizations under consideration have historically focused on different core businesses. Hub A has its traditional core competency in delivering business application solutions. Hence, hub A mainly resides on the application layer (see Fig. 2). Moreover, hub A has established its own SOA standard, providing an integration platform for various other application software components. Thus, hub A also covers the middleware layer. Hub B used to offer products and solutions in each of the five layers of the software stack. However, after a strategic shift in the 1990s, hub B decided to focus on infrastructure and middleware solutions. Accordingly, it is positioned on the middleware layer.

The two hub companies are both large, globally acting EAS vendors that have fostered partnerships with a multitude of smaller ISVs that build their solutions on top of the hubs' platforms. The solutions provided by these spokes can be found both on the business application as well as the middleware layers. For the purpose of this research, 17 spokes were selected that participate in one of the two networks: eight of them with hub A and nine with hub B.

The spoke organizations were selected purposefully [62]. First, it was ensured that each spoke represented an independent legal entity; i.e., none of them was a subsidiary of a larger organization. Second, each spoke was a solution provider, building its system on top of the hub's platform and, thereby, extending the overall system in a certain way. By increasing the number of cases rather than the number of interviewees per case, we were able to account for the huge diversity among spoke companies. Data were collected through expert interviews within each spoke organization, as well as by gathering secondary material on each case. Because the selected spoke organizations were fairly small (on average, the case companies employ around 20 individuals), one key individual per case was generally deemed sufficient to provide information about the partnership motives. Since the research question of this study concerns issues of strategic relevance, executives of the partner firms were selected as interview partners, whenever possible. In six of the 17 cases, the CEO (or equivalent) agreed to participate in the study. Four spokes had a dedicated role of establishing and managing the partnership with the hub company. Consequently, these partnership managers were chosen as experts. In all other cases, individuals that were considered to have the best understanding of the respective company's motives for partnering were selected (e.g., the head of software or product development). In two of the larger case companies (MEDIA and PIM), more than one interview was necessary for gaining a comprehensive picture. In two other spoke organizations (MACHINE and ARCHIVE) the interviews were completed in follow-up meetings. Overall, the dataset consists of 22 expert interviews within the 17 spoke organizations. Appendix I provides a summary of the analyzed spokes' core businesses and the conducted interviews.

All interviews were held face to face and took place onsite, except for one (PRINT) that was carried out via telephone, meeting the interviewee's preferences. The interviews were conducted by the first author and a research scholar in German language and had an average duration of one hour. The conversations were semi-structured and based on an interview guideline that reflected the theoretical propositions developed above and also included general questions about the interviewee and the respective company (see Appendix II). Although being guided by the theoretical framework, the semi-structured nature of the interviews allowed for new insights and model refinement in an exploratory manner. All interviews were tape-recorded and transcribed, except for one case (MOBILE), where the expert felt uncomfortable with recording of the interview. Instead, comprehensive notes were taken in this case. In sum, the interview protocols resulted in more than 80,000 words of qualitative data. To ensure triangulation of the data and, thus, increase the internal validity of the study, publicly available documents like the companies' Internet pages were analyzed [57].

C. Data Analysis

In line with the goal of this study, a literal replication strategy was chosen to substantiate and refine the preliminary framework [57]. That is, we focused on spokes that had actually entered a partnership with a hub and studied whether there is a

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TABLE I
DEFINITION OF CONSTRUCTS AND EXEMPLARY INDICATORS

Construct	Definition	Exemplary indicators
Technology	The hub's synchronic capability to provide a comprehensive EAS that offers the potential to technically integrate complementary third-party solutions (based on [47]).	Spokes access knowledge related to the platform
Innovation	The hub's diachronic capability to constantly renew the platform (based on [14]).	Spokes' modular innovations make use of platform innovations
Market	The hub's capability to provide partner firms with access to potential customers (based on [37]).	Spokes use hub's marketing channels
Reputation	The extent to which the hub's brand name is associated with high quality by customers (based on [37]).	Spokes use hub's brand name to signal reliability

congruent pattern in the motives of spokes to partner. These motives are reflected by the attractiveness of different hub resources and capabilities (P1 a-d) together with the level of product complementarity between hub and spoke (P2).

Accordingly, the first step of data analysis was to assess the relevancy of each of our four types of hub resources and capabilities as partnership motives for each spoke organization. For this purpose, the interview transcripts were coded according to our theoretical framework [56]. Brief labels (*Technology*, *Innovation, Market*, and *Reputation)* were assigned to the respective text passages using the qualitative data analysis tool NVivo. Table I offers definitions of each construct along with exemplary indicators, as drawn from the data. The coding was initially done by the first author, resulting in a table of 171 assigned statements [61]. Following the coding by the first author, the second author likewise assigned the 171 statements to the respective categories. The comparison of the coding resulted in a relatively high inter-coder reliability of 94 percent according to Holsti [63]. The two coders subsequently reexamined the mismatched coding and reached consensus with the help of the third author acting as a neutral investigator.

Based on this assessment, stories were written on each case separately. The case stories helped us understand the relative importance of each dimension within the context of each case [56], [62]. Through this qualitative data analysis, we were able to not only scrutinize the propositions deduced from the literature but also gain an in-depth understanding of the nature of technological, commercial, and social capital in the context of each case. Interestingly, we found some strong variations regarding the impact of particular resources and capabilities of the hub. In fact, contrary to our propositions (1a-1d) some of the hub resources and capabilities were seen as negative in some cases.

In order to substantiate our initial qualitative assessment and clearly identify the impact variations between cases, we went into a more detailed coding of the particular quotes. For this purpose, the first and second author estimated the importance and the directional impact of the 171 categorized interview statements [56]. We used a scale from -2 (highly negative influence) over 0 (neutral) to 2 (highly positive influence) for our coding. The inter-coder reliability of this estimation was 69 percent [63]. Again, mismatched estimations were reexamined by the two coders with the third author acting as a referee in order to reach consensus. Congruence between this evaluation and the initial qualitative findings for each case increased our confidence in the validity of the study's findings.

Finally, the data were reexamined in order to explore the role of product-level complementarity regarding the spokes' motivation to partner. For this purpose, the level of product-level complementarity between hub and spoke was first determined in each case [56]. This assessment was based on the product description by the interview partners as well as on an analysis of the hubs' and the spokes' company websites. For example, if the products of hub and spoke could be assigned to distinct layers in the software stack model (see Fig. 2), then the level of layer overlap was rated low, indicating a high level of product complementarity [42], [43]. The assessment of the layer overlap of the analyzed partnerships together with the evaluation of partnership motives were then used to discover patterns regarding the interplay of the input- and output-oriented factors (see P2). This examination was again followed by a qualitative in-depth analysis of the inter-relation between variations in layer overlap and the extent to which particular resources and capabilities of the hub motivated the spokes to partner [57], [64].

V. EMPIRICAL RESULTS

A. Analysis of Input-Oriented Dimension

Hub's Capability to Provide Integrated Systems (Proposition 1a): As a common theme throughout all analyzed case companies, the hub's synchronic capability to provide integrated systems was found to be one of the primary reasons for small EAS companies to partner with the hub. All analyzed spoke organizations saw limitations in their own solutions for covering customer demand. Hence, partnering with a hub was seen as a means to ensure the availability of a comprehensive enterprise system, which is necessary to sell niche solutions. Accessing technology-related know-how that resides within the hub organization was also found to be one of the primary partnership motives. To ensure knowledge absorption from the hub, some spokes emphasized the importance of personal informal ties with the hub. These relational ties helped the spokes build up the absorptive capacity necessary for getting access to the expertise of the hub personnel [65]. These findings are illustrated in more detail by the cases of WORKFLOW and MACHINE.

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WORKFLOW provides solutions for e-business and groupware as well as portal solutions based on the middleware platform offered by hub B. Shortly after it had been founded, WORKFLOW decided to enter a partnership with hub B because of its "broad and comprehensive product portfolio" (sales director of WORKFLOW). The company collaborates with employees of hub B in specific projects in order to benefit from their know-how. The sales director said that WORKFLOW had accumulated a large body of knowledge that is specific to hub B's solutions over the years. B's personnel have a very comprehensive understanding of B's platform and know where knowledge resides inside hub B. This platform knowledge is important to absorb for WORKFLOW in order to ensure platform compatibility of its own solutions.

MACHINE became a partner of hub A soon after being founded in 2005. The company complements the EAS provided by hub A by offering software tools that connect A's system to various kinds of machinery, for example vending machines or wind turbines; thus ensuring that data from the machines are automatically transferred to the ERP systems of customers (e.g., machinery owners). Since a large number of customers use hub A's ERP system, the primary reason for entering the partnership was to get immediate access to technical knowledge about hub A's system to ensure that the system interfaces built by MACHINE work properly. As one of the direct benefits from the partnership, MACHINE became one of the first companies to offer a complementary product based on the hub's recently developed SOA. This resulted in a head start for MACHINE compared to competitors. Interestingly, the CEO stated that the knowledge transfer between hub A and MACHINE is not a standardized procedure, but instead results from the personal contacts between MACHINE's and hub A's personnel—in particular to hub A's research area: "we have very good personal contacts to the research division. If we have a technological problem, we ask [hub A]'s people if they can help us. It's as if you ask a colleague within [MACHINE]" (CEO of MACHINE).

Hub's Capability to Innovate System Architectures (Proposition 1b): While the theoretical discussion suggests that spokes partner with a hub in order to benefit from its innovativeness, the empirical analysis showed that great variations exist regarding the spokes' appreciation of the hub's capability to innovate systems. Some companies were partnering with the hub because of its capability to provide system innovations. For example, the sales director of WORKFLOW stressed that his company depends on platform innovations for being able to constantly develop innovative complementary solutions, i.e., new product features that complement the hub's system. In a nutshell, WORKFLOW's sales director said that "[hub B] is innovative and this is something that we need."

However, in other cases system innovations by the hub were not generally seen as beneficial. In fact, contrary to our proposition (P1b) the hub's innovativeness was even seen as a threat for some spokes because it potentially renders the spokes' business model obsolete. One of these companies is ARCHIVE, a partner of hub A, which has been offering complementary archiving functionality based on hub A's EAS for almost 20 years. ARCHIVE entered the partnership and started to develop complementary solutions when the first version of hub A's EAS was on the market. The archiving functionality of this early version was very restricted (only four gigabytes of data could be filed), allowing ARCHIVE to successfully market its additional piece of software. Through the years, hub A released several new versions of its EAS with improved archiving functionality that partly rendered ARCHIVE's solution obsolete. Each of these innovations by hub A in turn triggered a process of coming up with own innovations within ARCHIVE. For instance, when hub A enlarged the amount of data that could be filed, ARCHIVE focused on offering solutions to improve archiving performance. Although performance is still a key selling point, recent releases of hub A's platform decreased the customers' need for additional performance-improving solutions, encouraging ARCHIVE to find a new niche. ARCHIVE then came up with tools that help customers comply with statutory requirements related to archiving that are specific to certain industries or regions. The historical development explains why ARCHIVE perceived hub A's innovativeness as a double-edged sword. On the one hand, ARCHIVE's partnership manager stated that "[hub A]'s innovativeness opens opportunities for [ARCHIVE] to develop new software based on these improvements." On the other hand, the interviewee admitted, "[ARCHIVE] has to be careful. If [hub A] develops new solutions in the field of archiving, this could overlap with our solutions and render them obsolete." Notably, the partnership manager explained that owing to the long-lasting collaboration between hub A's and ARCHIVE's employees and the personal relationships, it is often hub A's staff that "warn" ARCHIVE in advance if new developments overlap with ARCHIVE's functionality and even give hints about potential new niches for ARCHIVE. Thus, by being forewarned that own solutions may become obsolete, spokes may have more time to bring in their capability to innovate on a modular level and to come up with new solutions and functionalities that address new niches.

While ARCHIVE's take on hub A's innovativeness is ambivalent, it is clearly perceived to be a threat by MEDIA, another spoke organization within A's partnership network. MEDIA decided to provide complementary functionality specific to the media and newspaper industry, even though hub A offers a version of its EAS that is tailored to the needs of the media industry. Although MEDIA has been successfully developing niche functionality for the media industry for more than 20 years, the hub's innovativeness poses a constant threat for the spoke organization because new releases of hub A's industry solution may overlap with the functionality provided by MEDIA. Specifically, MEDIA struggles when decisions on investment for developing new functionality have to be made. MEDIA's head of product development framed it in the following way: "There is always a high risk to invest in the development of new functionality because [hub A] may decide to include it into its solution." Although personal and informal contacts between MEDIA's employees and hub personnel have emerged through the years, these links are of no great help for the spoke when it comes to anticipating future releases of hub A's software, as MEDIA's head of marketing explained.

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Hub's Capability to Provide Access to Broad Markets (Proposition 1c): The empirical analysis showed that the hub's capability to access broad and international markets generally played an important role in why small EAS vendors participate in hub-and-spoke partnership networks. Yet, there were some variations across the analyzed cases regarding the extent to which the hub's commercial capital motivated the spokes to partner.

The crucial role of the hub's commercial capital as a partnership motive is well illustrated by the case of GROUP. This company was founded in 1980 as an engineering office, but has been developing software based on hub A's platform since 2003. GROUP offers a tool that connects hub A's enterprise system to a third-party vendor's groupware solution. GROUP's head of product development reported that after having started its software business, the company struggled to market its product. Specifically, because GROUP is a local and rather small company, its plan to sell the tool on a global scale initially failed. According to the head of product development, "one important aspect [of the partnership] is that together with [hub A] we try to find new customers on a global scale, such as in the U. S. and in Southeast Asia."

PIM, another partner of hub A, develops a product information management solution that allows customers to manage a large amount of product data and publish it in various ways, such as websites, product brochures, or catalogs. Although PIM's system could be used by customers in combination with any EAS solution, PIM decided to enter an exclusive partnership with hub A. The CEO of PIM described the motive for this step as follows: "Ideally, through a partnership with an established player, a company obtains a very good market access through using the channel of the large organization. That's a very important aspect." According to the CEO, a crucial part of these marketing benefits are personal recommendations by hub employees: "In the best case, [the hub]'s sales staff tells the customer: 'If you need a product management system, you should choose the one from [PIM]. That's a great solution, and it is certified'." In addition, the sales director of PIM explained that product information management is a relatively new topic and not yet established in the market. Therefore, PIM had trouble in convincing customers about the advantages of a product information management system. The sales director said that the "strategic goal of the partnership is to sensitize the market for the product information management topic with the help of [hub A]."

Interestingly, some spoke organizations had high expectations regarding the access to the hub's marketing capabilities that were not fulfilled. For example, the partnership manager of CRM, a small software firm that develops customer relationship management software based on hub B's groupware system, was rather disappointed after having entered the partnership with B. "Our expectations concerning marketing advantages might have been too high," the interviewee concluded.

Hub's Reputation (Proposition 1d): The theoretical discussion suggested that tapping into an incumbent firm's reputation may be a primary motive for small software firms to participate in hub-and-spoke partnership networks. The two examples of EMAIL and MACHINE illustrate what was found to be true for all analyzed companies: signaling trustworthiness and reliability through a partnership with a hub is a key motive for spoke organizations to participate in hub-and-spoke networks.

EMAIL provides document and email archiving, IT security, and groupware solutions based on hub B's platform. The company was founded in 2002, and entered a formal partnership with hub B three years later. Asked about the reasons for partnering with hub B, EMAIL's head of software development stated that customers know that hub B and its products have been around for many years and will be around in the future. Since EMAIL's products complement hub B's solutions, customers trust that buying EMAIL's software will not be a false investment. "We benefit from [hub B]'s reputation because our company is not very well known yet," said the head of software development. "With [hub B]'s logo we signal trustworthiness to our customers. Partnering with a large and well-known company is beneficial for us because of the high degree of familiarity." A look at EMAIL's website corroborated the importance of hub B's brand name for the spoke as described by the head of software development, because the partnership is mentioned prominently on the cover page as well as in various other contexts.

The CEO of MACHINE mentioned similar reputation effects of the partnership. As described above, on account of its specific product portfolio, MACHINE's customers are almost exclusively large, global organizations. When approaching potential customers, the CEO of MACHINE experienced several times that "large corporations would not talk to a small software vendor like [MACHINE]. In these situations, the partnership with [hub A] and its reputation and brand name were a door opener for us."

Overall Assessment: The data analysis revealed partial support for the Propositions 1a-1d. While the hub's capability to provide integrated systems and its reputation (P1a and 1d) were found to be important motives for all analyzed spoke organizations, the picture was different for its innovativeness and its commercial capital (P1b and 1c). In particular, there were strong differences between the spoke organizations regarding the benefits of the hub's capability to innovate systems. While some spokes were found to benefit from the hub's innovativeness, others feared the threat of their own solutions becoming obsolete. The case analysis also revealed variations in the extent to which the hub's commercial capital motivated spokes to participate in a partnership with a platform vendor. Although all spokes rated the hub's capability to access broad markets as beneficial, the degree to which commercial capital actually motivated complementors to participate in partnerships with the hub differed across the cases.

The evaluation of the extracted interview fragments supports these findings. Table II shows the number of quotes per case and the average number of quotes across all cases for each of the four partnership motives. Moreover, Table II gives the average strength and direction of the influence of the partnership motives for each case as well as across all cases (on a scale from -2 to $+2$) [61].

Overall, the hub's capability to provide integrated systems (*Technology*) was the most frequently mentioned motive for

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TABLE II
EVALUATION OF INTERVIEW FRAGMENTS (NUMBER OF QUOTES PER INTERVIEW/AVERAGE STRENGTH AND DIRECTION, FROM −2 TO 2)

Case company	Technology	Innovation	Market	Reputation
MACHINE	4 / 1.5	1 / 1	2 / 1	1 / 1
CAD	3 / 1.67	5 / -1.4	5 / 1.4	n/a
GROUP	2 / .5	1 / -2	6 / 1.17	2 / 2
MOBILE	3 / 2	2 / -2	1 / 1	1 / 2
MEDIA	6 / 1.5	2 / -2	5 / 1.4	1 / 1
ARCHIVE	2 / 1.5	6 / 0	3 / 1.67	n/a
PRINT	n/a	2 / 0	1 / 2	4 / 1.5
PIM	2 / 1	1 / 1	5 / 1.8	4 / 1.5
PROCURE	7 / 1.29	4 / .5	2 / 2	2 / 1.5
FINANCE	3 / .67	3 / 0	9 / 0	1 / 0
EMAIL	1 / 1	1 / 0	3 / 1	5 / 1.8
CRM	1 / 0	n/a	2 / 0	3 / 1.67
ERP	4 / .75	n/a	1 / 0	3 / 1
DECISION	1 / 0	n/a	n/a	1 / 1
PORTAL	7 / 1.43	n/a	3 / 1	1 / 2
CONTENT	3 / 1.67	n/a	n/a	2 / 1
WORKFLOW	8 / 1.25	2 / 1.5	3 / 1	2 / 1.5
Aggregation across all cases	**3.35 / 1.26**	**1.77 / -0.33**	**3 / 1.04**	**1.94 / 1.45**

participating in the partnership network (on average 3.35 times per case). Also, the influence of this capability as indicated by the interview fragments was considerably high (on average 1.26). Although explicitly mentioned less than 2 times per interview (on average 1.94), the hub's reputation (*Reputation*) was suggested to be an important motive (on average 1.45). The hub's capability to access broad markets (*Market*) was ranked second with respect to the average number of explicit quotes (3) and third regarding the average importance indicated by the respective fragments (1.04). The picture was different for the hub's capability to innovate systems (*Innovation*). While the hub's innovativeness was an important issue (on average 1.77 mentions per interview), its influence on the spoke organization's motivation to partner varied considerably and was close to zero on average (−0.33). In order to explain this interesting observation, the next section sheds more light on differences and commonalities between the analyzed spoke organizations regarding product-level complementarity.

B. Analysis of Output-Oriented Dimension

The Role of Product-Level Complementarity (Proposition 2): When examining the profiles of the analyzed spoke companies, as shown in Appendix I more closely, it becomes apparent that they vary substantially. While some spoke organizations provide middleware solutions, others focus on business applications. Accordingly, the level of product complementarity, as indicated by the distance between hub and spoke in the layered EAS stack model (Fig. 2), varies substantially across cases. The solutions of some spokes overlap to a greater extent with the core business of their partner than do others. Table III provides an overview of the analyzed companies' layer overlap with the respective

TABLE III
LAYER OVERLAP OF HUB'S AND SPOKE'S SOLUTIONS IN THE ENTERPRISE SOFTWARE STACK

Layer overlap	Low	Medium	High
Case companies	PROCURE FINANCE CRM ERP DECISION CONTENT WORKFLOW	MACHINE CAD GROUP ARCHIVE PRINT EMAIL PORTAL	MOBILE MEDIA PIM

hub organization. For example, MEDIA offers business applications for the media industry that are closely integrated with the business applications of hub A. Thus, layer overlap in the EAS stack between MEDIA and hub A can be assumed to be high. As another example, ARCHIVE provides archiving solutions that complement hub A's EAS. Specifically, it connects hub A's platform to database systems and, therefore, acts on the middleware layer. Given that hub A mainly focuses on the application layer, but also offers middleware solutions, a medium layer overlap between hub A and ARCHIVE can be assumed. WORKFLOW provides applications based on hub B's middleware platform. Since hub B focuses on middleware solutions, layer overlap between WORKFLOW and hub B is rather low.

In line with Proposition 2, the question is raised whether there is a systematic link between the observed variations in layer overlap and the variations in the way in which certain resources and capabilities, such as innovativeness (*Innovation*) and commercial capital (*Market*), determine partnership motivation. In order to explore a possible interaction effect, Table IV was created which relates the average frequency as well as the average importance of each of the four resources and

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TABLE IV
EVALUATION OF INTERVIEW FRAGMENTS, CLUSTERED ACCORDING TO THE DEGREE OF LAYER OVERLAP

	Average number of quotes per interview			Indicated influence of respective factors (-2 to 2)		
Degree of layer overlap	Low	Medium	High	Low	Medium	High
Technology	3.86	2.71	3.67	1.07	1.37	1.55
Innovation	1.29	2.29	1.67	.56	-0.5	-1.4
Market	2.43	3.29	3.67	.41	1.26	1.55
Reputation	2	1.86	2	1.21	1.69	1.5

capabilities to the degree of layer overlap between hub and spoke (low, medium, and high).

The figures indeed suggest a relationship between layer overlap and inconsistencies in findings about the appreciation of innovativeness and commercial capital. Examining the lines of *Technology*, *Innovation*, *Market,* and *Reputation* reveals that the average ratings were relatively constant across the degree of layer overlap for *Technology* and *Reputation*. Thus, these two resources and capabilities were relatively important motivations for partnering irrespective of the level of product complementarity. In contrast, the influence of innovativeness moves toward negative values with an increasing degree of layer overlap between hub and spoke, i.e., from 0.56 for low levels of layer overlap to -0.5 and -1.4 for medium and high layer overlap.

Similarly, moving along the *Market* line indicates that the influence of the hub's commercial capital increased with higher levels of layer overlap, i.e., lower levels of product complementarity. Both the average number of quotes per interview (2.43, 3.29, 3.67) as well as the indicated influence of the hub's marketing capabilities (.41, 1.26, 1.55) increase considerably with higher levels of layer overlap. The following section explores the relationship between product-level complementarity and the hub's innovativeness, as well as its commercial capital by reexamining the qualitative data.

Interaction Effect Between Product Complementarity and the Hub's Innovativeness (Proposition 2a): The empirical analysis of Proposition 1b showed that although the analyzed spokes acknowledged the hub's innovative capability, it did not generally strengthen the partnership motivation of all spokes. In fact, some spokes were rather threatened by these diachronic capabilities. A reexamination of the cases in light of the discovered differences in layer overlap suggests that this is particularly true for those spokes with a relatively low level of product complementarity, i.e., if layer overlap between the hub and spoke solutions in the software stack is high. In this case, the solutions of hub and spoke cover related functionality. Therefore, the hub's innovativeness may eventually render the spoke's solution obsolete. Thus, the empirical findings suggest that the hub's innovative capability is not a key driver of partnership formation per se, but rather in combination with the level of product-level complementarity between hub and spoke. This observation is exemplified by the cases PIM, MEDIA, and WORKFLOW. PIM has a high layer overlap with hub A (see Table III), since its product information management solution clearly overlaps with hub A's core business on the application layer. PIM used to develop application functionality in a niche market that was different from that of hub A. Thus, the application software of PIM went beyond hub A's enterprise software system. However, a company that was recently acquired by hub A came up with a very similar solution, raising questions about the sustainability of the partnership and causing a serious threat to PIM's business model. The CEO of PIM commented "without doubt, this makes it very difficult for us to build up a real strategic partnership."

Similarly, the hub's system-level innovativeness was seen as problematic in the case of MEDIA, which not only acts on the same layer as hub A but even competes with hub A in several fields (high layer overlap). As a consequence, there is a constant threat of obsolescence, because future releases of hub A's enterprise system may wipe out the competitive advantage that MEDIA currently maintains in certain fields.

In contrast, if layer overlap is low, the positive impact of the hub's innovativeness is strengthened. For example, WORKFLOW and hub B have a very low layer overlap because hub B offers middleware solutions and WORKFLOW focuses on providing application functionality. Therefore, architectural innovations by the hub were perceived as rather beneficial by WORKFLOW. Even though these innovations may result in additional effort for WORKFLOW because its e-business, groupware, and portal solutions may have to be adjusted to the idiosyncrasies of new releases of hub B's platform, such platform innovations give WORKFLOW the chance to innovate on a modular level and come up with new products that attract customers. Taken together, this leads us to the following revised proposition:

> *Proposition 2a: The lower the level of product complementarity (i.e., the higher the layer overlap in the EAS stack) between the solutions offered by hub and spoke, the weaker is the proposed positive effect of the hub's capability to innovate system architectures on the spoke's motivation to participate in a partnership with the hub.*

Interaction Effect Between Product Complementarity and the Hub's Commercial Capital (Proposition 2b): The empirical data also revealed that the level of product-level complementarity changed the intensity with which the hub's commercial capital was seen as beneficial by the analyzed spokes. For some spokes, access to broad markets was the main reason for partnering, while for others it played a secondary role. The reason for this may be seen in the fact that if a spoke operates on the same layer as the respective hub, then the spoke is able to particularly make use of the hub's marketing channels. This is

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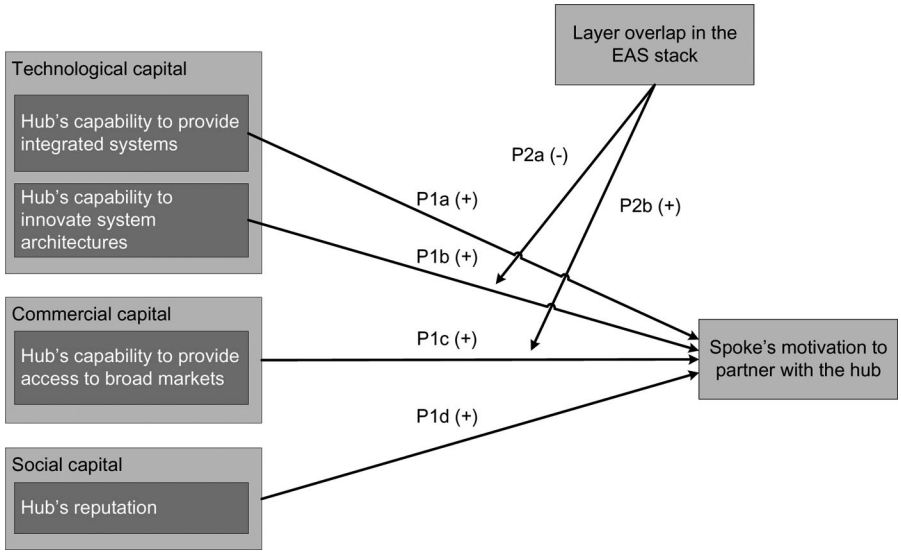

Fig. 3 Refined explanatory model of spokes' motivation to participate in hub-and-spoke networks in the EAS industry.

because both partners address very similar markets and target groups, such as similar procurement managers and users within potential customer organizations. In contrast, if the hub and spoke operate on different layers, it is more difficult to merge marketing campaigns. Thus, the impact of the hub's commercial capital on partnering motivation is not as high as in the case of high layer overlap.

CRM shows a low level of layer overlap with hub B's middleware platform. Accordingly, the benefits obtained from hub B's marketing activities were low, since they were directed to the middleware rather than to specific software applications such as the one offered by CRM. The picture was different for those spokes that show a higher degree of layer overlap with the respective hub, such as GROUP with hub A. The groupware solution of GROUP is closely integrated with the EAS system of hub A. In fact, as groupware functionality becomes more important for customers, hub A actively informs customers that this functionality is available through its partner GROUP. GROUP was even able to increase its sales to an international level via its partnership with hub A. According to the interviewee, this would not have been possible otherwise. Similarly, PIM was able to gain broad market access by tapping into the hub's distribution and sales network. Accordingly, the following revised proposition is put forth:

> *Proposition 2b: The lower the level of product complementarity (i.e., the higher the layer overlap in the EAS stack) between the solutions offered by hub and spoke, the stronger is the proposed positive effect of the hub's commercial capital on the spoke's motivation to participate in a partnership with the hub.*

Summary of Findings: Taken together, the results revealed that the impact of both the hub's innovativeness and its commercial capital are moderated by layer overlap. If layer overlap exists, then the impact of the hub's innovativeness moves from a positive to a negative effect (negative moderation effect), while the impact of the hub's commercial capital becomes stronger (positive moderation effect). The refined theoretical framework, including the newly formulated Propositions 2a and 2b, is illustrated in Fig. 3.

VI. Discussion and Conclusion

By studying the motivation of EAS companies to participate in partnerships with larger platform vendors, this study complements the existing body of knowledge on the emergence of hub-and-spoke networks [13], [23], [24]. While previous literature has largely focused on hub organizations, this study takes the perspective of spokes. Therefore, this study builds on previous work that examined specific partnership motives of firms in the EAS industry from an input-oriented perspective [18], [40], [41]. While previous research has focused on particular resources and capabilities as motives for partnering, this study considers multiple dimensions simultaneously. Based on the broader literature on inter-firm partnerships, four types of resources and capabilities of the hub are identified that motivate spokes to partner with the hub: (1) the hub's ability to provide integrated systems, (2) the hub's ability to innovate systems, (3) the hub's commercial capital, and (4) the hub's reputation.

In addition, this research builds on more recent work that has taken an output-oriented perspective in explaining the success of inter-firm alliances and partnerships [4], [43]–[45]. Based on this perspective, it has been proposed that the level of product complementarity between hub and spoke contributes to explaining why spokes are motivated to partner with the hub [42]. The empirical findings revealed a new and interesting interaction effect between the input- and output-oriented perspectives. The results indicate that out of the four hub resources and capabilities, only two are generally important motives for spokes to partner with the hub. These are the hub's capability to provide an integrated system and the hub's reputation in the market. The impacts of the two other factors, i.e., the hub's innovativeness

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and the hub's commercial capital, are contingent upon the level of complementarity that exists between the products offered by the partners.

By identifying an interaction effect between layer overlap in the software stack and the platform vendor's innovativeness and commercial capital, our results contribute to explaining the so far inconclusive findings on the role of product-level complementarity in partnership arrangements [18], [41], [43], [44]. In particular, our findings suggest that instead of having a direct positive or negative effect on the complementor's motivation to partner with the hub, product-level complementarity should be considered as a moderating factor regarding the benefits obtained from different types of external resources and capabilities. In other words, our results contribute to existing literature in that by combining the resource-based perspective on inter-firm arrangements and the notion of product-level complementarity, the explanatory power is higher than if both perspectives are applied in isolation.

This insight has wider implications for the determinants of partnership success [44], [54]. If product complementarity is low, i.e., if layer overlap between the hub and spoke solution is high, two opposing implications on partnership success may result. On the one hand, the benefits from the hub's commercial capital may be particularly high for the spoke. On the other hand, the threat of system-level innovations by the hub may be particularly high. Thus, in analyzing the success of hub-and-spoke networks, it appears useful to consider possible tradeoffs between particular hub resources and capabilities resulting from different levels of product complementarity.

The theoretical insights of this study lead to a number of managerial implications. Spoke organizations may benefit from the finding that not all of the hub's resources and capabilities are generally advantageous for them. In particular, if hub and spoke operate at the same layer in the software stack, the spoke has to be aware of the risks arising from the hub's innovative capability to introduce new system architectures or business applications that may render the spoke's solutions obsolete. In this case, the spoke is well advised to keep itself constantly up to date regarding the hub's planned innovations. Close interpersonal linkages to the hub's personnel seem to be particularly important for this purpose. Another counterstrategy lies in the spoke's own innovativeness. If the spoke is able to constantly innovate, the risk of becoming obsolete is generally smaller, especially if the spoke's innovations are aligned with those of the hub. In contrast, if a spoke's solution has the characteristics of a commodity with little innovative potential it may be more fruitful to complement the system of a hub that mainly acts on adjacent layers. As a consequence, benefits from the hub's commercial capital are smaller. At the same time, however, the risk of obsolescence decreases.

Large and well-established EAS vendors may also learn from the findings of this study. Platform vendors aim at fostering partnership networks with smaller niche players in order to benefit from network externalities and lower the costs and complexity of the overall systems. Knowing which capabilities the spokes aim at when participating in hub-and-spoke networks may help hub organizations attract and select partners and manage the partnerships in a better way. Also, in order to foster sustainable inter-firm networks, hub organizations should reflect carefully whether it might be advantageous to explicitly focus on one layer of the EAS stack and leave adjacent layers to the partners.

The findings of this study are specific to the EAS industry but can partially be transferred to other industries and provide guidance for organizations in hub-and-spoke networks outside the EAS sector. Spoke organizations in the EAS industry usually do not exchange goods with the respective hub but sell their solutions directly to the market, reinforcing the importance of the access to the larger partner's commercial capital and its reputation. While the hub's commercial and social capital may, therefore, be of minor relevance for spoke companies that engage in exchange relationships with platform vendors (as in the case of the automotive sector), complementors in these industries may still benefit from the findings of this study. In particular, the interaction effect between product-level complementarity and the hub's innovative capability may be important for these spoke companies. In addition, in industries that develop products or services that are less complex than enterprise software, the access to system integration know-how of the hub may be of lower importance because a higher degree of modularity is more feasible. Moreover, tapping into the hub's reputation may be less important because customers can assess the quality of less complex products in advance, reducing the necessity of signaling reliability through a partnership. On the other hand, a partner's commercial capital and its innovative capabilities may still be of primary interest for spokes, reinforcing the importance of the discussed interaction effects.

It should be kept in mind that the results of this research are based on a limited set of data. The dataset consists of the partnership networks of two hubs. Although only a limited number of large hub organizations exist within the global EAS industry, peculiarities of other hub organizations may not be reflected by the dataset. Moreover, even though rigor was ensured through having two authors code the data independently, the qualitative examination, the assessment of the importance and direction of motivational factors, as well as the evaluation of layer overlap may still be biased due to subjective ratings. In addition, despite the fact that increasing the number of cases and relying on a lower number of knowledgeable experts per case is consistent with the study's goals, this approach may entail the risk of a key informant bias [66].

A viable next step would be to corroborate the findings of this study by testing the developed explanatory model through a large-scale quantitative study. Another fruitful avenue for future studies would be to move away from the rather generic stack model and analyze the product complementarity between the solutions offered by hubs and spokes in more detail, both in the EAS industry and in other industries. Specifically, it may be interesting to find out whether effects similar to the ones identified between layers (i.e., layer overlap) also exist within the layers of the stack. In other words, a fine-grained inspection of the differences and commonalities between groups of spoke organizations and their implications promises to be particularly insightful.

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APPENDIX I

CASE COMPANIES AND INTERVIEWS

Case	HUB	Core business	Inter-views	Interview partner(s)
MACHINE	A	Integration between the hub's system and various machines such as vending machines	2	Founder and CEO
CAD	A	Integration between the hub's system and a CAD system of a different vendor	1	Partnership manager
GROUP	A	Integration between the hub's system and a groupware system of a different vendor	1	Head of product development
MOBILE	A	Systems for automatic, mobile data recording used for inventory management	1	Head of sales, marketing, and partnership management
MEDIA	A	Full-range supplier of IT systems and services for newspaper publishing companies	3	Head of product development Head of industry solution Head of marketing
ARCHIVE	A	Integration between the hub's system and various archiving systems	2	Partnership manager
PRINT	A	Integration between the hub's system and various enterprise output systems	1	Head of software development
PIM	A	Product information management systems for cross-media publishing	2	Founder and CEO Sales director
PROCURE	B	Groupware and e-procurement solutions	1	Head of IT
FINANCE	B	Groupware and workflow applications for the financial services industry	1	Founder and CEO
EMAIL	B	Document and email archiving, IT security, and groupware solutions	1	Head of software development
CRM	B	CRM, project and knowledge management systems	1	Partnership manager
ERP	B	ERP software based on hub B's middleware	1	Director of software development
DECISION	B	Decision support systems for credit approval processes in the financial services industry	1	Founder and CEO
PORTAL	B	Solutions for archiving, groupware, CRM, and portals	1	Co-founder and director
CONTENT	B	Applications for content management, enterprise portals, groupware, and ERP systems	1	Owner and director
WORKFLOW	B	E-business, groupware, and portal solutions	1	Sales director

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APPENDIX II

INTERVIEW GUIDELINE (TRANSLATED FROM GERMAN)

A. Information Regarding Company and Interview Partner

1) Organization's main business area, historical development
2) Interviewee's position within organization, role regarding partnership

B. Partnership Formation

1) When was the partnership formed? What were the strategic goals associated with the decision to enter the partnership?
2) Which formal criteria had to be met and which steps had to be taken in order to become a partner?

C. Partnership Dynamics

1) Which strategic challenges or risks emerge throughout the partnership? Which are the reasons for these challenges and risks?
2) Has the nature of the partnership changed over time?

D. Operational Aspects of the Partnership

1) What is the procedure of cooperating with the partner in a specific project?
2) How are operational challenges managed?

E. Partnership Success

1) What impact does the partnership have on the success of your business?
2) From your point of view, why is the partnership successful or not successful, respectively?
3) In your opinion, how should/will the partnership develop over time, and which steps have to be taken?

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