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Firms' intellectual property ownership aggressiveness in university–industry collaboration projects: Choosing the right governance mode

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Intellectual property (IP) ownership aggressiveness constitutes an organization's strategic stance that prioritizes its IP protection. An organization thus pursues a rigid approach to protect its background IP and strives for exclusive ownership of the foreground IP that results from collaborative projects. This paper investigates how firms' IP ownership aggressiveness influences university–industry collaboration (UIC) project success and examines if the relationship is contingent on the governance modes that firms employ in UICs, especially the intensity of contract formality and shared governance. Analysing survey data from UIC projects of medium-sized to large firms covering four industries, we find that the levels of contract formality and shared governance moderate the effect of firms' IP ownership aggressiveness on project success. Strong contract formality leads to a negative relationship between firms' IP ownership aggressiveness and UIC project success. Conversely, if firms apply strong shared governance, the relationship between IP ownership aggressiveness and UIC project success is positive. Given firms' strategic approach to protect background IP and claim ownership of foreground IP, these results have implications for UIC managers when selecting governance modes to best support UIC project success.

1 | INTRODUCTION

Firms increasingly seek external collaborative research opportunities to overcome resource constraints and stay ahead of competition (Chesbrough & Appleyard, 2007; Gama, Sjödin, & Frishammar, 2017). Especially collaborating with universities offers opportunities to access new research fields and benefit from cutting-edge knowledge (Wirlich, Kock, Strumann, & Schultz, 2016). Firms collaborate with universities in university–industry collaboration (UIC) projects, for instance, to expand their knowledge base and reduce their research and development (R&D) expenditures, thereby enhancing their innovative and economic performance (Bozeman, Fay, & Slade, 2013).

However, several contextual conditions affect UIC project success, including partners' distinct organizational structures (Hemmert,

Bstieler, & Okamuro, 2014), different cultures (Santoro & Gopalakrishnan, 2000) and misaligned strategies (Bercovitz & Feldman, 2007). Moreover, the paradox of openness and inappropriate management choices (Gama et al., 2017) can lead to unexpected results or even failure in UIC projects (Guzzini & Iacobucci, 2017). The paradox of openness refers to collaboration partners' trade-off decisions to reveal certain intellectual property (IP) and the need to protect their organization's knowledge base against imitation (Laursen & Salter, 2014, p. 868). Selective revealing is a related concept that refers to a partner's situation-dependent disclosure of carefully chosen background IP to signal attractiveness for joint problem-solving, while carefully withholding other knowledge (Henkel, 2006). With a few exceptions, scholars have hardly studied UIC project management (Bstieler, Hemmert, & Barczak, 2015; Cassiman, Di Guardo, & Valentini, 2010; Du,

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Leten, & Vanhaverbeke, 2014; Gama et al., 2017) and selective revealing (Alexy, George, & Salter, 2013; Henkel, Schöberl, & Alexy, 2014) in UIC. Accordingly, we focus on two aspects: firms' strategic management choices related to the enforcement of IP ownership in UIC and the choices related to governance modes in UIC.

First, managerial IP-related choices are arguably highly relevant for UIC project success (Belderbos, Cassiman, Faems, Leten, & Van Looy, 2014) and usually refer to two decisions: On the one hand, firms have to negotiate sharing their existing IP, i.e. their background IP, which they own prior to the start of the UIC and contribute during the project. On the other hand, firms have to reach an agreement with collaborating universities regarding the allocation of IP ownership rights resulting from joint research projects, i.e. foreground IP (Granstrand & Holgersson, 2014). In practice, many firms are very restrictive and selective about sharing their background IP and often want to claim ownership for all foreground IP resulting from UIC projects. We focus on firms' aggressiveness towards restrictive background IP sharing and their efforts at claiming as much of the foreground IP ownership as possible, which we conceptualize as IP ownership aggressiveness.

Second, UIC projects are often complex to plan, manage and monitor due to the participants' ambitious aspirations and ambiguous avenues for realization (Nishimura & Okamuro, 2018). We focus on governance mode choices that appear relevant for clarifying the partners' project contributions (Remneland-Wikhamn, 2013). We distinguish between two governance types that co-exist independently and represent different dimensions in UIC projects: contract formality as a form of formal governance and shared governance as a form of informal governance (Gesing, Antons, Piening, Rese, & Salge, 2015). Organizations employ contract formality as a protective mechanism; the contextual settings of the research project's purpose drive contract formality to ensure the intended project outcomes (Hofman, Faems, & Schleimer, 2017). Shared governance refers to the collaborating partners' joint activities and responsibilities for project contributions and addressing the challenges arising during a project's progress to enhance effectiveness (Bstieler et al., 2015). Previous studies suggest that both governance modes positively influence collaboration project success (Bercovitz & Tyler, 2014; Du et al., 2014; Gesing et al., 2015). UIC projects normally comprise both governance modes, but with varying intensity (Bstieler et al., 2015; Sihag & Rijdsdijk, 2019).

Since firms have to adequately secure their R&D investments and exploratory search strategy, we need to understand how the management of UIC projects influences the link between firms' IP ownership aggressiveness and project outcomes (Bercovitz & Feldman, 2007). Accordingly, this study addresses the research question: *How do governance mode choices affect the relationship between IP ownership aggressiveness and UIC project success?*

This study makes the following contributions. We propose IP ownership aggressiveness, which is inspired by the notion of selective revealing, as a novel concept to the UIC literature. We also operationalize and empirically investigate the concept's relevance in a sample of UIC projects. Furthermore, this study examines how choosing different governance modes influences the relationship between firms' IP ownership aggressiveness and UIC project success.

From a managerial perspective, this study contributes to a better understanding of how firms' IP ownership aggressiveness influences UIC project success and related governance mode choices.

2 | CONCEPTUAL FRAMEWORK AND HYPOTHESES

Firms often engage in UIC projects to advance their knowledge base (Belderbos et al., 2014; Santoro & Bierly, 2006). UIC projects are also a promising approach to reduce R&D expenses, signal innovative leadership and increase innovation speed (Chesbrough & Appleyard, 2007; Du et al., 2014). Hence, we conceptualize *UIC project success* as a multidimensional construct that includes *satisfaction* with the collaborative relationship with the university, the *transfer of knowledge* to the firm and the further *use of knowledge* for the firm's purposes.

2.1 | The paradox of openness

For collaborations to succeed, firms have to signal their IP's relevance, i.e. their background IP, and their contributory power, which is associated with the need to reveal certain IP to partners (Alexy et al., 2013). Consequently, a common collaboration challenge arises from the *paradox of openness*, which describes the trade-off decisions to reveal certain IP and the need to protect the firm's knowledge base against imitation (Laursen & Salter, 2014, p. 868). Arora, Athreya, and Huang (2016, p. 1353) summarize three options to deal with this paradox. First, firm's *spillover prevention* refers to the use of formal IP rights, such as patents and trade secrets, to protect the firm's IP, thereby reducing potential knowledge spillovers and avoiding imitation (Cassiman & Veugelers, 2002). Second, *organizational openness* refers to partners' interdependencies in collaboration and the reciprocal character of joint R&D endeavours, which contradict a firm's primary intention to gain exclusive IP ownership rights via patenting (Arora et al., 2016, p. 1353). In order to enhance the collaboration's efficacy and to strengthen the partners' interaction, the firm can, therefore, rely less rigidly on IP ownership (Chesbrough & Appleyard, 2007; Laursen & Salter, 2014). Third, *selective revealing* can be a compromise not only to signal the attractiveness of a firm's background IP for joint problem-solving but also to ensure its commercial interests for appropriating parts of the foreground IP generated (Alexy et al., 2013; Henkel, 2006). Consequently, depending on a collaboration's situational circumstances, partners select certain background IP for disclosure, while they carefully withhold other IP.

A UIC's purpose is often to generate new knowledge, which universities transfer to firms for further in-house R&D activities and commercial use. Although universities hardly compete in firms' markets and the risks arising from firms' knowledge leakage may differ from those of interfirm R&D collaboration, the management and commercialization of IP is also increasingly relevant for universities (Belderbos et al., 2014). Universities' third mission to pursue entrepreneurial activities in addition to research and teaching drives this trend.

Pursuing entrepreneurial activities is, moreover, also a means for universities to become more independent from public funds from government and constitutes a shift in the conception of university IP's relevance (Etzkowitz, 2003). Hence, it is essential to better understand how firms' IP ownership aggressiveness influences UIC project success.

2.2 | IP ownership aggressiveness

Clearly allocated IP rights are a necessity in UIC, because they determine the opportunities and set the boundaries for collaboration and knowledge transfer (Bercovitz & Tyler, 2014; Hertzfeld, Link, & Vonortas, 2006). Scholars often differentiate between two major IP categories: *Background IP* is the IP that collaboration partners possess before the start of the joint R&D project and *foreground IP* refers to the IP that the partners jointly develop during collaboration and is, therefore, an outcome of UIC projects (Granstrand & Holgersson, 2014). Agreeing on the allocation of the background and foreground IP prior to the start of a collaborative R&D project has proved to help the partners reduce objections regarding knowledge appropriation (Belderbos et al., 2014). UIC partners have to carefully consider and decide on the extent to which they are willing to share background IP and how aggressively they want to negotiate the ownership distribution of foreground IP (Hagedoorn & Zobel, 2015; Nelson, 2016). A common approach is to assign foreground IP ownership to one partner, with the other partner receiving more or less exclusive usage rights through licensing contracts (Hertzfeld et al., 2006).

Firms' approaches to handling the allocation of background and foreground IP may vary, depending on factors such as the type of collaboration partner (i.e., science-based or market-based), the type of knowledge involved (i.e., tacit or explicit) (Santoro & Bierly, 2006), and the degree of innovativeness (i.e., incremental or radical) (Wirsih et al., 2016). Yet, firms usually adopt an overall strategic approach regarding their sharing of background IP and their preference for foreground IP ownership. Firms' management often determines the above-mentioned overall strategic approach as part of their general IP policies and is likely to follow similar directions in multiple collaborations with the same or different partners (Cassiman & Veugelers, 2002).

We are particularly interested in the extent to which firms rigorously protect their background IP against university partners and claim ownership of the foreground IP generated in UIC projects; we refer to this characteristic as IP ownership aggressiveness. The paradox of openness and firms' potential opportunity to deal with this trade-off decision by selective revealing inspire this notion (Henkel, 2006; Laursen & Salter, 2014). On the one hand, it is necessary to protect firms' competitively relevant knowledge, i.e. background IP, in UIC, as university researchers are likely to also collaborate with other market actors who could be focal firms' competitors. On the other hand, firms need to leverage their in-house R&D resources by appropriating potential commercially important foreground IP (Henkel et al., 2014).

Accordingly, we define IP ownership aggressiveness as organizations' strategic stance to prioritize the protection of IP in and from research collaboration projects. High IP ownership aggressiveness

therefore means that an organization is only willing to share the absolute minimum of its background IP while having a strong preference to claim ownership of most, if not all, of the foreground IP.

Presumably, IP ownership aggressiveness does not have an overall direct effect on UIC performance, because it may unfold mixed effects. We posit that its effect on UIC project success is contingent on how a UIC is managed, i.e. the governance modes applied during a project's progress, such that either the positive or the negative effects prevail.

2.3 | Governance modes

Choosing appropriate governance modes for UIC projects appears to be crucial to assert firms' IP strategy (Bstieler et al., 2015; Gulati & Singh, 1998) and enable successful outcomes given UICs' ambiguous and idiosyncratic characteristics (Nishimura & Okamuro, 2018). Effective governance helps address the paradox of openness to ensure that firms' interests are protected when disclosing knowledge (Nelson, 2016). Moreover, effective governance supports project monitoring (Hofman et al., 2017), thus contributing to achieving a UIC's expectations and goals.

Prior literature distinguishes between formal and informal governance modes (Carson, Madhok, & Wu, 2006). We conceptualize formal governance as UIC management based on contract formality referring to outcome control and process control, which determine desired outputs and monitor the appropriate behaviours during project progress (Holgersson, Granstrand, & Bogers, 2018; Rijdsdijk & van den Ende, 2011). Shared governance as a form of informal governance builds on the team members' socialization processes to ensure cohesion and shared understanding (Bstieler et al., 2015; Turner & Makhija, 2006). Project participants sometimes consider shared governance to be more effective and more favourable than contract formality, due to lower monitoring costs. Previous research also indicates that contract formality and shared governance have complementary effects: Contract formality creates a common basis and supports partners' preferable behaviour, but can be considered rather inflexible, whereas shared governance can fill a gap by enabling faster adaptability (Poppo & Zenger, 2002; Rijdsdijk & van den Ende, 2011).

Although firms usually have fixed hierarchical structures and procedures, they can flexibly decide on the intensity and varying emphasis of using more contract formality or shared governance in UIC projects. While contract formality may be well suited to ensure efficient collaboration, shared governance can facilitate the planning, coordination and flexibility of adjustments (Bstieler & Hemmert, 2015). Consequently, contract formality and shared governance are not mutually exclusive governance modes but relate to different dimensions (Holgersson et al., 2018). Hence, the two governance modes can arguably co-exist with varying levels of intensity in UIC projects (Bstieler et al., 2015; Sihag & Rijdsdijk, 2019).

Consequently, it appears essential to better understand how management choices regarding the two governance modes influence the relation between firms' IP ownership aggressiveness and UIC project success. Figure 1 summarizes this study's research model.

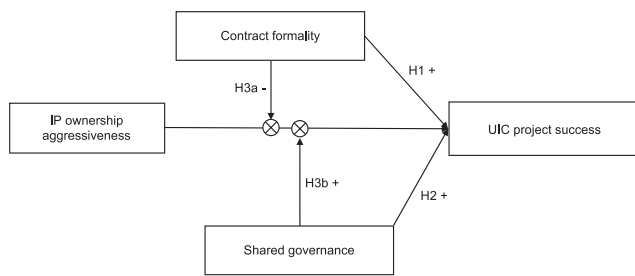


FIGURE 1 Research model

2.4 | Contract formality

Transaction cost theory (Williamson, 1981) suggests employing formal governance to control a partner's behaviour in highly uncertain situations (King, 2007). This applies to UIC projects, which are often knowledge-intensive with exploratory research goals and uncertain outcomes (Carson et al., 2006; Cassiman et al., 2010). Universities may, intentionally or unintentionally, use a partnering firm's IP, technological expertise and insights into future R&D intentions when working with future collaboration partners who may even be competitors to that firm (Axelson & Richtnér, 2017; Morandi, 2013). Contracts can solve these problems by providing the means and rules for governing the sharing and usage of background and foreground IP (Bogers, 2011; Carson et al., 2006), thereby mitigating the risk of unintended IP leakage (Buss & Peukert, 2015).

Strong contract formality creates rules and is a means to agree on each partner's contributions, performance obligations, responsibilities and expectations regarding the project results (Bercovitz & Tyler, 2014; Hagedoorn & Zobel, 2015). Hence, contract formality generally creates a framework for R&D collaboration partners' interactions, but it may unfold mixed effects in UIC projects (Du et al., 2014; Walter, Walter, & Müller, 2015).

On the one hand, considering a UIC's exploratory characteristics, university partners require autonomy and flexibility to decide on research approaches (Du et al., 2014). Strong contract formality may increase a UIC's complexity by ex-ante specifying obligations, responsibilities and tasks to be completed, procedures to adhere to, and detailed outputs to deliver (Poppo & Zenger, 2002). Furthermore, strong contract formality can lead to over-formalization, which could hamper the effective project progress (Hofman et al., 2017).

On the other hand, UIC partners are interdependent and often rely on reciprocity for successful project outcomes. Contracts help coordinate the timelines, workflows and information exchange for project progress (Bozeman et al., 2013). Moreover, contract formality allows to reach agreement on the distribution and ownership of foreground IP (Belderbos et al., 2014; Hertzfeld et al., 2006). Consequently, contracts reduce information asymmetries and create a mutual understanding (Nishimura & Okamuro, 2018). Contract formality can therefore be a promising approach for establishing a common collaboration basis (Faems, Janssens, Madhok, & Van Looy, 2008) and reducing uncertainty (Poppo & Zenger, 2002) in R&D collaboration

projects (Hofman et al., 2017). Thus, particularly for UIC projects, contract formality could unfold conducive effects.

H1. Contract formality relates positively to UIC project success.

2.5 | Shared governance

According to the relational view (Dyer, Singh, & Hesterly, 2018), joint actions are considered supportive for UIC projects' success, because partners have an opportunity to clarify their expectations, adjust their goals, and find ways whereby they can contribute best (Lazzarotti, Manzini, Nosella, & Pellegrini, 2016). Furthermore, in terms of information exchange, firms have incentives to be jointly involved in UIC in order to enforce their own research interests and ensure the project's adaptability (Carson et al., 2006).

In exploratory UIC projects, partners may most likely face the need to occasionally adjust research directions and flexibly adapt research approaches, due to changing surrounding conditions (Bercovitz & Feldman, 2007) for which a shared governance approach may be very suitable (Schleimer & Shulman, 2011). Moreover, if the partners have a trusted relationship, there may be a lower risk of a partner behaving opportunistically (Bstieler et al., 2015). Compared to contracts, shared governance can help create a common basis for an even better understanding of the innovation purpose and increases the chances of achieving joint goals (Lazzarotti et al., 2016) by strengthening partners' communication and flexibility for adjustments (Axelson & Richtnér, 2017). Since shared governance is based on joint efforts and decisions, it can also further enhance trust and increase teamwork quality in UIC projects (Bstieler et al., 2015; Hoegl, Weinkauff, & Gemuenden, 2004).

H2. Shared governance relates positively to UIC project success.

2.6 | Governance modes' interaction effects with IP ownership aggressiveness

IP ownership aggressiveness appears likely to affect the level of UIC partners' information exchange during the project and the value appropriated after project completion, as it determines which information to share (i.e., firms' background IP) and how to distribute foreground IP ownership (Jensen & Webster, 2009). Firms' strong IP ownership aggressiveness can thus risk undermining the UIC's purpose, because sharing at least certain IP and allowing for a reciprocal knowledge input appear to be necessary for creating a common basis and supporting project progress (Lazzarotti et al., 2016; Nelson, 2016). In order to remedy the potential negative effects of IP ownership aggressiveness, firms can adjust the intensity of the two governance dimensions of contract formality and shared governance by, for instance, incentivizing university researchers' commitment to UIC projects, thus positively impacting project success (Okamuro & Nishimura, 2013). We posit that the effect of IP ownership aggressiveness on

UIC project success is thus contingent on the governance mode choices, such that either the positive or the negative effects prevail.

2.6.1 | Interaction effect with contract formality

In UIC projects, formal contracts determine minimum rules and responsibilities to ensure transparency for monitoring project progress and to enable effective collaboration (Hagedoorn & Zobel, 2015). University researchers usually carry the major workload in UIC projects, as their interests to develop a better understanding and novel knowledge drive them forward (Bercovitz & Feldman, 2007). Given this strong intrinsic motivation, university researchers will most likely contribute greater efforts than stipulated in the contract (Bercovitz & Tyler, 2014).

On the one hand, in line with the transactional view (Williamson, 1981), firms' strong IP ownership aggressiveness coupled with a governance approach based on strong contract formality could be in the firms' best interest. This combination ensures that university partners fulfil their performance obligations, it limits firms' sharing their background IP to a minimum, and enables maximum value to be captured by claiming ownership for all foreground IP (Bercovitz & Tyler, 2014).

On the other hand, imposing strong IP ownership aggressiveness creates tensions with university researchers, for example, through restricted information exchange or the firm's self-serving attitude. Increased contract formality might further intensify this tension. According to the relational view (Dyer et al., 2018), the combination of firms' strong IP ownership aggressiveness and strict contract formality may therefore create an even more delicate and fragile relationship between UIC partners, as firms will primarily be inclined to serve their own interests by restricting their knowledge input and strictly appropriating UIC's returns, i.e. obtaining the foreground IP (Nelson, 2016). For instance, firms could insist that the researchers generate only relevant IP during collaboration (Jensen & Webster, 2009), meaning that they urge university partners to pursue firms' IP-related goals to realize not only specific types of IP (e.g., strategically relevant patents) but also specific types of knowledge (i.e., tacit or explicit), which facilitate the transfer of project results (Santoro & Bierly, 2006).

In other words, collaboration partners' expectations may differ substantially. University researchers may expect UIC projects to be reciprocal with both partners jointly working on foreground IP development. Yet, collaborating firms' IP ownership aggressiveness paired with scarce project contributions may disappoint and frustrate university researchers, thus severely limiting their motivation. University partners who would be willing to contribute their best to UIC success and exceed firms' expectations in reciprocal relationships when granted the appropriate autonomy in their research (Bercovitz & Tyler, 2014) may suddenly become reluctant and reduce their contributions to the minimum obligations specified in the formal contract (Lawson, Petersen, Cousins, & Handfield, 2009; Sihag & Rijdsdijk, 2019). Hence, one may conclude that firms' strong IP ownership aggressiveness can already provoke a relationship atmosphere fraught with conflicts and tensions, which are further amplified if firms employ strict formal

contracts, such that university researchers limit their contribution efforts (Bercovitz & Tyler, 2014; Faems et al., 2008). Consequently, strong contract formality combined with strong IP ownership aggressiveness may reflect negatively on UIC project success.

H3a. Contract formality and IP ownership aggressiveness interact negatively in such a manner that the relationship between firms' IP ownership aggressiveness and UIC project success becomes negative for high levels of contract formality.

2.6.2 | Interaction effect with shared governance

Strong IP ownership aggressiveness can create tensions and conflicts among partners, which special measures and a trustful relationship that benefits the collaboration can remedy (Gesing et al., 2015). If both UIC partners enhance communication and jointly engage in project progress, this can result in close interaction and create advantages to adapt more flexibly to change requests (Gulati & Singh, 1998; Lazzarotti et al., 2016). In line with the relational view (Dyer et al., 2018), shared governance may be better suited to share control in re-evaluating projects' progress, agree on adjustments to partners' management activities, and find ad hoc solutions (Bstieler & Hemmert, 2015; Hofman et al., 2017).

Shared governance as a more intensive and stakeholder-oriented governance mode will help mitigate the tensions that potentially arise from firms' strong IP ownership aggressiveness, because UIC partners strengthen their collaborative relationship by consulting each other and feeling obliged to jointly find solutions (Bstieler et al., 2015; Sihag & Rijdsdijk, 2019). Accordingly, it will be possible to strengthen collaboration partners' reciprocal knowledge input, thereby allowing them to agree more variably on the level of firms' necessary background IP sharing and foreground IP allocation. If firms still succeed in applying strong shared governance under these conditions, university researchers will have transparency of the firms' intentions and can be confident of their commitment to jointly contribute to the project (Hertzfeld et al., 2006). Moreover, through shared governance, firms can actively prevent conflicts arising from IP ownership aggressiveness by committing themselves and actively contributing to UIC projects.

H3b. Shared governance and IP ownership aggressiveness interact positively in such a manner that the relationship between firms' IP ownership aggressiveness and UIC project success becomes positive for high levels of shared governance.

3 | METHOD

3.1 | Data and sample

We tested the research model on a cross-industry sample of German medium-sized to large firms covering four industries, i.e. mechanical

engineering, electronics and information technologies, biotechnology and pharmaceutical industry, and energy. Table 1 provides an overview of the UIC projects' distribution by industry, project type, and geographical proximity.

The unit of analysis is a single UIC project. Using a key informant approach, we contacted firms' project managers in R&D who previously conducted joint research projects with universities and had significant responsibilities for managing the project. We initially identified potential informants in relevant positions by using open access contact data, such as websites, conferences, events and professional online networks. We contacted potential participants by e-mail to explain the purpose of the study. Subsequently, we had several rounds of phone calls to follow up on the e-mails, to further explain issues that remained unclear, and verify that informants had sufficient UIC experiences.

Interested participants had to register on a dedicated website and subsequently received an individualized questionnaire to ensure that we only included relevant UIC decision makers. The questionnaire first comprised questions regarding the participants' firm, followed by project-specific questions regarding a UIC project they managed and completed within the last five years. In total, 100 website registrations resulted in 65 responses. Due to missing values, we could run the analysis to assess distinct UIC projects by using 51 fully completed questionnaires.

3.2 | Measures

We used existing construct scales, if available, or adapted them slightly from previously published conceptual and empirical studies in peer-reviewed journals, mostly using seven-point Likert scales (1: strongly disagree; 4: neutral; 7: strongly agree). We created each variable as the mean over all its item values (see the appendix for details about constructs and item wordings).

3.2.1 | Dependent variable

In accordance with previous research, we consider generating new knowledge, i.e. IP, and transferring it to the firm a primary purpose of exploratory UIC projects (Belderbos et al., 2014). Consequently, we

measure *UIC project success* as a second-order construct that includes three factors: *satisfaction*, *knowledge transfer* and *knowledge use*. *Satisfaction* is adapted as a three-item construct and refers to the firm's contentment with the following: the UIC project in general, the relationship and the university partner's performance, and the fulfilment of the initial project expectations (Mora-Valentin, Montoro-Sanchez, & Guerras-Martin, 2004). *Knowledge transfer* is a three-item construct that includes the assessment of whether the firm learned much, whether it was possible to assimilate knowledge, and whether the knowledge gained resulted directly in new products or services (Santoro & Bierly, 2006; Simonin, 1999). *Knowledge use* is a three-item construct referring to the firm's absorption of new scientific knowledge, the discovery of new future R&D themes, and the training of in-house researchers via this UIC project (Bstieler et al., 2015). We calculated each of the factors *satisfaction*, *knowledge transfer*, and *knowledge use* as the mean of its items. We calculated *UIC project success* as the mean of the three factors.

3.2.2 | Independent variables

IP ownership aggressiveness (three items) captures the firm's strategic orientation for the protection of its IP rights, the degree of aggressiveness to protect its knowledge base in UIC projects (i.e., background IP), and the firm's willingness to strive for foreground IP ownership. We established this construct afresh by building on Hertzfeld et al. (2006) and Nelson (2016). *Contract formality* (three items) captures the use of a written contractual statement clarifying the use of IP rights and the potential transition of IP rights from one partner to another, the partners' roles and responsibilities, and the expectations regarding the performance obligations (Bstieler & Hemmert, 2015; Lusch & Brown, 1996). *Shared governance* (three items) covers joint responsibility, joint planning and joint advice on how the project should be run (adapted from Bstieler et al., 2015; Schleimer & Shulman, 2011).

3.2.3 | Controls

Project team size refers to the total number of full-time equivalent employees who worked on the selected UIC project throughout its

TABLE 1 Sample characteristics

| Industry | Project type | Geographical proximity | Firm size (full-time equivalents) | Team size (full-time equivalents) |
|--|-------------------------------------|---------------------------|-----------------------------------|-----------------------------------|
| Mechanical engineering | 31.37% Joint technology development | 72.55% Regional (<100 km) | 43.14% <100 | 37.25% <3 |
| Biotechnology & pharmaceutical | 29.41% Contract research | 23.53% National | 47.06% 100–500 | 21.57% 3–5 |
| Energy | 21.57% Scientific consulting | 3.92% International | 9.8% >500 | 41.18% >5 |
| Electronics & information technologies | 17.65% | | | 11.76% |

duration (Du et al., 2014). *UIC type* accounts for the type of project, i.e. joint technology development, contract research and scientific consulting (Bruneel, D'Este, & Salter, 2010; Bstieler et al., 2015). *Partner experience* is a dummy variable indicating whether this partner participated in previous UIC projects (Santoro & Bierly, 2006). This variable takes the value 1 if the partner formerly participated in one or more UIC projects and 0 otherwise. We measure *geographical proximity* with a set of dummy variables accounting for the distance between the collaboration partners and dividing this into three segments: regional (<100 km), national, and international (Mora-Valentin et al., 2004).

We used a key informant approach in our survey and, therefore, common method bias might be an issue (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). In order to prevent bias in the informants' answers that are related to implicit theories or social desirability, we used previously validated items and conducted several pre-tests with 20 representatives from industry and university. Only the construct IP ownership aggressiveness comprised newly established items, which we also included in the pre-tests. To avoid implicit theories, we aimed to prevent item complexity and ambiguity (MacKenzie & Podsakoff, 2012). We carefully chose and briefed the respondents: We asked them to answer the survey questions as honestly and spontaneously as possible and guaranteed them confidentiality and anonymity. We chose the survey participants selectively by approaching them through direct conversation, awaiting their study registration, and only choosing UIC project managers with relevant responsibilities. Following recommendations by Podsakoff et al. (2003), we used Harman's single-factor technique. A principal component factor analysis showed that the largest factor only explained 42.1% of the variance and that three factors with eigenvalues greater than one jointly explained 74.5% of the variance.

Table 2 shows the descriptive statistics and correlations of variables used in the analysis. The Cronbach's alpha of all the variables (with the exception of *knowledge use*; see appendix) is above .7, which shows a satisfactory scale reliability above the cut-off value.

TABLE 2 Descriptive statistics and correlations

| Construct | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|--------------------------------|------|-----|------|------|------|------|------|------|------|------|------|-----|-----|
| 1 UIC project success | 5.29 | .15 | | | | | | | | | | | |
| 2 Project team size | 3.20 | .60 | .24 | | | | | | | | | | |
| 3 Joint technology development | .73 | .06 | .23 | -.02 | | | | | | | | | |
| 4 Scientific consulting | .04 | .03 | -.17 | -.10 | -.33 | | | | | | | | |
| 5 Contract research | .24 | .06 | -.17 | .07 | -.90 | -.11 | | | | | | | |
| 6 Partner experience | .55 | .07 | .04 | .02 | .33 | -.02 | -.33 | | | | | | |
| 7 Regional | .45 | .07 | .03 | .25 | .20 | .22 | -.32 | .27 | | | | | |
| 8 National | .45 | .07 | .09 | -.27 | -.24 | -.18 | .33 | -.29 | -.82 | | | | |
| 9 International | .10 | .04 | -.21 | .03 | .06 | -.07 | -.03 | .03 | -.30 | -.30 | | | |
| 10 IP ownership aggressiveness | 5.59 | .18 | .13 | .18 | -.21 | -.04 | .24 | -.21 | -.21 | .17 | .07 | | |
| 11 Contract formality | 6.31 | .13 | .28 | .11 | .26 | -.35 | -.12 | .23 | .10 | -.02 | -.13 | .11 | |
| 12 Shared governance | 5.78 | .17 | .68 | .11 | .13 | -.24 | -.03 | .00 | .05 | .04 | -.16 | .23 | .56 |

All items, except the dummy variables for UIC type and geographical proximity, were measured on a seven-point Likert scale; $n = 51$; correlations larger than .27 are significant at the 5% level.

4 | RESULTS

We used hierarchical ordinary least squares regression analyses to test the hypotheses. Our analysis combined the cross-level interaction of the firm-specific strategic orientation IP ownership aggressiveness and project-specific governance modes, namely contract formality and shared governance. Table 3 shows the results of the hypothesis tests.

Model 1 includes all the control variables. Only project team size has a significantly positive effect (.076; $p = .047$). Model 2 shows the main effects, revealing that IP ownership aggressiveness has no direct effect on UIC project success. Contract formality has a negative effect on UIC project success (–.271; $p = .083$). Therefore, our data does not support H1. Shared governance appears to be strongly positively related to UIC project success (.672; $p = .000$). Hence, the results support H2.

Including the moderating effects of contract formality and shared governance on the relationship between IP ownership aggressiveness and UIC project success increases the explained variance by almost 7 per cent. The results show that contract formality interacts negatively with IP ownership aggressiveness in its relationship with UIC project success (–.272; $p = .050$). This finding supports H3a. Moreover, we find that shared governance interacts positively with IP ownership aggressiveness (.193; $p = .040$), which, thus, supports H3b. We also tested the quadratic effects of all the variables involved in interactions to rule out alternative explanations for the significant interaction effects (Dawson, 2014). Furthermore, as an additional analysis, we tested a possible interaction between contract formality and shared governance, because they might show complementary effects. However, this interaction term was close to zero and non-significant.

We explored contract formality's and shared governance's interaction effects with IP ownership aggressiveness by using simple slopes. The interaction displayed in Figure 2 shows that UIC projects in which firms employ high IP ownership aggressiveness together with strong contract formality will, in all likelihood, be less successful than projects in which firms employ a low level of formalization by

TABLE 3 Regression results

| Dependent: UIC project success | (1) | (2) | (3) |
|--|----------------------------|----------------------------|----------------------------|
| Project team size | .076 [.037] | .063 [.028] | .069 [.027] |
| Joint technology development | .821 [.790] | .227 [.636] | .067 [.604] |
| Contract research | .126 [.866] | -.379 [.675] | -.598 [.637] |
| Partner experience | -.015 [.321] | .127 [.247] | .136 [.231] |
| National | .389 [.363] | .411 [.274] | .556 [.260] |
| International | -.666 [.525] | -.301 [.405] | -.284 [.380] |
| IP ownership aggressiveness | | -.017 [.097] | .016 [.091] |
| Contract formality | | -.271 ⁺ [.152] | -.212 [.143] |
| Shared governance | | .672 ^{**} [.112] | .606 ^{**} [.110] |
| IP ownership aggressiveness × Contract formality | | | -.272 [*] [.135] |
| IP ownership aggressiveness × Shared governance | | | .193 [*] [.091] |
| Constant | 4.320 ^{**} [.759] | 4.788 ^{**} [.611] | 4.831 ^{**} [.577] |
| Adjusted R ² | .086 | .499 | .565 |
| F | 1.782 | 6.535 | 6.894 |

⁺ $p < .1$, ^{*} $p < .05$, ^{**} $p < .01$; $n = 51$; unstandardized regression coefficients with standard errors in brackets.

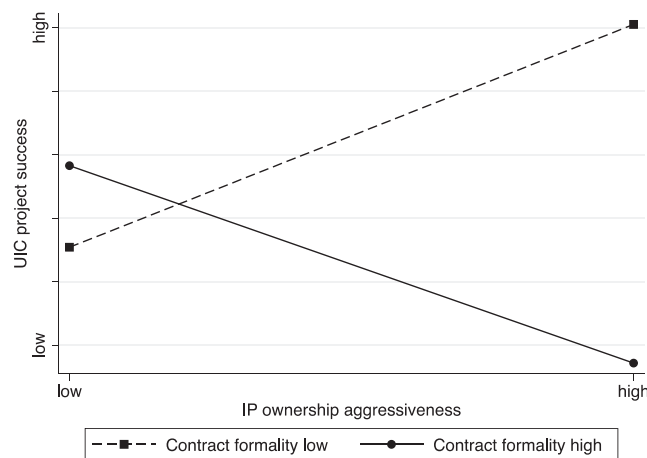


FIGURE 2 Simple slopes of IP ownership aggressiveness's relationship with UIC project success for low and high intensity of contract formality

contracts. In other words, the results indicate that firms can use low levels of contract formality to remedy the negative effects of high IP ownership aggressiveness on UIC project success. Interestingly, we

find that UIC projects are likely to be most successful when firms combine a high degree of IP ownership aggressiveness with a low level of contract formality. However, if firms employ rather weak IP ownership aggressiveness, higher degrees of contract formality appear beneficial for UIC project success.

Figure 3 shows the results of the simple slope analysis for the interaction effect of shared governance. UIC project success appears to be highest for projects in which firms combine a high level of IP ownership aggressiveness with a high degree of shared governance. However, if firms employ a low degree of shared governance, UIC projects are likely to be more successful if a lower level of IP ownership aggressiveness is pursued.

5 | DISCUSSION

For direct effects of governance modes on UIC project success, our findings are mostly in line with previous studies indicating the relevance of contract formality and shared governance in R&D collaboration (Bstieler & Hemmert, 2015; Gesing et al., 2015). However, our results do not support contract formality's positive effect on UIC success (Faems et al., 2008). One may consider strong contract formality rather inflexible to adjustments during project progress and therefore it can limit university researchers' autonomy, which might be essential to decide effectively on research approaches (Du et al., 2014; Hofman et al., 2017). Furthermore, strong contract formality may increase UIC's complexity by specifying partners' responsibilities and deliverables up front, or worse, may even lead to over-formalization (Poppo & Zenger, 2002). Yet, in line with previous studies, we find that shared governance strengthens partners' joint engagement and therefore supports UIC success (Bstieler et al., 2015; Bstieler & Hemmert, 2015).

Our study supports the notion that the effect of IP ownership aggressiveness on UIC project success is contingent on the applied governance modes. High levels of firms' IP ownership aggressiveness

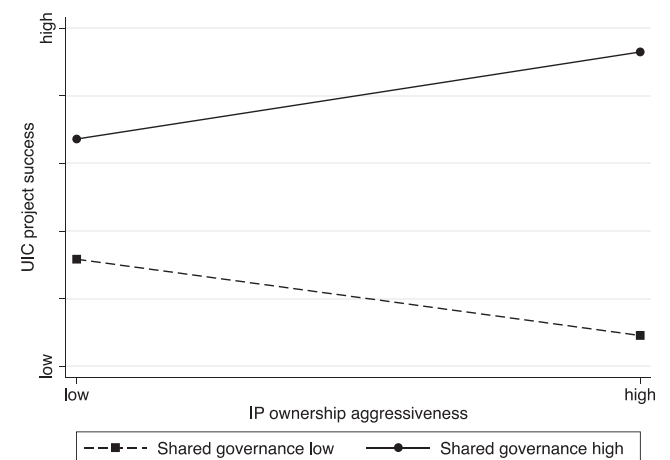


FIGURE 3 Simple slopes of IP ownership aggressiveness's relationship with UIC project success for low and high intensities of shared governance

appear reasonable to appropriate returns from UIC, i.e. foreground IP, but can create tensions and, therefore, lead to a fragile relationship between partners. Consequently, higher levels of shared governance, i.e. joint commitment and trustful interaction, may work best. In this context, strong contract formality may be detrimental, because contracts may result in university partners' reluctance to contribute voluntarily. In fact, strong contract formality may have the opposite rather than the desired effect in that university partners' contributions are limited to a minimum as stipulated through contractual obligations. However, if firms prefer a less aggressive IP ownership strategy, strong contract formality could be more efficient, because contracts require firms to contribute less effort (Williamson, 1981). Yet, for UIC projects to succeed and achieve results in firms' best interest, strong shared governance is advisable, in terms of higher and lower intensities of firms' IP ownership aggressiveness (Dyer et al., 2018).

5.1 | Theoretical implications

UIC projects usually comprise both governance modes, i.e. contract formality and shared governance, with varying intensities, depending on the project's type and purpose (Holgerson et al., 2018; Sihag & Rijdsdijk, 2019). This study empirically examines firms employing varying degrees of intensity for the two governance modes and their influence on the relationship between firms' IP ownership aggressiveness and UIC project success.

We also address previous research on the paradox of openness (Arora et al., 2016; Henkel et al., 2014; Laursen & Salter, 2014) and contribute to the understanding of the relationship between firms' IP strategies and UIC success (Belderbos et al., 2014). The balance between firms' sharing background IP and claiming foreground IP ownership remains a delicate matter, as both UIC partners have to agree. Hence, collaborating organizations' intentions should be taken into consideration when analysing the management of UIC projects.

To the literature, we contribute *IP ownership aggressiveness* as a novel concept, which is inspired by the notion of selective revealing (Henkel, 2006; Henkel et al., 2014; Hertzfeld et al., 2006; Nelson, 2016). We operationalize and test the effects of IP ownership aggressiveness on UIC project success, particularly its interaction effect with contract formality and shared governance. We specifically find that a high intensity of firms' IP ownership aggressiveness requires a higher level of shared governance and a lower level of contract formality for UIC projects to succeed.

5.2 | Managerial implications

Firms' UIC managers should consider how their firms' IP ownership aggressiveness influences collaboration success already during the projects' preparatory stages. Depending on their firms' IP ownership aggressiveness, managers are advised to adapt the intensity of the typically co-existing governance modes of contract formality and shared governance. By adapting the intensity of the governance

modes, firms can be assured of having effective mechanisms not only to impose their interests on the UIC, i.e. to safeguard background IP and to acquire as much foreground IP as possible, but also to mitigate the concomitant risk of unintended project outcomes or conflicts with university partners.

For firms that employ strong IP ownership aggressiveness, higher levels of shared governance appear promising. Even despite the potentially detrimental effects of this rigid strategy causing a relationship fraught with tensions, shared governance leads to joint engagement and may assure university researchers that firms are committed to and highly interested in the success of the project.

Yet, if firms employ a less aggressive IP ownership strategy, strong contract formality can be an efficient approach to govern UIC projects. Contracts help create a common basis, define responsibilities and obligations, tasks and procedures, and may safeguard firms' interests, allowing them to benefit from foreground IP generated in projects. Furthermore, in certain instances, it appears that firms may succeed in addressing university researchers with low contract formality when establishing UIC. From firms' perspective, this approach may give the impression of being effective, but it may create tensions with university researchers. In other words, low contract formality combined with high IP ownership aggressiveness may help firms take advantage of university researchers in that they appropriate UIC results and IP to an extent describable as being inequitable or even unfair. Consequently, firms' managers may perceive low contract formality paired with high IP ownership aggressiveness as being favourable for UIC project success, which university researchers may perceive with less optimism.

5.3 | Limitations and future research

This study is subject to limitations, which open up avenues for further research. The sample size is quite small and we use key informants to evaluate the relationships between IP ownership aggressiveness, governance modes and UIC project success. Moreover, the data may also be subject to common method bias. Future research could reduce this bias by collecting dyadic data from both industrial and academic UIC partners. Researchers can use data from one party to analyse the UIC management activities and data from the other to measure UIC project success.

Future research on UIC should also control for firms' general willingness to share IP in joint R&D projects. Former studies set a promising basis, both conceptually and empirically (Arora et al., 2016; Henkel et al., 2014; Laursen & Salter, 2014), but firms' strategic intentions require a more in-depth understanding (Belderbos et al., 2014; Nelson, 2016). The IP ownership aggressiveness construct we propose in this study and its operationalization need further tests and refinement. Moreover, scholars should investigate further contingency factors, besides the governance modes' influence on the relationship of IP ownership aggressiveness and UIC project success. For instance, third parties or intermediaries (e.g., firms' legal advisors and universities' technology transfer offices) may be involved in the

project negotiation phase in which the characteristics of firms' IP ownership aggressiveness show up. These contingency factors may have important implications on how UIC projects are managed and how partner selection choices are realized.

Furthermore, it is possible to measure contract formality and shared governance at a different point in time than IP ownership aggressiveness. This approach may help distinguish if the intensity of governance modes changes over time.

Finally, a more diverse and longitudinal dataset that includes multiple science-based and market-based partner types would be promising to control for changes in firms' strategic approaches towards IP ownership aggressiveness and their effect on the success of R&D projects.

6 | CONCLUSION

This study's results contribute to a better understanding of the relationships between the novel concept of IP ownership aggressiveness, the governance modes applied, and UIC project success. We build on the literature of the paradox of openness, particularly selective revealing, which is of high strategic importance for firms active in UIC (Henkel et al., 2014). Firms' managers may strategically pursue strong IP ownership aggressiveness in UIC and may, therefore, have to decide which governance mode to employ in order to support a project's progress and success.

For situations in which firms employ strong IP ownership aggressiveness, a shared governance is more conducive to UIC project success. For firms employing lower IP ownership aggressiveness, strong contract formality may be more efficient and also less detrimental than in the context of high IP ownership aggressiveness. Yet, strong shared governance is still advisable to support UIC project success. Further research will be necessary to better understand the potential downsides of IP ownership aggressiveness for UIC project success and the influence of other strategic orientations (e.g., firm's entrepreneurial orientation).

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APPENDIX A

Survey items

Dependent variable:

UIC project success (second-order construct) (3 constructs; $\alpha = .8391$).

Project satisfaction (Mora-Valentin et al., 2004) (3 items; $\alpha = .9517$)

- We are satisfied with the project in general.
- We are satisfied with the relationship and the performance of our partner.
- Project results have met the initial expectations.

Knowledge transfer (Santoro & Bierly, 2006; Simonin, 1999) (3 items; $\alpha = .8011$)

- The business unit learned a great deal from the UIC project.
- The knowledge held by the university had been assimilated by the business unit and contributed to new products/services developed by the business unit.
- The knowledge held by the university directly resulted in new products and services offered to our customers.

Knowledge use (Bstieler et al., 2015) (3 items; $\alpha = .6894$).

Through this UIC project ...

- ... new scientific knowledge was absorbed.
- ... new future R&D themes were discovered.
- ... in-house researchers were trained.

Independent variable:

IP ownership aggressiveness (newly established and inspired by Hertzfeld et al., 2006; Nelson, 2016) (3 items; $\alpha = .8334$)

- The protection of intellectual property is of high priority to our business unit in UIC projects.
- Our business unit pursues an aggressive IP strategy in collaborative projects with universities to protect our knowledge base.
- It is the typical business unit policy to strive for ownership of all IP rights resulting from UIC projects.

Moderating variables:

Contract formality (adapted from Bstieler & Hemmert, 2015; Lusch & Brown, 1996) (3 items; $\alpha = .7989$).

At the beginning of this UIC project, the handling of the following issues was clearly spelled out in writing:

- ... The use of IP rights and the potential transition of IP rights from one partner to another.
- ... The roles and responsibilities of the partners.
- ... Expectations as regards the performance obligations of each partner.

Shared governance (Bstieler et al., 2015; Schleimer & Shulman, 2011) (3 items; $\alpha = .8629$)

- We were jointly responsible for getting things done.
- We jointly planned how this project should be run.
- Advice and counsel was sought from each other.