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Exploring the Motivational and Behavioral Foundations of External Technology Experts' Knowledge Sharing in Collaborative R&D Projects: The Contingency Role of Project Formalization

Jeroen Schepers, Jelle de Vries, Arjan van Weele, and Fred Langerak

High-tech manufacturers increasingly rely on the knowledge contributions of external technology experts (ETEs), who contribute to collaborative R&D projects on behalf of suppliers. Many scholars have considered knowledge sharing in R&D collaborations from a firm-level or project-level perspective and focused on formalization as a potential remedy. While individual supplier employees at the operative level make the decision to share critical knowledge, the individual-level perspective in literature on knowledge sharing in collaborative R&D projects is virtually nonexistent. Because knowledge sharing in collaborative R&D is a largely discretionary act on behalf of the supplier employee, personal motivations rather than inter-firm relationship elements (e.g., network position or dependency) become the primary determinant of one's sharing behavior. Abstracting from or ignoring these motivations of supplier employees in studies on collaborative R&D may obscure important insights for R&D managers. This study is an important first step in providing the empirical evidence needed to uncover the motivational and behavioral foundations for ETEs' knowledge sharing in a collaborative R&D setting. Building on theories of gift and social exchange, this article identifies customer stewardship and distributive fairness as two important personal motivations of ETEs to share knowledge. Project formalization is considered as a key contingency condition. Analyzing survey responses of 186 ETEs, a multilevel regression-based moderated-mediation analysis of direct and indirect effects shows that customer stewardship predicts an ETE's knowledge sharing behavior under (very) low levels of project formalization, and distributive fairness predicts knowledge sharing behavior under medium to high levels of formalization. Together, the results provide R&D project managers who aim to leverage external knowledge contributions with valuable insights that have been obscured in past firm-level collaborative R&D studies.

Practitioner Points

- Managers need to match external team members' (1) perceived responsibility for the partnership and (2) perceptions of fair outcome distributions with the level of project formalization employed in the collaborative R&D team to facilitate knowledge sharing of these external members. More specifically:
- When managers use rules or standard procedures to govern the interaction between individuals within the collaborative R&D team, the degree to which external members share knowledge is determined by their perceptions of the fairness of the collaboration for both parties.
- When managers (very) strongly rely on norms, trust, and mutual understanding to govern the interaction between individuals within the collaborative R&D team, the degree to which external members share knowledge is determined by feelings of responsibility for the partnership.

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Introduction

High-tech manufacturers increasingly orchestrate collaborative research and development (R&D) projects in which they work intensively with employees of one or more suppliers to develop a new product or service offering. Such projects help manufacturers to stay ahead of competition because they get quick access to unique expertise (Yeniyurt, Henke, and Yalcinkaya, 2014). Suppliers' employees are often cautious to share their knowledge though; the tension between knowledge sharing and protection is a classic theme in collaborative R&D, open innovation, and alliances literature (Bogers, 2011; Estrada, Faems, and De Faria, 2016). Building on transaction cost economics and agency theory, many scholars have proposed formalization, i.e., codifying desired outputs and behaviors in contracts, as a means to better coordinate knowledge sharing between innovation partners (Hofman, Faems, and Schleimer, 2017). However, empirical findings show mixed results with formalization both suppressing and promoting knowledge sharing (Walter, Walter, and Müller, 2015). In response, some scholars shifted attention to the *contingency* role of formalization in the collaboration (Gesing, Antons, Piening, Rese, and Salge, 2015; Wagner and Bode, 2014). Striving toward more detailed explanations, other scholars opened up the "black box" of collaborative R&D processes (Faems, Janssens, Madhok, and Van Looy, 2008). Their focus shifted from the firm level to the project level of analysis and from inter-organizational mechanisms (e.g., contracts) to intra-organizational mechanisms (e.g., socialization and incentives; Estrada et al., 2016; Lawson, Petersen, Cousins, and Handfield, 2009).

Despite the move to more fine-grained project level of analysis, the individual level of analysis in collaborative R&D projects with suppliers remains underexposed. This is remarkable because, ultimately, individual employees at the operative level make the decision of sharing critical knowledge of one partner with the other (Walter et al., 2015). Knowledge sharing in collaborative R&D is a largely discretionary act on behalf of the supplier employee (Brown and Duguid, 2001; Huysman and de Wit, 2004) and in these situations, personal motivations rather than inter-firm relationship elements (e.g., network position or dependency) become the primary determinant of one's sharing behavior (Dolfsma and Van der Eijk, 2017). Such personal motivations are described by theories of social and gift exchange, which highlight individuals' felt *obligation* and *reciprocation* (Blau, 1964; Mauss, 2000; Sherry, 1983). In other words, individuals are motivated to share their knowledge when they feel responsible for upholding the relationship and when something is expected in return (Chen and Choi, 2005). Abstracting from or ignoring these motivations of supplier employees in studies on collaborative R&D may obscure important insights for R&D managers.

So far it has remained unexplored how personal motivations of supplier employees drive their individual knowledge sharing behavior in collaborative R&D projects. It is also unknown whether personal motivations to share knowledge are affected by

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different levels of formalization that managers employ in their project team. Formalization has been studied in R&D collaborations within a company, with a focus on how the R&D department exchanges information with other departments (e.g., Moenaert, Souder, De Meyer, and Deschoolmeester, 1994; Song and Thieme, 2006). Formalization has also been considered in collaborative R&D projects with suppliers, with a focus on project-level dynamics (e.g., Walter et al., 2015) and project outcomes (e.g., Hofman et al., 2017). However, how formalization affects individual knowledge sharing considerations of supplier employees in collaborative R&D projects has, to the best of the authors' knowledge, not been considered before. Specifically, we do not know which type of personal motivation is most effective to trigger knowledge sharing behavior under which level of project formalization. This study addresses this research gap and in doing so makes several contributions.

First, we add an individual-level perspective to the literature on knowledge sharing in collaborative R&D projects. Studies in this field have concluded that integrating supplier knowledge in such projects may improve project performance indicated by speed-to-market (Zhang, Wang, and Gao, 2017), technical performance (Thomas, 2013), manufacturing costs (Jayaram and Pathak, 2012), and design quality (Jayaram, 2008). Other studies have outlined mechanisms that facilitate or obstruct knowledge sharing such as co-location (Axelson and Richtnér, 2014); knowledge protection mechanisms, such as contracts (Hurmelinna-Laukkanen, 2011); and extent of integration between the two parties (Rosell, Lakemond, and Melander, 2017). However, what motivates individual employees to share knowledge is yet to be explored. We address this gap and focus on supplier-provided experts to a manufacturer working in a collaborative R&D project which is orchestrated by that manufacturer. We refer to these employees as external technology experts (ETEs).

Second, we answer a recent call of Dolfsma and Van der Eijk (2017) to empirically investigate the individual-level motivational and behavioral foundations for knowledge sharing in collaborative R&D. Although their conceptual paper highlights personal motivations of felt *obligation* and *reciprocation* to explain individual knowledge sharing, Dolfsma and Van der Eijk (2017) do not operationalize these motivations. Building on literature on boundary-spanning employees' discretionary efforts (e.g., De Ruyter, de Jong, and Wetzels, 2009; Maxham, Netemeyer, and Lichtenstein, 2008), this article proposes that customer stewardship and distributive fairness represent ETE's personal motivations of felt obligation and reciprocation, respectively. Customer stewardship is defined as an ETE's felt ownership of and moral responsibility for the overall welfare of the manufacturer and other parties (e.g., other suppliers) that are involved in the collaborative R&D project (cf. Schepers, Falk, de Ruyter, de Jong, and Hammerschmidt, 2012; see Table 1 for an overview

Table 1. Definitions

Construct	Definition
Collaborative research and development (R&D) project	A project, aimed to develop a new product or service offering, in which a manufacturer works with employees provided by one or more suppliers.
External technology expert (ETE)	A supplier-provided expert to a manufacturer working in a collaborative R&D project which is orchestrated by that manufacturer.
Customer stewardship	An ETE's felt ownership of and moral responsibility for the overall welfare of the manufacturer and other parties (e.g., other suppliers) that are involved in the collaborative R&D project (cf. Schepers et al., 2012).
Distributive fairness	An ETE's subjective evaluation of the "rightness of the distribution of outcomes to different actors" in the collaborative R&D project "anticipated on the basis of the terms and conditions" of the collaboration (Franke, Keinz, and Klausberger, 2012, p. 1497).
Project formalization	The degree to which rules, contractual agreements, or standard procedures are used to govern the interaction between individuals within the collaborative R&D team (Ruekert and Walker, 1987).
Knowledge sharing intention	An ETE's willingness to engage in knowledge sharing behavior in the (near) future.
Knowledge sharing behavior	An ETE's disclosure of supplier-specific information, past experiences, and expert insights, to have it acquired and processed by the collaborative R&D team to create new knowledge, improvements, and innovations (cf. Golden and Raghuram, 2010).
Risk taking propensity	An ETE's inclination to take bold action by venturing into the unknown and/or commit significant resources to activities in uncertain environments (cf. Bolton and Lane, 2012).
Extraversion	An ETE's tendency to be energetic, assertive, sociable, expressive, and seek stimulation in the company of others (cf. John and Srivastava, 1999).

of definitions). Distributive fairness represents the "rightness of the distribution of outcomes to different actors" in the collaborative R&D project "anticipated on the basis of the terms and conditions" of the collaboration (Franke et al., 2012, p. 1497). This "individual subjective evaluation that a given distribution is 'fair' (or not) can be understood on the basis of […] outcome-to-input ratios" where the outcome factors that can be distributed between suppliers and the manufacturer can be monetary, but also social, or intellectual in nature (Franke et al., 2012, pp. 1497–98).

Finally, the way interactions between individuals are governed in collaborative R&D projects has received surprisingly little attention as most scholars have focused on how inter-organizational governance mechanisms affect these projects' outcomes (Yan and Nair, 2016). This article highlights the contingency role of the intra-organizational mechanism of *project formalization*, i.e., the degree to which rules, contractual agreements, or standard procedures are used to govern the interaction between individuals within the collaborative R&D team (Ruekert and Walker, 1987). Project formalization can integrate work activities and orient interactions toward achieving project goals (Moenaert et al., 1994), but may also constrain information exchange and learning (Badir, Buchel, and Tucci, 2005). This article thus investigates whether project formalization facilitates or hinders ETEs' personal knowledge sharing motivations in collaborative R&D.

Analyzing survey responses of 186 ETEs, a multilevel regression-based moderated-mediation analysis of direct and indirect effects shows that customer stewardship predicts an ETE's knowledge sharing behavior only under (very) low levels of project formalization. Distributive fairness predicts knowledge sharing behavior under medium to high levels of formalization. In the following the theoretical foundation of the conceptual model is outlined and hypotheses are developed. After discussing the analytical strategy and results, important implications for R&D managers are provided.

Theoretical Background and Conceptual Development

Knowledge Sharing in Collaborative R&D

In high-tech collaborative R&D projects, technology advancement is rapid and not all knowledge needed or generated can be foreseen upfront (Badir et al., 2005). This is why research concludes that individual employees involved in innovation activities are necessarily acting discretionary (Aalbers, Dolfsma, and Koppius, 2014). In these situations "individual members' *willingness* to contribute tacit information and to work toward integrating that knowledge toward collective goals" (Li, Bingham, and Umphress, 2007, p. 202, emphasis added) is a strong driver of discretionary knowledge sharing behavior.

In investigating the motivational and behavioral foundations for knowledge sharing in collaborative R&D, it is thus important to distinguish between ETEs' knowledge sharing intention and behavior (cf. Witherspoon, Bergner, Cockrell, and Stone, 2013). Knowledge sharing behavior is an ETE's disclosure of supplier-specific information, past experiences, and expert insights, to have it acquired and processed by the collaborative R&D team to create new knowledge, improvements, and innovations (cf. Golden and Raghuram, 2010). Where knowledge sharing behavior is the *actual disclosure* of information, knowledge sharing intention reflects the *willingness to engage* in knowledge sharing behavior in the (near) future.

ETEs' Personal Motivations: Customer Stewardship

Knowledge sharing does not only transfer utility from a supplier to the participants in a collaborative R&D project, but also represents socially meaningful interaction embedded in relations of mutual dependence. Therefore, theories of social and gift exchange can be used to identify factors that "contribute […] to the willingness to transfer knowledge" (Dolfsma and van der Eijk, 2017, p. 297). While sometimes erroneously associated with giving and receiving explicit gifts on occasions, such as birthdays, gift exchange theory instead describes individuals' considerations to give and take within firms (Ensign, 2009), between firms (Uzzi, 1997) or even in markets of product exchange (Smart, 1993). Essential in the theory is the concept of the felt obligation to give, receive, and reciprocate (Mauss, 2000; Schwartz, 1996). Gifts can be monetary, but the theory specifically applies to nonmonetary exchanges such as effort invested or knowledge shared.

In the context of boundary-spanning employees, such as ETEs, the notion that "gift exchange […] is driven by obligations of social and informal nature"

(Dolfsma and van der Eijk, 2017, p. 297) is embodied by the concept of customer stewardship. This reflects an ETE's felt ownership of and moral responsibility for the overall welfare of the manufacturer and other parties that are involved in the collaborative R&D project, and has been uncovered as a potent driver of boundary-spanning employees' behavior and performance (De Ruyter et al., 2009; Schepers et al., 2012). Central to the stewardship concept is that advancing the cause of an organization and its shareholders aligns with an individual's personal interests, such that the value received from organizational prosperity will be reciprocated by additional personal investments (cf. Davis, Schoorman, and Donaldson, 1997). Although not previously considered in a collaborative R&D context, customer stewardship may be explanatory for ETEs' knowledge sharing behavior, because it deals with the issue of balancing interests and obligations of shareholders inside and outside the organization (Hernandez, 2008). This balancing act is needed because suppliers may impose disclosure restrictions, while the collaborative R&D project can only become a success when ETEs share their knowledge.

ETEs' Personal Motivations: Distributive Fairness

The balance between giving and receiving, and the motivation to reciprocate are also central to social exchange theory (Blau, 1964), which argues that individuals mentally weigh the costs and rewards from their involvement in a relationship and adjust their motivation and investments accordingly. Especially in collaborative R&D projects where ethical issues surrounding knowledge sharing are paramount, social exchange theory explains the behavior of actors involved in the collaboration (Chen and Choi, 2005). Here, the perceived fairness of the distribution of outcomes among collaboration partners determines whether firms are willing to continue and expand the relationship with partners (Griffith, Harvey, and Lusch, 2006; Wagner, Coley, and Lindemann, 2011), and to make investments in joint new product development projects (Wowak, Craighead, Ketchen, Tomas, and Hult, 2016).

Interestingly, at the individual level distributive fairness is also an important theme in research on boundary-spanning employees' discretionary behaviors. For instance, Maxham et al. (2008) identify justice perceptions (e.g., fair rewards) as the strongest driver of extra-role performance of retail employees, while Kang, Stewart, Kim, and Lim (2012) concludes that such perceptions energized nurses to contribute to the goals of their organization. Although most studies have focused on ex-post fairness judgments based on concrete experience, human behavior is also driven by ex-ante fairness expectations (Franke et al., 2012). In addition, individuals' fairness perceptions of decisions at higher organizational levels influence behavior at lower, operative levels (Li et al., 2007). This article follows Franke et al.'s (2012) argument that an individual (i.e., an ETE) will align any cognitive and behavioral responses with the subjective, and individually anticipated outcome-to-input ratio between participants in the project and the organizing firm. In other words, distributive fairness is a potentially important driver of ETEs' knowledge sharing behavior in the collaborative R&D project.

R&D Project Formalization

Extant research on collaborative R&D outlines two forms of governance to reduce the risk of opportunism and coordinate knowledge sharing between innovation partners. First, *structural* governance refers to the design phase where the basis of the governance structure is defined (Steinicke, Wallenburg, and Schmoltzi, 2012). The effects of structural governance elements, such as contractual incentives and specification level (De Vries, Schepers, van Weele, and van der Valk, 2014), the number of contractual clauses (Reuer and Ariño, 2007), contractual functions such as coordinating or safeguarding (Hofman et al., 2017), and ownership models such as equity- and non-equity-based relationships (Murray and Kotabe, 2005) have been extensively evaluated in past works.

This article focuses on a second form of governance because it more likely influences the effectiveness of personal motivations for knowledge sharing. Specifically, *operational* governance refers to the post-formation cooperation management phase. Such governance can be formal or informal. Formal governance is characterized by systematic rules and procedures stemming from contracts, handbooks, or organizational culture, while informal governance is characterized by norms, trust, and social identification (Steinicke et al., 2012). For instance, Song and Thieme (2006) argue that when integrating actors with different functions and backgrounds in the R&D process, systematic rules and procedures in decision-making may reduce role ambiguity and other problems that typically arise due to jargon and specialization. However, formalization may also thwart individuals' motivation to fulfill social obligations and engage in reciprocation because disputes and ambiguities are resolved by pointing to rules and procedures rather than through discussion and involvement (Song and Parry, 1993).

Because formalization at the operational level may either enhance or limit the efficacy of ETEs' personal motivations, project formalization is considered to be an important contingency variable in this research. This aligns with seminal theoretical developments in organizational behavior, such as the job-modification framework (Oldham and Hackman, 1981) and the demands–constraints–choices model (Stewart, 1982). These models argue that contextual characteristics, like project formalization, may influence behavioral decision processes by either facilitating or restricting the opportunities to demonstrate specific behaviors (Walter and Bruch, 2010). In other words, the relevance of customer stewardship or distributive fairness perceptions in stimulating knowledge sharing behavior is likely to depend on the formalization characteristics of the project context in which the ETE operates. Figure 1 summarizes the above discussion and outlines the conceptual model. The underlying hypotheses are developed below.

Hypotheses

ETEs in collaborative R&D projects find themselves in a spot in which they have to constantly balance the interests of their company and the interests of the manufacturer and the project's shareholders. Employees who have to practice balancing acts such as sharing or withholding knowledge, are likely to feel vulnerable and "push decision-making toward paralysis" (Hernandez, 2008, p. 122). Stewardship proponents outline three underlying mechanisms that can be used in this new context to explain why ETEs with a sense of customer stewardship are less apprehensive in their knowledge sharing decisions.

First, stewards (i.e., those individuals with high levels of stewardship) experience a strong need to reach higher levels of achievement (Davis, Schoorman, and Donaldson, 1997). This self-actualization motivates such employees to move a project forward because doing so aligns with their own interests—they improve the situation of an object they psychologically own (Block, 1996). Apart from the pride taken in advancement, in a setting of ETEs, moving the project

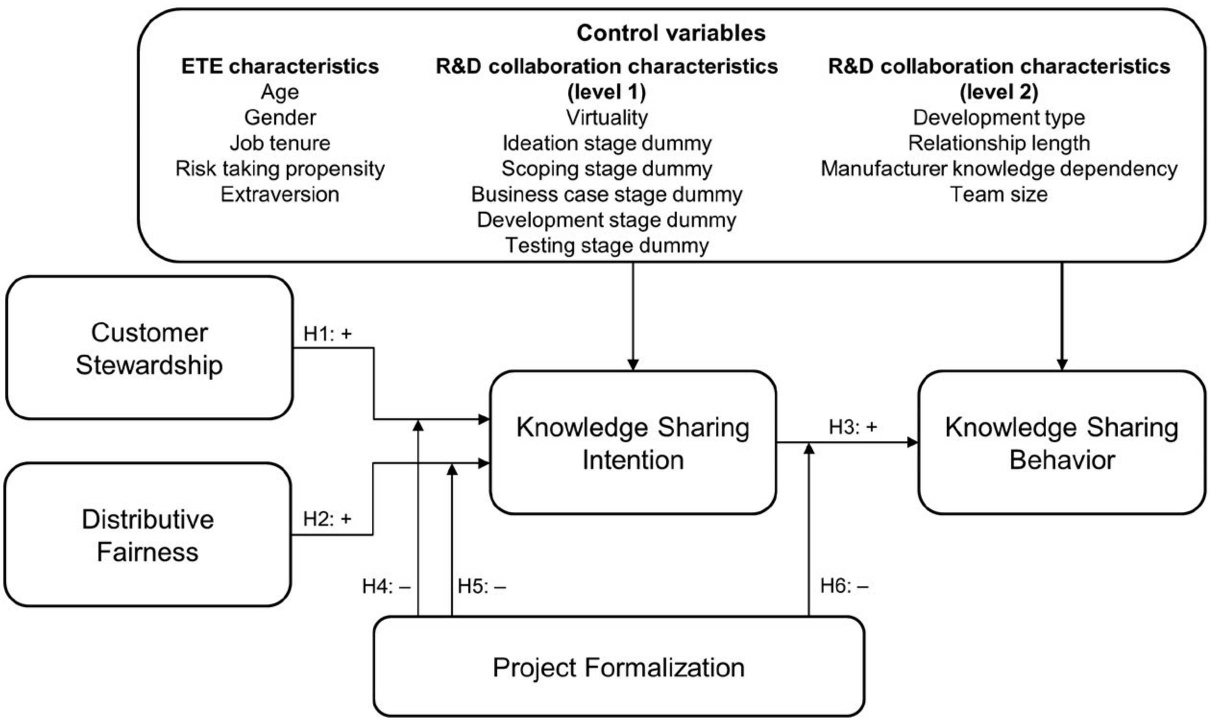

Figure 1. Conceptual Model

ahead also lets these individuals enjoy appreciation from the manufacturer, and other parties involved, and may even open up new job opportunities or collaboration proposals.

Second, stewards follow the logic of appropriateness (March, 1994). This logic holds that behavioral decisions in social environments result from an interpretation of the appropriate behavior in a given situation. The expected appropriate behavior develops into norms that in turn become a primary intrinsic motivational force (De Ruyter et al., 2009). The social environment in R&D collaborations is multifaceted with many parties included. ETEs with a sense of customer stewardship operating in such a context may thus look to enhance the well-being of the manufacturer, and other parties involved in the project (cf. Davis et al., 1997), and not only to satisfy the interests of their own (supplier) company.

Third, stewards display moral courage by engaging in "risky action in service of upholding individual moral principles and standards" (Hernandez, 2008, p. 125). Thus, ETEs with a high degree of customer stewardship feel in control of the knowledge sharing decisions they make, the risks they take in making those decisions, and the consequences they are willing to accept as a result. This implies that ETEs who feel responsible for the manufacturer likely dare to challenge the "conventional modes" of working (cf. Dubin, 1982), such as the emphasis on economic outcomes that is typical in many supplier–manufacturer collaborations (Slowinski, Hummel, and Kumpf, 2006). In sum:

H_1: An ETE's customer stewardship positively associates with his/her knowledge sharing intention.

One of the key challenges in today's R&D collaborations is to make sure that each party gets a fair payoff at the end of a collaborative new product or service development cycle (Wowak et al., 2016). The reward is considered fair if there is a balance between the inputs each party contributes (e.g., resources, effort) and the outcomes each party receives (e.g., revenue, reputation, intellectual property, etc.; Franke et al., 2012). Griffith et al. (2006) show that fair outcome distributions in supply chain relationships lead to desirable relational behaviors, such as sharing of information. Scholars have argued that individuals' subjective evaluations, and even ex-ante anticipations, of intra-firm fairness influence these individuals' cognitive and behavioral responses in such situations (Franke et al., 2012; Li et al., 2007). This article follows these insights in the argumentation for the effect of distributive fairness on ETEs' knowledge sharing intention and behavior in R&D project teams.

Applying fairness theory in a collaborative R&D context, ETEs (and their supplier) expect something in return to balance the (mental) costs and risks of sharing knowledge that has taken time and effort to build up. ETE knowledge sharing in collaborative R&D projects may lead to a supplier's solutions or technological features being designed into manufacturers' products or services without misappropriation. The more likely the ETE perceives this outcome to materialize, the more fair the balance of knowledge inputs and project outcomes, and the more inclined ETEs are to engage in knowledge sharing (cf. Laurin, Fitzsimons, and Kay, 2011). In other words, distributive fairness reduces ETEs' worries and uncertainty about exploitation and waste of effort (cf. Chen, Zhang, Leung, and Zhou, 2010). In contrast, when ETEs believe the distribution of future returns is unfair, they likely experience an unpleasant emotional state that requires them to "cognitively reframe efforts" such as knowledge sharing intentions to restore the contribution-return ratio (Janssen, 2001, p. 1041). Hence:

H_2: An ETE's perceived distributive fairness positively associates with his/her knowledge sharing intention.

As explained earlier, in exploring the motivational and behavioral foundations of ETEs' knowledge sharing, it is important to distinguish between intention and actual behavior. It is well documented in cognitive psychology literature that intention to perform a specific behavior precedes the actual behavior (Ajzen and Fishbein, 1977; Sheeran, 2002). This finding has been replicated for a wide variety of behaviors, including helping behaviors (Vallerand, Pelletier, Deshaies, Cuerrier, and Mongeau, 1992), innovation adoption behaviors (Arts, Frambach, and Bijmolt, 2011), and organizational citizenship behaviors (Dalal, 2005). Also for individuals' decisions to share knowledge, Witherspoon et al. (2013) conclude that intention to share knowledge is the prime determinant of knowledge sharing behavior. In line with these works:

H_3: An ETE's knowledge sharing intention positively associates with his/her knowledge sharing behavior.

Next, it is argued how project formalization may moderate the relationships between knowledge sharing antecedents and intention. Previous literature in other domains provides both arguments for why project formalization enhances *or* limits the efficacy of ETEs' personal motivations in collaborative R&D projects. Badir et al. (2005), for example, argue that formalization benefits coordination but hampers communication between R&D parties. Because knowledge sharing falls in the communication domain, the moderating hypotheses are built on the logic of scholars' arguments for formalization's detrimental effects.

Project formalization includes rules, procedures, and even detailed work plans that focus on known courses of action. However, in typical R&D collaborations many unforeseen issues pop-up that need new and unbounded solutions (Song and Thieme, 2006). ETEs with a sense of customer stewardship may possess the knowledge to work toward such a solution, but with a higher degree of formalization they need to overcome strong and clearly articulated conventional modes of working. ETEs need to have more moral courage to be willing to push the project in a direction that may be beneficial to their customers but could violate rules and procedures. When formalization is strong, the positive relationship between the ETE's customer stewardship and knowledge sharing intention thus is expected to be attenuated. In contrast, when formalization is low, employees are allowed more autonomy in their work environment. Stewardship theorists argue that "a steward's autonomy should be deliberately extended to maximize the benefits of a steward" (Block, 1996, p. 25). In a collaborative R&D context this means that lower formalization would not attenuate the positive relationship between an ETE's customer stewardship and knowledge sharing intention. Therefore:

H_4: Project formalization moderates the positive relationship between customer stewardship and knowledge sharing intention such that this relationship becomes weaker when an ETE perceives a higher level of project formalization.

An ETE's possibility to cognitively reframe his or her efforts in response to a perceived level of distributive fairness is an important underlying argument for the potential efficacy of distributive fairness in predicting knowledge sharing intention (cf., Janssen, 2001). However, with increasing project formalization in a collaborative R&D project, modes of working become more strict. The lowered levels of autonomy may attenuate the effects of distributive fairness on job attitudes and behaviors. For instance, Chen et al. (2010) find that employees with less control over how they spend their time on the job experience a weaker relationship between distributive justice and their organizational commitment. Xie, Schaubroeck, and Lam (2008) show that with stronger on-the-job monitoring pressure, distributive justice's beneficial effect on employee health indicators, such as emotional exhaustion is attenuated and may even become negative for non-traditionalist employees (i.e., those likely to work in innovation settings). Analogously, in a collaborative R&D setting, ETEs who work in projects with a high degree of formalization experience less leeway to reframe their efforts based on the perceived level of distributive justice. This makes distributive justice a less potent driver of ETEs' knowledge sharing intention. Therefore:

H_5: Project formalization moderates the positive relationship between ETE perceived distributive fairness and knowledge sharing intention such that this relationship becomes weaker when an ETE perceives a higher level of project formalization.

Finally, the moderating role of project formalization on the relationship between knowledge sharing intention and behavior is considered. Previous work shows that formalized rules and procedures constrain the creative solution space in collaborative problem solving tasks (Jansen, Van Den Bosch, and Volberda, 2006). Formalization acts as a frame of reference that limits the deviation from existing knowledge, and thus promotes coming up with extant solutions to new problems (Lyles and Schwenk, 1992). In collaborative R&D, project formalization thus limits ETEs' opportunity to contribute new knowledge, ideas, or solutions to a challenge. In addition, in formalized work settings disputes and ambiguities are resolved by pointing to contracts, rules, and procedures rather than through discussion (Song and Parry, 1993). Work artifacts, such as contract books and sign-off forms further limit

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social interactions in which expert knowledge and ideas are most easily shared (Yan and Nair, 2016). In sum, formalization hampers ETEs to convert their knowledge sharing intention into behavior because it limits their opportunities to share: the uniqueness of ETEs' knowledge is not needed (or valued) within constrained solution spaces and social interactions to transfer their insights to other project members are more limited. Therefore:

> *H_6: Project formalization moderates the positive relationship between knowledge sharing intention and knowledge sharing behavior such that this relationship becomes weaker when an ETE perceives a higher level of project formalization.*

Methodology

Research Setting and Data Collection

To empirically test the conceptual framework, survey data were collected from ETEs involved in R&D projects at seven global manufacturers in the high-tech industries medical, semiconductor, agriculture, process automation, and robotics. These manufacturers were sampled as they integrate a wide range of components from specialist suppliers in their R&D projects. Suppliers provide experts to work in these R&D projects to secure seamless integration of supplier parts and to develop solutions for specific modules. These activities require a great deal of information exchange. ETEs' knowledge sharing is thus crucial for the manufacturers to be able to successfully develop new products or services.

In cooperation with R&D managers from the seven manufacturers, one or more R&D projects were selected to develop a *new* high-tech product or service, not just a refinement of an existing market offer. The projects required large investments in terms of (non-)monetary resources, carry high-risk and uncertainty, and depended heavily on integration of external know-how. Only those projects that were in an advanced phase of development (nearing first release) or that were recently completed (within the last six months) were considered. In cooperation with the manufacturers the suppliers involved were contacted and asked for their cooperation. After the explicit consent from the suppliers' management, the ETEs involved were identified based on human resource and R&D project records. Temporary hires (e.g., from consulting firms) were excluded because they may lack experience and the ability to understand the conflicts of interest among the parties. The identified ETEs received an e-mail that they would soon be invited to participate in a survey and that their participation was supported by manufacturer and supplier management. Confidentiality and anonymity were also guaranteed. A next e-mail contained the survey link and the name of the project on which the respondent was asked to reflect throughout the survey.

Sample Characteristics

Five hundred thirty-six surveys were sent out and 236 were returned; 40 surveys had to be discarded because of missing data and another 10 surveys because of patterns indicative for response bias (e.g., straight-lining). Table 2 presents the characteristics of the remaining 186 respondents, who contributed to 68 different projects.

The mean values of age, gender, and job tenure of the sample were compared to those of relevant studies on R&D teams. The mean age reported varies from 30 (e.g., Chi, Huang, and Lin, 2009) to 45 (e.g., Petroni, 2000), with multiple studies reporting a mean of 39 years (Cordero, Ditomaso, and

Table 2. Sample Characteristics

Returned surveys	236	
Response rate	44%	
Respondents in final sample	186	
Male	81%	
Age[a]	36.4 (8.8)	years
Job tenure[a]	6.4 (5.4)	years
Supplier–manufacturer relationship length[a]	19.7 (10.6)	months
Size of R&D team[a]	12.9 (7.6)	members
Number of projects in final sample	68	
Average number of ETEs per project	2.7 (1.0)	
Percentage of service projects	25%	
Percentage of ETEs involved in stage(s)		
Ideation stage	61%	
Scoping stage	52%	
Business case stage	68%	
Development stage	63%	
Testing stage	61%	
Launch stage	54%	

[a]Descriptive indicates mean, standard deviation between parentheses.

Farris, 1996; Faraj and Sproull, 2000; Zenger and Lawrence, 1989). Similarly, a meta-analysis on innovation-related behavior by Ng and Feldman (2013) includes 6153 individuals with a mean age of 36 with a standard deviation of 8.3. The mean in the sample (36.4 years), including standard deviation (8.8 years) corresponds to these samples. The relatively high percentage of men in the data set (81%) corresponds to percentages found in other recent studies on R&D teams, e.g., Chi et al. (2009; 78%), Garcia Martinez, Zouaghi, and Garcia Marco (2017; 74.2%), and Tortoriello and Krackhardt (2010; 90%). Finally, the mean job tenure of the sample (6.4 years) also corresponds to earlier work: e.g., Tortoriello and Krackhardt (2010; 5.2 years) and Zenger and Lawrence (1989; 5.7 years). Therefore, the descriptives of the sample are fairly typical for research on R&D projects.

Finally, 55% of the respondents completed the survey before a first reminder was sent and only 14% of the respondents completed the survey after having received a third reminder. To test for nonresponse bias, the 24 respondents filling out the survey within one week from the invitation were selected, as were the 26 respondents who only responded after a third reminder e-mail (after eight weeks) (cf. Armstrong and Overton, 1977). ANOVAs compared these two sets of respondents on their personal characteristics (age, gender, job tenure, risk taking propensity, and extraversion), the individual-level R&D collaboration characteristics (virtuality and stage dummies), as well as the focal variables (customer stewardship, distributive fairness, project formalization, and knowledge sharing intention). No significant differences between these two groups of respondents were found. Comparing other fractions (e.g., 5%, 10%, and 15% early versus late respondents) yielded the same conclusion.

Measures

Where possible validated scales from existing works were used to operationalize the constructs from the conceptual model. For some concepts, the specificity of the research context led us to formulate new scale items that were nevertheless inspired by extant works. The survey was pretested by seven practitioners and eight academic researchers prior to the actual data collection and minor wording changes were made in response to their feedback. The item wordings, loadings, and psychometric properties of the key concepts in the hypothesized model are listed in Table 3.

Knowledge sharing behavior was measured on a 5-point Likert scale using six items inspired by He and Wong (2004) and Im and Rai (2008). The items capture the extent to which respondents shared expertise to help a manufacturer's R&D department gain novel insights that may positively influence the technical capability, cost aspects, and innovativeness of the product or service under development. *Knowledge sharing intention* was also measured on a 5-point Likert scale using a 4-item scale adapted from Bock, Zmud, Kim, and Lee (2005). The challenge in measuring *customer stewardship* was to capture the breadth of the stewardship concept with relatively few items. Drawing on De Ruyter et al. (2009) and Schepers et al. (2012), responsibility, accountability, and ownership were identified as the central elements in their measurement items. These three items were made context-specific and included in the pretest, which indicated no need to further adapt this measurement instrument. Responses were recorded on a 7-point Likert scale. The onset of the questions specifically instructed ETEs to consider the collaborative R&D project mentioned in the e-mail and to think about the manufacturer and the other parties involved as representing their customers. To measure *distributive fairness* three items from extant literature were used (Franke et al., 2012; Zaefarian, Najafi-Tavani, Henneberg, and Naudé, 2016). Again, responses were recorded on a 7-point Likert scale.

Preliminary interviews with practitioners indicated that the organization of work in the R&D projects considered can be typified on a continuum ranging from very formal, to having some formal and informal elements, to very informal. Existing scales from Moenaert et al. (1994), Song and Thieme (2006), Schultz et al. (2013), Steinicke et al. (2012), and Walter et al. (2015), did not adequately discuss this formal–informal continuum. Practitioners further indicated (in)formality to occur in three domains: governance structures, process coordination, and the flexibility to deal with unplanned events in the R&D project. Elements in the previously validated scales that captured these domains were adapted to fit the research context. As a result, *project formalization* was

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Table 3. Key Measurement Scales and Level 1 Properties

Variable	FL	CR	AVE
Customer stewardship		.947	.857
Consider collaborative R&D project [x] and think about the manufacturer and the other parties involved (e.g., other suppliers) as your customers. To what extent do you agree with the following statements?			
I feel accountability for results of my customers.	.902		
I feel owner of problems my customers face.	.933		
I feel a sense of responsibility for results of my customers.	.942		
Distributive fairness		.848	.652
The benefits of the product/project development for both companies feel balanced.	.848		
The contribution in amount of resources against the expected payoff feel fairly split (e.g., people, tools, and investments).	.864		
In my eyes, there is a balance between what my company contributes and receives from this project.	.702		
Project formalization		.728	.487
I had the feeling this R&D project team is mostly governed by: mutual understanding—contractual agreements	.872		
The work processes in this R&D project are influenced by: informal coordination—formalities	.457		
In case of disagreement or unplanned events, it was solved by: mutual understanding—referring to the contract	.702		
Knowledge sharing intention		.947	.816
I intended to teach knowledge to my coworkers of the R&D team.	.876		
I felt I had to make an effort to transfer my expertise to my coworkers of the R&D team.	.924		
I wanted to share my experience and knowhow with my coworkers of the R&D team.	.914		
I meant to share knowledge with my coworkers of the R&D team.	.899		
Knowledge sharing behavior		.886	.610
I shared knowledge with the project team to increase efficiency levels.[a]			
I shared knowledge with the project team to realize cost savings.	.717		
I shared knowledge with the project team to reduce consumption of materials or resources.	.824		
I shared knowledge with the project team to generate new services.	.792		
I shared knowledge with the project team to open up new markets.	.824		
I shared knowledge with the project team to enter and/or apply new technologies.	.742		
Risk taking propensity		.806	.581
I like to take risk by venturing into the unknown.	.729		
I am willing to invest a lot of time and/or money on something that might yield a high return.	.808		
I tend to act “boldly” in situations where risk is involved.	.747		
Extraversion		.907	.661
I am sociable.	.727		
I am very talkative.	.822		
I am assertive and active.	.832		
I am enthusiastic.	.827		
I am full of power and keen on action.	.852		
Manufacturer knowledge dependency		.783	.482
Which company has the strongest solution design practice? (manufacturer–supplier)	.605		
Which company has the strongest software engineering capabilities? (manufacturer–supplier)	.885		
Which company owns more architectural skills? (manufacturer–supplier)	.671		
Which company owns more software development resources? (manufacturer–supplier)	.574		

FL = standardized factor loading, CR = composite reliability, AVE = average variance extracted.
[a]Item dropped due to low factor loading.

measured with three items to which ETEs responded on 7-point semantic differential scales, anchored by two polar adjectives to describe the formality of the R&D project in which they participated. The items were pretested using the panel of seven practitioners and eight academic researchers to confirm their reliability and validity.

Finally, control variables were included to account for alternative explanations for knowledge sharing intention and behavior. In terms of an ETE's individual characteristics, *gender, age*, and *job tenure* (in years) were included. *Risk taking propensity* was included to account for the fact that some individuals are less apprehensive to share knowledge; three items from Bolton and Lane (2012) were used. Also *extraversion* was added as a control variable, using a scale by John and Srivastava (1999). Responses to risk taking propensity and extraversion items were recorded on a 7-point Likert scale. The *stage(s)* in which an ETE was involved in a specific R&D project were included as a control because the nature of the collaboration and the subsequent knowledge sharing intentions and behavior may differ between early stages (i.e., ideation) and later stages (i.e., development stage) (cf. Ernst, Hoyer, and Rübsaamen, 2010). Six stages were accounted for: ideation, scoping, business case, development, testing, and launch. The first five stages are represented as dummies in the model (i.e., 1 representing that an ETE contributed to the project in this stage, 0 representing that the ETE did not); the sixth stage represented the reference or base group. A dummy variable was included to indicate whether the *R&D development type* was a new service (i.e., 1) or new product (i.e., 0). To control for the power dynamics in supplier–manufacturer relationships, *relationship length* was accounted for (i.e., the total number of months the supplier has actively worked with the manufacturer in the past) as was *manufacturer knowledge dependency* (i.e., whether the supplier or the manufacturer had more engineering practices, capabilities, skills, and resources) which was measured on a 7-point scale. Supplier–manufacturer relationship length displayed a skewness value of .913. Although this is below the commonly accepted threshold of 1, a square root transformation was employed to reduce the skewness. Because social interactions are conducive to knowledge sharing (Yan and Nair, 2016), the *virtuality* of the R&D project team was controlled for by asking respondents to indicate, on average, what percentage of team members were virtually present (e.g., through video conferencing software) during team meetings. Finally, the R&D project's *team size* was included.

Data Analysis and Results

Measurement Model

An individual-level confirmatory factor analysis was conducted to examine the psychometric properties of the measures and fit of the measurement model. Table 3 shows that most measures exceed the commonly accepted thresholds for reliability and convergent validity. In addition, Table 4 shows that the discriminant validity criterion was met for all constructs, as for any construct its AVE exceeded the squared correlation (i.e., shared variance) with any other construct. Further analyzing the variance inflation factors (VIF), it was concluded that multicollinearity is not a concern in the data either (highest VIF: 1.864). Overall, model tests reveal a good fit of the measurement model: χ^2 (377) = 678.44, CFI = .92, RMSEA = .06.

Potential common method bias (CMB) was empirically tested for, next to the applied a priori measures to reduce the potential for CMB (survey design separating measurement, variability in response and randomization of item order; Podsakoff, MacKenzie, Lee, and Podsakoff, 2003). First, a principal component analysis with varimax rotation revealed the presence of eight distinct constructs, rather than a single factor. The factors together accounted for 75.5% of the total variance; the first (largest) factor did not account for a majority of the variance (12.8%). Thus, no general factor was apparent; this provided a first relief for CMB concerns. Second, in an alternate CFA a common latent factor was modeled to load on all manifest variables. The single factor revealed a common variance of 5.0%, confirming that CMB is not of concern and unlikely to confound the interpretations of results.

Analyses

To account for the nested data structure (i.e., ETEs in projects), a multilevel regression analysis was conducted. As a first step, the intra-class correlation coefficients (ICCs) were calculated for all constructs in

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Table 4. Correlation Matrix

Level 1 correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Customer stewardship	**.926**															
2. Distributive fairness	.288**	**.807**														
3. Project formalization	.011	.052	**.698**													
4. Knowledge sharing intention	.327**	.151*	.030	**.903**												
5. Knowledge sharing behavior	.342**	.292**	−.014	.404**	**.781**											
6. Age	−.106	−.282**	.002	.023	−.124	–										
7. Gender (1 = male)[a]	.133	−.063	.094	.041	.155*	.199**	–									
8. Job tenure[b]	.074	−.146*	−.025	−.046	−.057	.399**	.176*	–								
9. Risk taking propensity	.454**	.184**	−.018	.242**	.382**	−.098	.121	.053	**.762**							
10. Extraversion	.578**	.365**	.006	.304**	.357**	−.246**	.008	−.066	.444**	**.813**						
11. Virtuality	.073	−.092	−.021	−.038	−.015	.150*	.051	−.045	.004	−.025	–					
12. Ideation stage dummy[a]	.024	−.038	−.084	.138	.132	.085	.027	.011	.099	.005	.153*	–				
13. Scoping stage dummy[a]	.045	.000	−.025	.155*	.092	−.147*	.172*	−.076	.104	.043	−.203**	.227**	–			
14. Business case stage dummy[a]	.056	−.140	−.100	.042	.049	.101	.187*	.119	−.022	.083	.069	.253**	.174*	–		
15. Development stage dummy[a]	.277**	.062	−.084	.185*	.156*	.056	.257**	.177*	.103	.173*	.029	.084	.084	.343**	–	
16. Testing stage dummy[a]	.075	.045	−.177*	−.032	.023	−.014	.027	.185*	−.085	.000	−.018	.105	.074	.300**	.174*	–
Mean	5.703	4.476	4.034	4.008	3.278	36.38	.81	6.390	5.263	5.742	31.82	.61	.52	.68	.63	.61
Standard deviation	1.148	1.315	1.471	.773	.894	8.827	n/a	5.440	1.050	.887	32.17	n/a	n/a	n/a	n/a	n/a
Level 2 correlations	**17**	**18**	**19**	**20**												
17. Development type (1 = service)[a]	–															
18. Relationship length[b]	.437**	–														
19. Manufacturer knowledge dependency	.479**	−.399**	**.694**													
20. Team size[b]	.411**	.196*	−.381**	–												
Mean	.253	19.71	4.459													
Standard deviation	n/a	10.56	.948													

Note: Square root of average variance extracted plotted on the diagonal.
[a]Categorical variable.
[b]Observed variable.
*Correlation is significant at the 0.05 level (two-tailed).
**Correlation is significant at the 0.01 level (two-tailed).

the model that could conceptually carry between-project and between-manufacturer variance.[1] The ICC of each construct was derived by estimating a null (i.e., no predictors) random-intercept multilevel model and comparing the between-group variance to the total variance. These analyses considered both projects and manufacturers as level 2 cluster variables. Most between-level variance was explained by considering projects as a level 2 cluster variable. In fact, the variance on the manufacturer level approached zero when variance on the project level was controlled for. Thus, variance on the latter level was accounted for and relationship length (ICC = .321) and manufacturer knowledge dependency (ICC = .259) were considered as (aggregated) level 2 variables because their ICC exceeded the commonly suggested .05 threshold (Bliese, 2000; LeBreton and Senter, 2008). Also development type and team size were considered as level 2 variables, as these are project characteristics by definition.

Although distributive fairness also displayed an ICC above .05 (i.e., .097), entering distributive fairness as a level 2 variable in the core model led to a worse model fit (cf. Burnham and Anderson, 2004), as measured by the Akaike information criterion (i.e., AIC_{fair_level1} = 1014.799, AIC_{fair_level2} = 1018.599). Variables like project formalization (ICC = .012) and virtuality (ICC = .019) did not display much between-project variance, which indicates that these concepts are individual-level perceptions that do not converge toward project-level phenomena. Conceptually and from the research setting, this is possible as two or more ETEs who have worked in the same project have not necessarily worked in the same stage(s) of the project. The level of formalization and the virtuality employed for team communication may be markedly different between stages.

To test the conceptual model, the items of each construct were averaged to create latent variables and then these variables were standardized. The core model and hypothesized model were estimated using multilevel regression analysis with the maximum likelihood estimator. Random-intercept models with fixed slopes were employed, as the interaction effects were not cross-level (i.e., customer stewardship, distributive fairness, and project formalization were all specified as level 1 variables).

Table 5 displays the results of the estimations. The columns under "core model" indicate the linear effects of independent variables on knowledge sharing intention and knowledge sharing behavior, respectively. The columns under "hypothesized model" indicate the results of the linear effects and the interaction effects of project formalization. The column "full moderated mediation model" will be discussed later. The table reports standardized Beta values and significant effects (i.e., $t > 1.97/p < .05$) are printed in bold.

Results

The hypothesized model explained 23.1% of the variance in knowledge sharing behavior and 39.8% in knowledge sharing intention. In support of H1 the results confirm the expected positive effect of customer stewardship on knowledge sharing intention ($\beta = .167$, $t = 2.129$, $p < .05$). Interestingly, H2, which relates to the effect of distributive fairness on knowledge sharing intention, was not supported ($\beta = .060$, $t = .920$, *n.s.*). In support of H3, knowledge sharing intention and knowledge sharing behavior were positively related ($\beta = .283$, $t = 3.518$, $p < .01$).

Regarding the hypothesized moderating effects, H4 was not supported because the relationship between customer stewardship and knowledge sharing intention was unaffected by project formalization ($\beta = -.028$, $t = -.372$, *n.s.*). In contrast, the relationship between distributive fairness on knowledge sharing intention did depend on project formalization ($\beta = -.127$, $t = -2.539$, $p < .05$). This supports H5. Finally, a significant moderating effect of project formalization on the relationship between knowledge sharing intention and

[1]ANOVAs were also used to compare the mean values of the focal variables across manufacturers and projects. No significant differences were found in customer stewardship ($F_{(6,179)} = 1.293/F_{(67,118)} = 1.162$), distributive fairness ($F_{(6,179)} = 1.612/F_{(67,118)} = 1.194$), knowledge sharing intention ($F_{(6,179)} = .181/F_{(67,118)} = .772$), knowledge sharing behavior ($F_{(6,179)} = 1.674/F_{(67,118)} = 1.349$), and project formalization ($F_{(6,179)} = 1.154/F_{(67,118)} = .921$), across manufacturers and projects respectively. ETEs' demographics were also compared across teams and projects. Gender composition did not differ significantly across teams and projects ($F_{(6,179)} = .501/F_{(67,118)} = .920$), but age ($F_{(6,179)} = 4.836/F_{(67,118)} = 1.811$) and tenure ($F_{(6,179)} = 3.969/F_{(67,118)} = 1.703$) did. ICC estimations confirmed that age (.213) and tenure (.194) carry some between-project variance. However, it is not conceptually valid to enter these concepts as level-2 variables, since ETEs have not necessarily worked in the same stage(s) of the R&D project, such that project-level ETE age or project-level ETE tenure cannot always influence an ETE's intention or behavior. Empirically, analyses can therefore only account for the between-project differences in these variables by allowing their slopes to be random across projects. Such an alteration of the core model led to a worse model fit (cf. Burnham and Anderson, 2004), as measured by the Akaike information criterion (i.e., AIC_{fixed_slope} = 1014.799, AIC_{random_slope} = 1023.118). In addition, the variances in the random slopes were not significant, indicating that it is unlikely to find level 2 factors explaining variance in these demographic variables (which also would not correspond to this study's purpose). Hence, age and tenure were entered as level-1 fixed slope variables in the multilevel regression equations.

Table 5. Results of Hypothesis Testing Using Multilevel Regression Analysis

	Core Model				Hypothesized Model				Full Moderated Mediation Model	
	Dependent variable				Dependent variable				Dependent variable	
	Knowledge sharing intention		*Knowledge sharing behavior*		*Knowledge sharing intention*		*Knowledge sharing behavior*		*Knowledge sharing behavior*	
	β	*t*	*β*	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Constant	−.242	−1.183	**−.572**	**−2.767**	−.231	−1.104	**−.535**	**−2.586**	**−.509**	**−2.397**
Direct effects (level 1)										
Customer stewardship (CS)	**.201**	**2.550**	.008	.108	**.167**	**2.129**	−.005	−.068	.011	.142
Distributive fairness (DF)	.041	.602	**.152**	**2.527**	.060	.920	**.131**	**2.020**	.103	1.495
Project formalization (PF)					.042	.761	.003	.050	.034	.535
Knowledge sharing intention (KSI)			**.281**	**3.051**			**.283**	**3.518**	**.298**	**3.573**
Moderating effects (level 1)										
KSI x PF							**−.165**	**−2.379**	**−.166**	**−2.229**
CS x PF					−.028	−.372			−.124	−1.620
DF x PF					**−.127**	**−2.539**			**.120**	**2.653**
Control variables										
ETE characteristics (level 1)										
Age	.130	1.587	−.053	−.800	.156	1.856	−.045	−.681	−.049	−.775
Gender (1 = male)	−.117	−.730	**.361**	**1.961**	−.135	−.808	**.381**	**1.968**	**.408**	**2.138**
Job tenure	−.102	−1.510	−.027	−.397	−.097	−1.466	−.012	−.174	−.001	−.008
Risk taking propensity	.048	.699	**.212**	**3.203**	.043	.618	**.219**	**3.301**	**.227**	**3.461**
Extraversion	**.157**	**2.082**	.084	1.272	**.201**	**2.589**	.081	1.203	.040	.596
R&D collaboration characteristics (level 1)										
Virtuality	−.047	−.540	−.006	−.105	−.051	−.610	−.016	−.274	−.033	−.530
Ideation stage dummy	.228	1.885	.213	1.661	**.253**	**2.109**	.209	1.676	.167	1.291
Scoping stage dummy	.219	1.427	−.110	−.811	.225	1.525	−.094	−.696	−.076	−.570
Business case stage dummy	−.070	−.426	.023	.207	−.126	−.776	.010	.084	.067	.579
Development stage dummy	.217	1.291	.054	.414	.270	1.607	.039	.315	−.040	−.331
Testing stage dummy	−.119	−.717	.070	.455	−.113	−.670	.082	.518	.063	.392
R&D collaboration characteristics (level 2)										
Development type (1 = services)	**.284**	**2.015**	.120	.564	.251	1.531	.088	.396	.022	.111
Relationship length	−.048	−.582	−.132	−1.266	−.053	−.649	−.160	−1.528	−.168	−1.633
Manufacturer knowledge dependency	−.024	−.266	−.015	−.132	−.044	−.489	.011	.095	.023	.208
Team size	**−.187**	**−2.613**	−.126	−1.443	**−.160**	**−2.359**	−.091	−1.023	−.089	−1.086
Variance explained (R^2)	21.0%		37.8%		23.1%		39.8%		39.9%	

Notes: In the full moderated mediation model, results on the dependent variable knowledge sharing intention are omitted because these are analogous to the results reported in the hypothesized model. Bold values indicate significant effects ($p < .05$, two-tailed).

behavior was found ($\beta = -.165$, $t = -2.379$, $p < .05$). This significant negative effect provides support for H6.

Regarding the control variables, significant effects of extraversion ($\beta = .201$, $t = 2.589$, $p < .05$) and the ideation stage dummy ($\beta = .253$, $t = 2.109$, $p < .05$) on knowledge sharing intention were found. Gender ($\beta = .381$, $t = 1.968$, $p < .05$) and risk taking propensity related positively to knowledge sharing behavior ($\beta = .219$, $t = 3.301$, $p < .01$). Other control variables did not display any significant effects.[2]

Post-hoc Analyses: Total Effects in a Full Moderated Mediation Model

Because the model has a moderated-mediation structure, the total effects of customer stewardship and distributive fairness under different levels of project formalization were explored. To get the most accurate and detailed picture, a full moderated mediation model was considered, which means that project formalization's potential moderation of the direct effects of the antecedents on knowledge sharing behavior was also accounted for.

Figure 2 shows two plots that provide a graphical representation of the total effects. To facilitate interpretation of the plot in Panel A: the red line represents the sum of the indirect effect (customer stewardship => knowledge sharing intention => knowledge sharing behavior) and the direct effect (customer stewardship => knowledge sharing behavior) under different conditions of project formalization (i.e., from very low [−2SD] to very high [+2SD]). The purple and green lines represent the upper and lower limits of the 90% confidence interval of the total effect, respectively. Panel B provides a similar overview for distributive fairness' total effect but plots the 95% confidence interval.

The positive total effect of customer stewardship on knowledge sharing behavior attenuates when project formalization increases. In fact, customer stewardship's total effect is only significant for (very) low values of project formalization (i.e., <−1.4 SD). For higher levels of project formalization, the 90% confidence interval contains the value 0, meaning that the effect is not significant. In fact, in a 95% confidence interval, customer stewardship's total effect is not significant under any condition of project formalization. This provides more insight into H4 and H6; in line with these hypotheses, increasing project formalization attenuates the stewardship–intention link, and the intention–behavior link, such that the indirect effect is only significant for low values of project formalization. Because there is no significant direct effect of customer stewardship on knowledge sharing behavior, and there is a weak negative interaction effect of project formalization in this direct relationship ($\beta = -.124$, $t = -1.620$), the direct effect does not counterbalance the weak indirect effect.

The total effect of distributive fairness is strengthened, rather than attenuated, when project formalization increases. Panel 2B shows that the positive total effect is significant from approximately the midpoint of project formalization (+0.2 SD) and above—the lower bound of the 95% confidence interval then exceeds 0. This result provides an in-depth view on H5 and H6. Where these hypotheses state that project formalization weakens the fairness–intention link and the intention–behavior relationship, considering the direct effect provides a different perspective. Because distributive fairness displays a weak positive direct effect on knowledge sharing behavior ($\beta = .103$, $t = 1.495$) and this effect becomes stronger and significant under higher levels of project formalization ($\beta = .120$, $t = 2.653$), the direct effect dominates in calculating the total effect for higher values of project formalization. Conceptually, this means that ETEs who work in a highly formalized project that features a fair distribution of outcomes among collaboration partners do not have to build a cognitive intention to share knowledge, but show a direct behavioral knowledge sharing reaction. This interesting point is considered further in the discussion section.

Discussion

Although employees' knowledge sharing actions are central to the success of complex, multidisciplinary R&D projects, a deeper understanding of their motivations to share knowledge has not yet been provided by existing literature. In fact, the individual-level perspective in literature on knowledge sharing in collaborative R&D projects has been virtually nonexistent. Building on theories of gift and social exchange, this article identified customer stewardship and distributive fairness as two potentially important personal motivations of ETEs to share knowledge. Project formalization was considered as a key contingency condition.

The results show that customer stewardship influences ETEs' knowledge sharing intention, but

[2]Although not hypothesized, there could exist nonlinear effects of project formalization. To empirically check this thought, additional analyses were conducted in which the project formalization squared term was added as a covariate to the hypothesized model. The term turned out not to be significantly related to knowledge sharing intention, nor knowledge sharing behavior. In addition, it could also be that customer stewardship and distributive fairness interact in their relationship to knowledge sharing intention and behavior. To empirically check this possibility, additional analyses were conducted in which we added this term to the hypothesized model. The term turned out not to be significantly related to knowledge sharing intention, nor knowledge sharing behavior.

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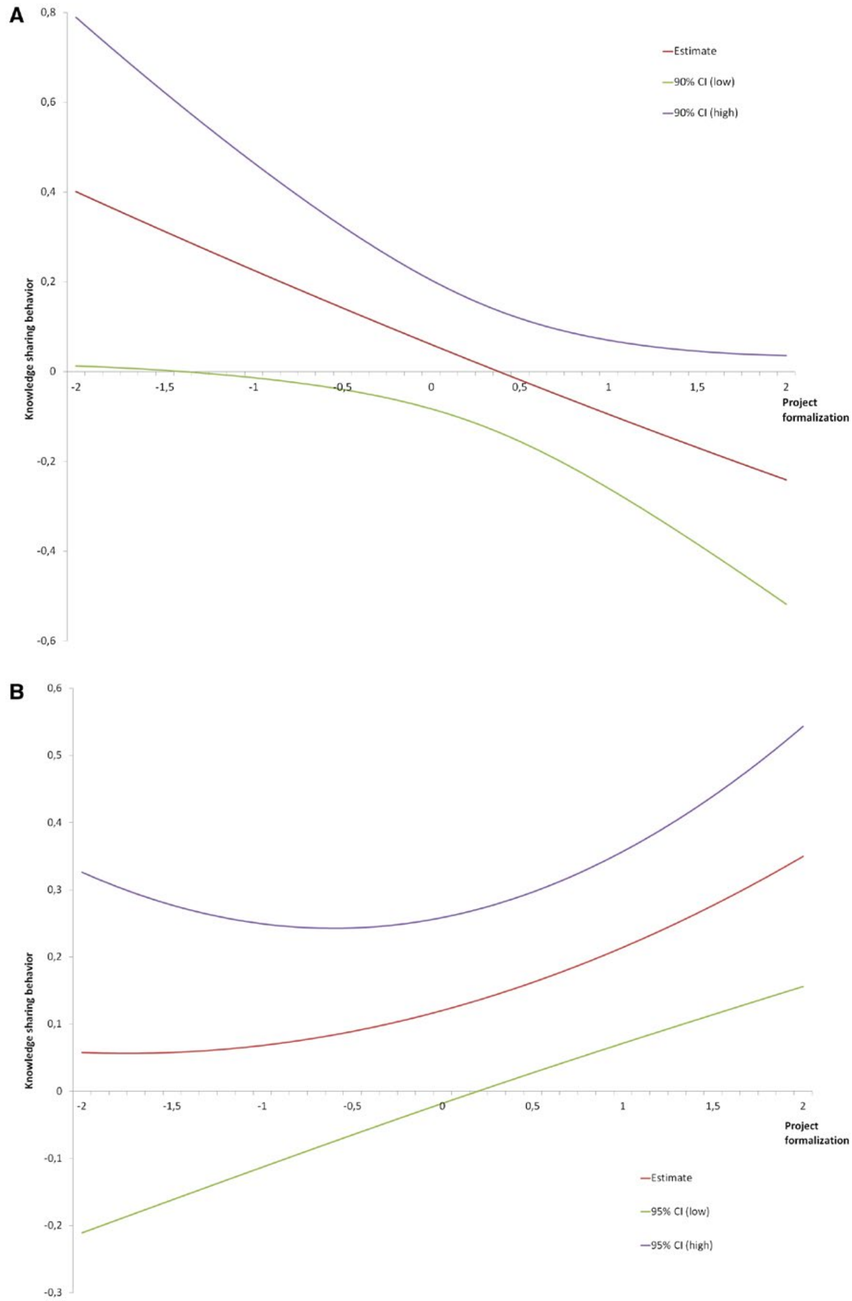

Figure 2. Total Effects. Panel A: Total Effects of Customer Stewardship on Knowledge Sharing Behavior. Panel B: Total Effects of Distributive Fairness on Knowledge Sharing Behavior

not knowledge sharing behavior. This contrasts previous studies that find customer stewardship to directly influence the behavior of boundary-spanning employees (e.g., De Ruyter et al., 2009; Schepers et al., 2012). It could be that knowledge sharing requires more thought and deliberation than the job performance-related behaviors in previous works. It could also be that the longevity of work relationships plays a role. To illustrate, in the sample the average relationship length between a supplier and manufacturer is 19.74 months. Frontline employee job tenure in Schepers et al. (2012) is 4.21 years (in study 1) and 5.1 years (in study 2). These figures are 2.55 and 3.10 times as large as the relationship length in the sample. Perhaps the sense of stewardship needs a longer "incubation time" to display direct effects on behavior; future research could further investigate this issue.

Furthermore, distributive fairness influences knowledge sharing behavior, but not knowledge sharing intention. This finding can perhaps be explained by the observation that distributive fairness is a more extrinsic motivator than customer stewardship, which is more intrinsic in nature. Extrinsic motivation focuses on goal-driven reasons and cost-benefit analyses for performing an activity, while intrinsic motivation indicates the pleasure and inherent satisfaction derived from a specific activity (Deci and Ryan, 1985). Intrinsic motivation has been found to more strongly influence knowledge sharing intentions than extrinsic motivation because it influences behavior through internalization rather than direct compliance (Lin, 2007). Also, in the collaborative R&D research setting distributive fairness involved an evaluation of the distribution of outcomes over different *actors* in the collaboration (i.e., suppliers and the manufacturer) rather than the fairness in ETEs' *personal* rewards. This may be another reason why fairness evaluations in this particular research setting may appeal less to these employees' internal beliefs but more to their professional behavior.

The results also show that project formalization weakens the relationship between customer stewardship and knowledge sharing intention, and between knowledge sharing intention and knowledge sharing behavior. Project formalization thus attenuates the indirect effect of customer stewardship on knowledge sharing behavior, such that this relationship is only significant for very low values of project formalization. This extends the findings of Schepers et al. (2012), who also report that the positive effects of customer stewardship fade when formal elements, such as goal setting and monitoring, are introduced in the work environment.

A final interesting result comes from the consideration of distributive fairness' total effects under different project formalization conditions. The positive direct effect of distributive fairness on knowledge sharing behavior, and thereby its total effect, becomes stronger and significant under higher levels of project formalization. Likely, low project formalization provides ETEs with higher levels of autonomy, which makes their job more stimulating and leads these workers to be less sensitive to inequity in the distribution of outcomes (cf. Rousseau, Salelk, Aubé, and Morin, 2009; Schreurs, Guenter, van Emmerik, Notelaers, and Schumacher, 2015). Conversely, a high level of formalization would make the job less stimulating and thus intensify distributive justice's effect.

Theoretical Implications

This study is an important first step in providing the empirical evidence needed to uncover the motivational and behavioral foundations for ETEs' knowledge sharing in collaborative R&D projects. The basis for the *conceptual* development of these foundations was provided by Dolfsma and van der Eijk (2017). They argued that personal motivations rather than inter-firm relationship elements, such as network position or dependency, are the primary determinant of an individual's knowledge sharing behavior in collaborative R&D projects. This study has further developed this embryonic line of research in at least three ways.

First, this article has added an individual-level perspective to literature on knowledge sharing in collaborative R&D projects. Previous studies in the collaborative R&D domain consider the benefits of supplier involvement to achieve better project outcomes and have accentuated the importance of information exchange in these collaborations (e.g., Thomas, 2013; Zhang et al., 2017). This literature is extended by showing that the process through which individual supplier employees, like ETEs, decide to share their knowledge can be described by a combination of personal motivations and the level of formalization in the R&D collaboration. The results of the multilevel regression analysis support that concepts like distributive fairness and project formalization carry little between-project variance and much within-project variance. Modeling these concepts as group-level phenomena thus neglects the explanatory power of individual-level perceptions of the work environment. It also underscores that collaborative R&D projects are very dynamic and that no two development stages are similar (cf. Ernst et al., 2010).

Second, this article extends the work of Dolfsma and van der Eijk (2017) and empirically investigate the individual-level motivational and behavioral foundations for knowledge sharing in collaborative R&D. Specifically, the suggested personal motivations of obligation and reciprocation from theories of gift and social exchange (Blau, 1964; Mauss, 2000; Sherry, 1983) are conceptualized by the concepts of customer stewardship and distributive fairness.

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The former influences knowledge sharing behavior through intention; this adds to works that have only considered direct behavioral effects of stewardship (e.g., De Ruyter et al., 2009; Schepers et al., 2012). Distributive fairness rather has direct effects on knowledge sharing behavior. Taken together the insights also add to the network perspective on innovation. Works in this stream have argued that knowledge transfer results from network structure and position (e.g., Landry, Amara, and Lamari, 2002; Nahapiet and Ghosal, 1998), a premise that has also been central to many studies on supplier involvement in new product development (e.g., Klioutch and Leker, 2011; Yeniyurt et al., 2014). However, controlling for structural inter-firm relationship elements such as supplier-manufacturer relationship length and manufacturer knowledge dependency, this article empirically substantiates that personal motivations are more powerful drivers of knowledge sharing intention and behavior.

Finally, the way interactions between individuals are governed in collaborative R&D projects has received surprisingly little attention as most scholars have focused on how inter-organizational governance mechanisms affect these projects' outcomes (Yan and Nair, 2016). For instance, Gesing et al. (2015) investigate the relationship between formal, contractual governance, and incremental and radical R&D outcomes, while Hofman et al. (2017) explore the project performance implications of different contractual configurations. Other studies consider intra-organization governance in R&D projects that do not feature supplier collaboration nor consider individual behavioral responses to such governance. For instance, Carbonell and Rodriguez-Escudero (2013) consider the relationships between formal and informal management controls and job satisfaction of R&D teams as a whole. Schultz, Salomo, de Brentani, and Kleinschmidt (2013) study whether formal control influences decision-making clarity in the project and subsequent innovation performance. This study brings refreshing new insights by considering project formalization jointly with individuals' intentions and behaviors.

Managerial Implications

The results suggest that managers should first assess the level of project formalization practiced in a specific collaborative R&D team. Is the operational governance in the project team characterized by norms, trust, mutual understanding, and informal coordination? Or by systematic rules, procedures, and formalities? Or by a mix of both?

In case of a mix or a dominance of formal project governance, R&D managers are encouraged to make sure that the distribution of outcomes to different actors feels fair to the supplier-provided project members. Such fairness perceptions can even be communicated before the start of a project. For instance, the long-term reputation of the manufacturer in how collaborators are rewarded may be an important cue to ETEs' fairness perceptions (Wagner et al., 2011). In fact, when suppliers are small scale (relative to the manufacturer) or when there is competition among suppliers to enroll in the project, reputation may determine whether suppliers are willing to collaborate at all (cf. Franke et al., 2012). At the start of a project, joint kick-off meetings can be used to ensure that team members from both firms (or from a multitude of shareholders) have a common understanding of what is the goal of the project, what information needs to be shared to achieve that goal, and how the benefits flowing from reaching that goal will be distributed (Slowinski et al., 2006). During the project R&D managers should be visible and open to exchange thoughts with team members. Especially when disagreements arise they should try to find solutions that meet the needs of the involved partners "in a win-win spirit" (Bstieler, 2006, p. 69). This is especially important in formalized settings, where contracts cannot anticipate and cover every issue that may arise during collaborative innovation development.

Only when project formalization in R&D projects is very low, it pays off for managers to make sure that ETEs experience a sense of stewardship for the well-being of the parties involved in the collaborative R&D project. This can be done by nurturing three basic social needs of ETEs (Schepers et al., 2012): (1) provide ETEs a great deal of autonomy to work and share know-how in the R&D team. This makes these external experts more willing to take full responsibility. Providing high levels of autonomy is a logical companion to having a low degree of project formalization in the project. (2) Secure ETEs' relatedness to the R&D project and make them "feel at home." This can be done by having extensive onboarding procedures and inviting

ETEs to informal events that the company may organize on a regular basis. (3) Be appreciative of the unique competency that ETEs bring to the table. Employees that are valued for their knowledge feel more control over the outcomes of unstructured situations and are hence more willing to take responsibility in R&D projects.

Limitations and Future Research

As with any study, this article is subject to some limitations which at the same time provide interesting cues for future research. First, although care was exercised in setting up the sampling procedure, it turned out that the raw relationship length data are slightly skewed with only 32 ETEs indicating that their supplier has been in a relationship with the focal manufacturer for three years or longer. Although this represents 17.2% of the sample, the average relationship length tends to be relatively low yet fairly typical for high-tech settings where start-ups may bring advanced technology into a manufacturer's project (De la Tour, Soussan, Harlé, Chevalier, and Duportet, 2017). Follow-up research is needed to substantiate whether the results hold in a sample of more mature R&D collaborations.

Second, another drawback of the sample is that customer stewardship and distributive fairness were measured at the same time. This makes it hard to argue and test for a potential causal relationship between the two concepts. Nevertheless, it could be that ETEs who observe a fair distribution of outcomes experience more moral courage, or more easily see how moving the project forward aligns with their personal interests. Future research may therefore further explore the relationships between customer stewardship and distributive fairness.

Third, not all shared know-how holds the same value for the manufacturer. Hence, future research may account for the applicability, quality, or innovativeness of shared insights. Additionally, scholars could also consider whether the relationships uncovered are different for sharing different types of tacit or explicit knowledge (e.g., written documents, drawings, and specific instructions).

Finally, while this article focused on knowledge sharing, literature also outlines the concepts of knowledge transfer and knowledge exchange. Knowledge transfer occurs when the knowledge shared by the source has affected the knowledge of the recipient (Argote, McEvily, and Reagans, 2003). Knowledge exchange occurs when both source and recipient engage in knowledge sharing behaviors with the aim to enhance each other's knowledge (Yeniyurt et al., 2014). Knowledge sharing requires neither a "learning effect" nor reciprocal engagement of the receiver; it simply indicates that an individual displays an effort to communicate his/her knowledge to another party. Future research could investigate whether the mechanisms used in this study also explain knowledge transfer and exchange.

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