Qui s'engage et comment ? Les thèses CIFREs, terrain d'exploration de l'engagement industriel envers la recherche

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Résumé :

L'engagement académique dans les collaborations science-industrie étudie les chercheurs qui collaborent avec les industriels. Son équivalent, l'engagement industriel peine à se structurer. Cette étude comble ce vide en analysant les micro-fondations de l'engagement des entreprises à travers les encadrants industriels de thèses CIFRE en France. En mobilisant un jeu de données unique sur 6 209 encadrants, enrichi par 23 entretiens nous faisons deux contributions. (1) Nous structurons le champ de l'engagement industriel. L'expertise scientifique ne se restreignant pas aux départements de R&D et aux docteurs. Ces derniers étant plus enclins à répéter l'expérience d'encadrement mais pas les seuls à effectuer cette tâche. Les liens faibles entretenus avec l'écosystème académiques peuvent être remobilisés pour aller chercher les facteurs de performances de ces dernières. (2) Nous complétons la littérature sur les capacités d'absorption en s'intéressant aux multiples facteurs de performances issus des collaborations science - industrie et en documentant les moyens d'y parvenir.

Mots-clés : recherche partenariale – engagement industriel – capacité d'absorption

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1 INTRODUCTION

University–industry collaborations (UICs) are well-documented phenomena (Rossoni et al., 2024; Rybnicek & Königsgruber, 2019). At the individual level, a substantial body of research has emerged around the concept of academic engagement, which examines how academics establish ties with industry partners (Perkmann et al., 2021). In contrast, the counterpart notion of industry engagement—that is, the involvement of industry actors in collaborative relationships with academia—remains comparatively underexplored. Specifically, individual-level dynamics on the industry side of UICs have received limited scholarly attention (Locatelli et al., 2021).

Building on the micro-foundations perspective (Felin et al., 2012, 2015), examining individual actors engaged in university–industry collaborations offers a way to investigate how personal backgrounds, motivations, and organizational contexts intersect in shaping collaborative efforts to serve industrial needs. On the academic side, academic engagement refers to research partnerships characterized by "high relational involvement in situations where individuals and teams from academic and industrial contexts work together on specific projects and pro- duce common outputs" (Perkmann & Walsh, 2007, p.263). Academics who collaborate with industry tend to share several traits: they often have prior exposure to industrial environments (Perkmann et al., 2021; Tijssen, 2018), hold senior positions, have been trained locally, and typically work in applied disciplines (Perkmann et al., 2021). Peer effects also appear to play a facilitating role (Perkmann et al., 2021). Such collaborations are often pursued to secure resources relevant to their research or to access learning opportunities (Lee, 2000; Perkmann et al., 2013).

In contrast, insights into the industry side of engagement remain scarce. Industry participants involved in academic collaborations often have no formal academic appointments (Borrell-Damian et al., 2010), yet are intrinsically motivated to sustain academic activities they previously engaged in (Blind et al., 2022; Suominen et al., 2021). Their dual familiarity with both academic and industrial domains makes them particularly well-positioned to bridge institutional boundaries (Al-Tabbaa & Ankrah, 2019). Indeed, many firms initiate collaborations through employees with prior academic experience, suggesting a continuity of individual trajectories (Colombo & Garcia, 2022). Such individuals tend to build long-term relationships to ensure the effectiveness of collaborations (Baba et al., 2010) and are adept at mobilizing weak ties—especially in R&D contexts—enhancing access to diverse sources of knowledge (Ahuja, 2000; Tsai, 2001).

Industry actors involved in UICs are thought to specialize in research-related activities over time, as sustained collaboration is often necessary for such partnerships to succeed (Bengtsson et al., 2015; Boschma, 2005; Rossoni et al., 2024). One key mechanism enabling this continuity is the PhD student, who frequently acts as a bridging agent between academic and industrial worlds. Industrial PhD students are recurrently described as instrumental in translating scientific knowledge into formats intelligible and actionable within firms (Kihlander et al., 2011). Supervisors of these students—especially those based on the industry side—are increasingly recognized as playing a pivotal role in knowledge dissemination of the PhD content (Abu Sa'a & Yström, 2024). Yet, empirical studies focusing on these supervisors remain limited (Gustavsson et al., 2016; Locatelli et al., 2021). While often framed as boundary spanners, their actual roles and positions vary: some are not directly embedded in R&D departments but still contribute meaningfully to research collaboration, sometimes even involving fundamental science (Cabanes et al., 2024). Evidence from industrial PhD schemes, such as CIFRE in France, suggests considerable heterogeneity in these roles, reflecting different degrees of organizational anchoring (Plantec et al., 2023). Moreover, the boundary spanning literature has primarily focused on innovation-related outcomes. However, UICs—especially those structured around PhD training—often produce a broader range of outputs, including learning, capability development, and institutional change (Ankrah & AL-Tabbaa, 2015; Bozeman et al., 2015; Fernández-Esquinas et al., 2016; Mangematin, 2000; Rosenberg, 1991). These alternative outcomes are particularly relevant in doctoral collaboration contexts, where knowledge flows are not limited to product innovation but extend to diverses organizational and individual outcomes (Locatelli et al., 2021).

How do industrial actors engage with academia to pursue diverse performance outcomes beyond innovation according to their specifications?

Investigating the micro-foundations of industry engagement helps address this research gap. While engaging with academia is known to generate innovation-related value for firms (Durand et al., 2008; Gambardella, 1995; Zucker et al., 2002), its benefits often extend beyond innovation. Understanding the individual-level drivers of such engagement by investigating industry engagement micro-fondation (Felin et al., 2012) can offer firms practical levers to better support and capitalize on its diverse outcomes.

France has a unique opportunity to access data from industrial PhD, named "CIFRE", carried out between 2000 and 2023 thanks to the *Association Nationale de la Recherche et de la Technologie* (ANRT). These data offer insights into industrial supervisors, with additional details accessible through the LinkedIn professional network. This is a unique opportunity to have a concatenated view on a very large scale on industry engagement, from various disciplines and companies. This allows us to examine how supervisors mobilize the CIFRE scheme, leveraging their academic connections in pursuit of diverse organizational goals. Prior work validates that industrial supervisors are a relevant lens for studying industry engagement (Locatelli et al., 2021). This setting not only enables systematic identification of engagement patterns but also supports targeted exploratory interviews to uncover the motivations and performance factors behind such collaborations. This is why to investigate the micro-foundations of industry engagement, we adopt a sequential exploratory mixed-method design (Creswell & Clark, 2017).

This study contributes to the literature on industry engagement within university–industry collaborations and absorptive capacity. Our findings shed light on the diversity of profiles involved in engagement and the complex forms of repetition that characterize sustained collaboration. We show that scientific expertise extends beyond formal R&D roles, and that supervisors with strong prior exposure to the academic ecosystem—particularly through a PhD—are more likely to engage repeatedly in industrial PhD supervision to pursue new research directions. The strength of their academic ties significantly influences how they initiate and manage projects, and the types of performance factor—personal, organizational, or disconnected from innovation—they extract from them.

2 THEORETICAL BACKGROUND AND HYPOTHESIS

Individuals from diverse backgrounds, both academic and industrial, play key roles in fostering university–industry collaborations. While academic engagement has been well structured as a community (Perkmann et al., 2021), industry engagement remains less explored. Research on industrial actors engaging with academics is scarcer and has largely focused on innovation as the sole performance outcome (Locatelli et al., 2021).

2.1 Industry Engagement as the Counterpart to Academic Engagement? A Conceptual Inquiry

2.1.1 Academic engagement

A substantial body of research has focused on academics engaging with industry, enabling the identification of common characteristics among them. These individuals are typically senior researchers, high-ranked within the academic hierarchy (Abreu & Grinevich, 2013; Lawson et al., 2019; Tartari & Breschi, 2012), locally trained, and often immobile (Perkmann et al., 2021). In the U.S., foreign-born researchers are less likely to be approached by firms for consulting activities compared to their American counterparts (Libaers, 2013). In the UK, holding a British PhD reduces cognitive barriers to industry collaboration (Lawson et al., 2019; Tartari & Breschi, 2012). Many of these academics have prior industrial experience, either through commercialization (Tartari & Breschi, 2012) or non-academic work (Gulbrandsen & Thune, 2017; Perkmann et al., 2021). More broadly, any past link to industry fosters repeated engagement (Lawson et al., 2016). They often have colleagues similarly engaged with industry, benefiting from peer effects (Tartari et al., 2014). These academics tend to work in applied disciplines (Zi & Blind, 2015), motivated by collaborations that complement their research, providing access to resources or learning opportunities (D'Este & Perkmann, 2011; Lee, 2000; Perkmann et al., 2013). They are also highly productive, with those collaborating with industry publishing more than their non-collaborating counterparts on similar discoveries (Bikard et al., 2019). Figure 1 Industry Engagement as a Mirror of Academic Engagement - summarizes these findings.

2.1.2 Industry engagement

On the industry side, research has primarily explored firms' motivations to collaborate, emphasizing intrinsic drivers over financial incentives (Blind et al., 2022; Suominen et al., 2021). Core researchers with sustained collaborations and a habit of publishing and patenting foster mutual understanding, playing a crucial intermediary role (Baba et al., 2010). These individuals, often described as boundary spanners, navigate both academic and industrial domains and act as translators across institutional logics (Baba et al., 2010). Originally conceptualized by Tushman and Scanlan (1981), who explained that « *informational boundary spanning is accomplished only by those individuals who are well connected internally and externally* »(Tushman & Scanlan, 1981, p.1). These people "*mediated expectations of the partnership and helped to manage con ict and tensions that arose from culture clashes or motive disparities*" (Ryan et al., 2018). Boundary spanners can facilitate both tacit and explicit knowledge transfer (Argote et al., 2021), using weak ties to access less complex but necessary knowledge (Hansen, 1999) and leveraging a network of relationships to enhance problem-solving (Lovejoy & Sinha, 2010). Employees working in R&D can signal the likelihood of collaboration between firms, providing valuable insights into the dynamics of UICs (Williams & Allard, 2018). Beyond simply linking the needs of academia and industry, boundary spanners may also combine the resources of both sectors to create value as it is the case for PhD students working in collaborative research centers (Harman, 2004).

Cognitive proximity facilitates collaboration by enabling shared knowledge bases (Asheim, 2007; Caloghirou et al., 2004; Colombo & Garcia, 2022; Mangematin, 2000; Thune, 2009). Firms often collaborate more with universities from which their employees graduated (Colombo & Garcia, 2022), though this repeated engagement may not always stem directly from individual ties.

While employees holding PhDs can initiate collaborations that persist beyond their departure, they are often the only ones capable of triggering such initial connections (Afcha et al., 2023). This supports the idea that boundary spanners are effective due to their dual familiarity with academic and industrial logics. However, it also suggests that non-boundary-spanning employees may still sustain pre-existing academic relationships—implying mechanisms of peer learning and forms of engagement that do not necessarily rely on prior academic exposure. These insights are summarized in Figure 1 Industry Engagement as a Mirror of Academic Engagement.

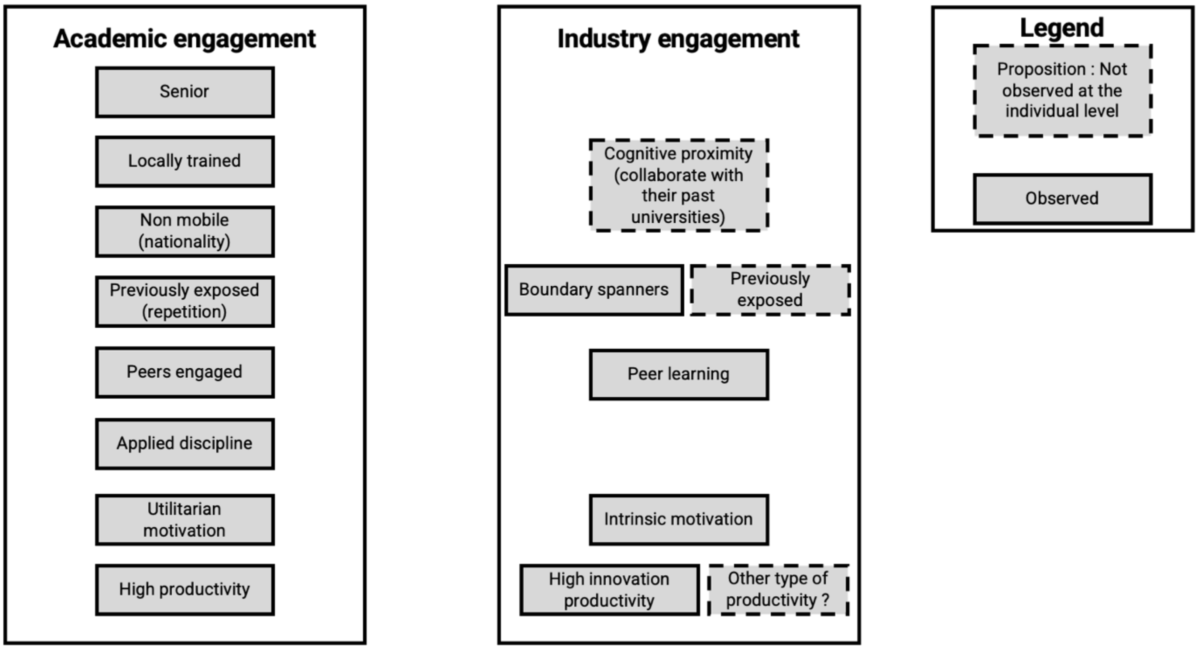


Figure 1 Industry Engagement as a Mirror of Academic Engagement

2.2 Industrial PhD for industry engagement

Industrial PhD candidates act as boundary spanners, bridging the gap between academia and industry (Mangematin, 2000; Thune, 2009), translating scientific knowledge into industry-appropriate language (Kihlander et al., 2011). They offer a valuable lens for studying science–industry collaboration. Notably, collaborative management approaches involving shared decision-making between firms and universities enhance the likelihood of industrial PhD project success (Salimi et al., 2016).

Industrial PhD program are 3 to 4 years project, they involve at least one university and one industrial company, with at least one supervisor on both sides (Borrel-Damian et al., 2015; Plantec et al., 2023; Salimi et al., 2016). These programs offer valuable insights into the micro-foundations of University-Industry Collaboration (UIC), they provides a unique framework for understanding the dynamics of such partnerships (Harman, 2004; Locatelli et al., 2021). For companies, investing in industrial PhD presents a strategic avenue for gaining targeted skills, accessing new knowledge, and enhancing innovation capabilities (Thune & Børing, 2015). This model has been replicated across various countries, including the CASE program in the UK, the Danish Industrial PhD Programmes, Marie Curie Actions (Borrell-Damian et al., 2010), and similar initiatives in Sweden (Abu Sa'a & Yström, 2024), Australia through cooperative research centers (Harman, 2004) or Norway (Thune et al., 2012).

The flexibility of the collaboration means that the PhD project can be oriented in favor of one or both parties (university or company) (Cabanes et al., 2024; Plantec et al., 2023). Projects are more often oriented towards fundamental research (Cabanes et al., 2024), which suggests that industrial PhD projects have exploratory value for companies (Buenstorf & Heinisch, 2020). Although these industrial PhD involve an industrial partner, it does not seem to affect the ability to produce good publications (Gaughan & Robin, 2004; Plantec et al., 2023). Beyond publication and patent performance, industrial phd seems to play a fairly indirect or remote role in the innovation process. G. Locatelli (2021) observes that they rarely lead to products and patents, and that they seem much more likely to enhance the company's social impact, the professional development of industrial supervisors, employee skills, enable meetings with other industrial players, provide access to infrastructures or legitimize work/expertise vis-à-vis third parties. L. Gustavsson (2016) on the other hand, has observed the development of skills, the search for new market opportunities, the creation of networks, the quest for legitimacy or the strengthening of existing collaborations with academic partners. However, the factors driving industrial partners to prioritize one type of performance factor over another remain unclear. Interviews with PhD students also reveal insights into the role of middle management in disseminating knowledge, underscoring the importance of an open-minded attitude to PhD knowledge and the development of strong relationships with stakeholders (Abu Sa'a & Yström, 2024), raising then question about the role of the industrial supervisor in these projects. As written before G. Locatelli (2021) started to use the lens of the supervisor and the observed the multiplicity of goals behind the use of PhD but only at a qualitative level without drawing up a portrait of industry engagement and linking it to this multiplicity of performance factors.

2.3 Performance factors of industry engagement

University-industry collaborations (UICs) generate value beyond innovation-related outcomes. S. Al-Tabbaa et al (2015) identify 22 distinct benefits for industry, spanning institutional performance, financial gains, and social impacts. UICs can contribute to new production tools (Rosenberg, 1991), problem-solving and organizational understanding (Bishop et al., 2011), access to diverse resources (Fernández-Esquinas et al., 2016), recruitment opportunities (Mangematin, 2000) or even addressing societal challenges (Bozeman et al., 2015). These outcomes highlight UICs' multifaceted nature, demonstrating their potential to achieve broader organizational and societal goals beyond knowledge production and innovation.

Studies focusing on innovation as a performance metric highlight the role of absorptive capacity—the ability to identify, assimilate, and exploit external knowledge (Cohen &

Levinthal, 1990). Absorptive capacity enables organizations to effectively engage in knowledge transfer (KT), defined as "the process by which knowledge concerning the making or doing of useful things contained within one organized setting is brought into use within another organization context" (Bloedon & Stokes, 1994, p.44). These processes are facilitated by factors such as trust, communication, intermediaries, and prior experience (De Wit-de Vries et al., 2019), as well as geographic proximity to high-quality universities (Bishop et al., 2011), co-publication with academic stars (Zucker et al., 2002) or participation in conferences with leading scientists (Baruffaldi & Poege, 2024).

To fully capture and apply academic knowledge, researchers distinguish between use value—direct application in collaboration—and exchange value, which requires strong negotiation capabilities to extract future benefits from accumulated capital (Chesbrough et al., 2018). Zahra and George (2002) further differentiate between potential absorptive capacity (PACAP)—the ability to acquire and assimilate diverse knowledge—and realized absorptive capacity (RACAP), which refers to the transformation and application of that knowledge. While PACAP depends on exposure and organizational memory, RACAP relies on routines and social integration to generate innovation. University–industry interactions can foster both types of absorptive capacity.

Different organizational forms can support the absorption of academic knowledge. Studies on boundary spanners point to the existence of **dedicated research departments** within industrial firms—spaces primarily focused on exploration under an exploitative logic, yet structurally hybrid as they host a minority community of researchers (Perkmann et al., 2019). Given that 50% of European PhD graduates enter non-academic careers (Borrell-Damian et al., 2010), it is reasonable to assume that many join such departments, continuing research-oriented activities. However, this is not the sole organizational form linking industry to academic knowledge. Cohendet et al. (2003) describe **epistemic communities** as "a group of agents sharing a common goal of knowledge creation and a common framework allowing the shared understanding of this trend. The goal of epistemic communities is thus simultaneously outside and above the community members" (cohendet et al.,2003 , p. 283). Unlike communities of practice or functional groups, they are driven by a cognitive quest and often rely on codebooks to codify their knowledge. Similar to expert networks, these communities may serve as hosts for research activities even when the firm's overall research intensity is low.

2.4 Industrial PhD supervisor, proxy for industry engagement toward its performance

Compared to academic engagement, industry engagement remains less structured. Yet, industrial actors often draw on academic ecosystems to strengthen their innovation capabilities (Arora et al., 2023; Durand et al., 2008; Gambardella, 1995; Stephan, 1996; Zucker et al., 2002). While innovation has long been seen as a central outcome of such collaborations, recent work highlights that industry engagement with academia can also generate a broader range of performance outcomes (Ankrah & AL-Tabbaa, 2015). This underscores the need for a more comprehensive understanding of how industry engagement is structured and mobilized. To explore its microfoundations (Felin et al., 2012), industrial supervisors of industrial PhD offer a valuable analytical entry point. They embody multiple performance logics (Locatelli et al., 2021), act as boundary spanners (Borrell-Damian et al., 2010), and contribute to the internal diffusion of academic knowledge within organizations (Abu Sa'a & Yström, 2024).

3 METHODOLOGY

To investigate how industrial supervisors' strategies for engaging with the industrial PhD program are shaped by their backgrounds and the value they seek from these programs, we employ a mixed-methods research design (Creswell & Clark, 2017) leveraging data on industrial PhDs in France.

Desccriptive statistics provided the foundation for framing 23 semi-structured interviews, which offered deeper insights into the phenomenon observed at scale. This approach allowed us to enrich our understanding of the mechanisms driving supervisory decisions within the CIFRE framework.

Among mixed-methods approaches, we adopted an explanatory sequential design, characterized by the collection and analysis of quantitative data in the first phase, followed by the collection and analysis of qualitative data to explain or expand on the quantitative findings (Creswell & Clark, 2017). This design allowed us to leverage the quantitative results as a foundation for complementary qualitative inquiry.

In our study, the quantitative sample itself was particularly insightful due to the uniqueness of nationally aggregated data on industrial thesis supervisors and the significant proportion of supervisors without doctoral degrees, indicated subtle practices that warranted further exploration. These findings guided the qualitative phase, where interviews provided a deeper understanding of the underlying logics and enriched our investigation of the research question.

3.1 CONTEXT: POPULATION, DATA AND SAMPLE

Industrial PhD programs in France are primarily structured under the CIFRE (*Industrial Research Training Agreements*) scheme, managed by the National Association for Research and Technology (Association Nationale de la Recherche et de la Technologie, ANRT), which operates under the mandate of the French Ministry of Higher Education, Research, and Innovation. The CIFRE program is a tripartite arrangement involving a university or research laboratory, a company, and a PhD candidate. The core framework consists of four key components: (1) A research collaboration agreement is established between the company and the laboratory to define their partnership, often extending beyond the scope of the specific PhD project. (2) The company recruits a new employee, assigning them a research-focused mission. (3) The laboratory supervises the research activities and enrolls the employee-PhD candidate in a doctoral school. (4) ANRT contracts with the company, providing an annual grant of €14,000 to support the initiative (ANRT, 2024).

3.1.1 Clustering and Dataset Construction

Thanks to a collaboration with ANRT we gain access to the data on the 24,365 CIFRE agreements that took place between 2000 and 2023. This dataset included extensive information, such as the PhD serial number, the launch year, the names of the 18,218 industrial supervisors, and the names of the companies involved.

To construct our sample, we focused on identifying supervisors for whom we could retrieve additional information on LinkedIn. Out of the initial dataset, we gathered data on the lLinkedIn profiles of the industrial supervisors. To ensure accuracy, we retained only those profiles that matched on key identifiers: full name, university attended, company affiliated with the CIFRE agreement, and consistent data across relevant variables. For example, dates related to the CIFRE agreement and career events had to fall within a plausible range (1900 < x < 2023), and binary variables had to exhibit valid values (0 or 1). This rigorous filtering process resulted in a final sample of **6,209 individuals** with complete and coherent profiles, suitable for analysis based on the collected variables.

3.1.2 Variables

We provide descriptive statistics visible in Table 1: Variables and descriptives statistics. These data were selected according to what was available in the ANRT data and what could be interesting regarding academic engagement and industry engagement findings documented in Table 1: Variables and descriptives statistics

Table 1: Variables and descriptives statistics

Variables	Description	Mean	SD	Min	Max	Frequency	%
Number of cifres supervised	How many times the name and surname of the supervisor appears in the data	1.498	1.262	1	39		
Average number of employers cifres	average number of cifres based on all the supervisor's employers' number of cifres	147.928	280.851	1	928		
Average number of employers PhD industrial supervisor	average number of PhD supervisors of employers based on the total number of industrial PhD supervisors of all the supervisor's employers	95.250	175.930	1	610		
Number of employers over the career	Number of employers on LinkedIn profile, before the company providing the cifre	2.662	2.226	0	22		
Number of linkedin connections	Number of linkedin connections with a maximum of 500	396.633	145.635	0	500		
Professional seniority	2024 - year of first LinkedIn job	21.704	7.995	1	58		
Collaboration with several laboratories in at least one of the PhD projects	Binary variable: 1=yes					6 179	99.629%
PhD graduate	Binary variable: 1= the supervisor is a phd graduate					2 984	48.059%
University experience	Binary variable, 1= University experience or a postdoc, distinct from the PhD graduation, listed in the employers section of the linkedin profile					1 179	18.989%
International University experience	Binary variable, 1= International university experience or a postdoc, distinct from the PhD graduation, listed in the employer's section of the linkedin profile					366	5.895%
Collaboration with its training universities	Binary variable, 1= the supervisor supervises a cifre with at least one university of which he or she is a graduate (bachelor's, master's or doctoral level)					788	12.691%

N= 6209

3.2 QUALITATIVE PHASE

Based on the quantitative findings, we conducted 23 semi-structured interviews with a purposive sample of supervisors, selected to represent key patterns and outliers identified in the descriptives statistics.

In the quantitative phase, we observe that some supervisors that were PhDs graduated seem to have different practices for using CIFRES than other supervisors (they specialize more in supervision, following several CIFRES). We therefore felt it appropriate to interview 4 groups of industrial supervisors: (1) those with a PhD who have supervised several CIFRES in their career, (2) those with a Phd who have supervised only one CIFRE and conversely (3) those without a PhD who have supervised several CIFRES and (4) those without a PhD who have supervised only one CIFRE. Table 2: Description of the interviewees details this reasoned sample, giving the position, field of activity, employer, PhD graduation status and number of CIFREs supervised for each person interviewed according to ANRT data. For some of them we detailed how many industrial PhD they truly supervised since sometimes they are not the principal supervisor, some other time the PhD candidate doesn't finish. Several interviewees were not asked about themselves or only about themselves, but about their department or organization: R1, R5, R6, R10, R17, R19, this is why Table n displays a few "?".

All of the interviewees were contacted by email or linkedin and met by visio, using teams. The average interview time was 52 min, and the questions asked concerned the supervisor's career and training, any research practices in his or her profession, the genesis of the first CIFRE supervised, the motivations behind it and the possible repetition of the supervision, the organizational tools used in the service or as part of this CIFRE experience, the choice of laboratory, the direct and indirect outcomes, what remains or may have remained.

Table 2: Description of the interviewees

N°	Work	Discipline	Enterprise	PhD Degree	N°of Cifres supervised according to ANRT	N° of Cifres actually supervised	Type of supervisor
R1	Scientific and clinical partnerships manager	IRM	Siemens Healthineers	1	39	~3	Epistemic community
R2	R&D expert on power system and market integration	Economy, management	RTE	0	3	~4	R&D
R3	R&D Engineer, environment, prospects and society division – Coordination of the PhD work of her division	Economy, management	RTE	0	3	~4	R&D
R4	Eco-mobility technical expert, previously Prospective Project Manager at RATP, R4 completed his thesis during his career at SNCF.	Economy, management	SNCF Reseau	0 then 1	2	~9	R&D & Epistemic community
R5	Scientific director of SafranTech: Safran Group Research & Technology Center	Scientific direction	Safran	1	0	?	R&D

R6	Head Technology Exploration & Ecosystems	Technology Design Platforms	ST Microelectronics (STM)	1	0	?	R&D
R7	R&D Engineer on technology Exploration	2.5D/3D Integration, Radiation Hardening for Space, Energy Harvesting	ST Microelectronics (STM)	1	5	~6	R&D
R8	R&T Engineer, awarded by the Irène Joliot Curie prize for a woman's career in R&T	Materials and processes in aeronautics	Safran	1	0	~10	R&D
R9	Head of Research, Innovation and Digital Continuity Section for SNCF Réseau.	Coordinating, designing and supporting innovation efforts	SNCF Reseau	0	0	0	Epistemic community
R10	Innovative Design Leader	Coordinating, designing and supporting innovation efforts.	SNCF	1	1	?	Epistemic community
R11	Clinical Scientist, in charge of collaboration for advanced application in Magnetic Resonance Imaging	IRM, Neurological and MR-PET Applications	Siemens Healthineers	1	0	2	Epistemic community
R12	VP of the SMART Factory: Leads of the digital transformation of SAFRAN Landing Systems	Digital transformation (MEDS/MES, MCS , Industrial Data , Digital inspection , IoT , VR & AR, Energy monitoring)	Safran	0	0	~2	Individual
R13	Product Owner, previously, initiate a research effort in a specific business direction	Eco-design	Siemens	0	1	1	Individual
R14	Engineer on manufacturing Data & Analytics Program	Semantic Modelling & advanced analytics across the manufacturing chain	ST Microelectronics (STM)	0	8	8	Epistemic community
R15	Director of the "New rural uses and services" program	Design & Psychology about UX Mobility	SNCF	0	1	1	Individual
R16	Platinum production manager, previously R&D platform manager	Functional Coatings & Thin Films for Industrial Process Optimization	Saint Gobain	1	1	1	R&D, then Individual
R17	Business Unit Director	logistics and local transport	La Poste	1	1	1	Individual
R18	Aerodynamic expert & Deep learning research engineer	Rapid Aerodynamic Modelling	Airbus	1	1	~2	R&D and Epistemic community
R19	Research & Technology Strategic Partnership management France	Direction, design and coordination of R&T	Airbus	0	1	?	Epistemic community
R20	R&D engineer	Materials Engineering	Saint Gobain	1	2	~3	R&D
R21	Director of Strategic Studies, formerly in charge of the Foresight Department	Sociology, economy and management on innovation, intrapreneurship, or purpose-driven company	La Poste	1	2	2	Epistemic community
R22	Head of R&D, prevalthough R&D engineer	Operation research, design and coordination of R&D	La Poste	1	0	?	R&D and epistemic community
R23	Pipeline Integrity Manager, previously R&D engineer	Buried pipelines	Air Liquide	1	1	1	R&D, then individual

3.2.1 Qualitative data analysis

The interviews were transcribed and coded using MaxQDA software. Following the recommendations of M. Miles and M. Huberman (2003), the interviews were systematically synthesized before being transcribed, with first-, second- and third-order categories emerging before links between them were identified, and these links were then checked against the reactions of other researchers. Once the categories and links had stabilized, we moved on from inductive coding to more axial coding, with subsequent interviews filling in the previously identified categories.

3.3 External Validity

To ensure the validity of the analyses, this study was conducted within the framework of collaborative research in partnership with the ANRT. Our work was guided by five steering committees held with the ANRT, complemented by regular discussions among researchers to refine our approach. These committees included the board and managers from the ANRT to ensure methodological triangulation and align the study with its objectives. They enabled us to develop the regression model, identify interviews to be added, and rework the qualitative conceptual model

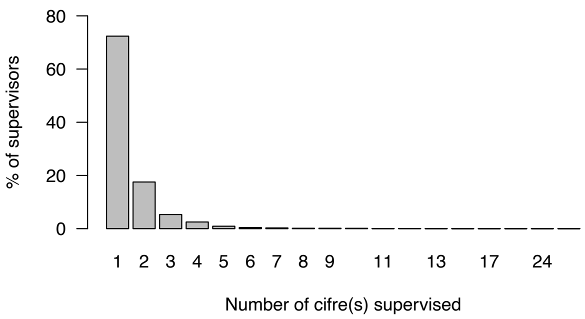
4 RESULTS

The quantitative analysis explores the profile of the industrial supervisors and serve as a guide to select the supervisors interviewed. Additional insights provided through these follow-up interviews deepen the understanding of the findings.

4.1 DESCRIPTIVE STATISTICS

Table 1: Variables and descriptives statistics present the descriptive statistics of the sample. On the 6209 Industrial supervisor, most of them only supervised one PhD. Only 27% of them will repeat the experiment and engage themselves in more than one PhD supervision, Figure 2: Distribution of supervisors by number of cifres supervised showing this result.

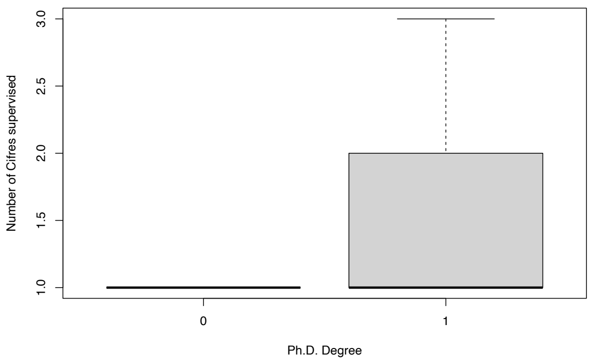
Figure 2: Distribution of supervisors by number of cifres supervised



We observe how many supervisors repeated the experience and test the relationship between the background of the supervisor and the number of PhD they supervised, and then we looked if collaborating with the past university could explain the number of PhD supervised.

Only 27% of the supervisor repeat the experience. Most of them supervising only one PhD in their all career. We however observe a significant effect of being a doctor on the number of PhD supervised (coefficient = 0.340, $p<0.01$). Suggesting that PhDs are part of a different management strategy to non-doctors. Only 48% of the industrial supervisor display a phd degree on their linkedin profile. Figure 3: Number of cifres supervised by PhD degree holders illustrates this phenomenon.

Figure 3: Number of cifres supervised by PhD degree holders



4.2 EXPLORING SUPERVISORS PROFILES : A QUALITATIVE PERSPECTIVE

We explore the underlying realities behind these distinctions between PhD holders and non-PhD holders among the supervisors by conducted interviews to know more about the profile of the supervisors, the factor of performance they want to achieve and the strategies they put in place according to them.

4.2.1 Different Cifres strategies

The interviews design 3 situations: (1) those who are individually behind the Cifre initiative, and those for whom Cifres are a normal part of the landscape, because they are (2) in an R&D department or (3) in professional communities that discuss the existence of these programs and act as epistemic communities. The profile and strategies seems to be influenced by these organizational positions.

In the first case, the individual is the only one to carry out the cifre project within his organization, in the other two cases a collective interacts with the individual strategy. Figure 5 Supervisory strategies according to his/her profile and facotrs of performance sought in the industrial PhD project - illustrates these three situations and shows how the strategies implemented by supervisors in these 3 cases differ according to whether or not they are PhDs.

These strategies are divided between those who repeat and those who do not. Expertise is synonymous with repetition, to some extent in practical communities, but above all in R&D, where the value of the cifre is perfectly aligned with the supervisor's day-to-day professional objectives, whereas when it's a question of a momentary, more individual problem, the cifre has difficulty in sustaining itself, and its effort often disappears with the supervisor's departure and/or change of job.

The results below show (1) the diversity of values sought by industrial supervisors through Cifres, (2) the strategies implemented to capture this value, depending on their training and past exposure to the academic ecosystem.

4.2.2 Heterogeneous factors of performance with uneven benefits across scales

The interviews reveal a wide variety of values captured by Cifres, which can be divided into the 3 categories described above: individuals, R&D departments and communities of practice.

Individual initiatives often focus on problem-solving or internal recognition needs. For instance, R13 at Siemens identified a critical skills gap related to the operation of internally used instruments, which hindered the company's operational capacity. After learning about industrial PhD programs, he launched a Cifre project specifically to address this issue. Similarly, R15 at SNCF, who does not hold a PhD, spent time in an innovation department alongside PhD colleagues. Highly intrinsically motivated, he sought scientific validation to strengthen his works. Supervising a PhD became a strategic tool, as it is widely recognized within the innovation division as a marker of legitimacy.

R&D departments are more likely to engage in exploratory projects, using industrial PhD programs to dedicate full-time equivalents (FTEs) to topics of interest that cannot be addressed internally but hold potential value. For example, R8 at SafranTech emphasized the fresh perspective PhD candidates bring: "*They add phenomenal value to the company because they come from outside and are not yet shaped by our way of thinking*"(R8, R&T engineer at SafranTech). Similarly, F7 at STM explained, "*Very quickly, we realize there are topics that need to be explored, but we lack the capacity to address them. It might not be feasible to assign someone else in the team because the topic isn't particularly popular*." (R7, R&D engineer at STM). In some cases, these projects focus on designing standards. For instance, one participant described their involvement with Île-de-France Mobilités: '*The advantage is that you build a reputation for providing insights others lack, which enhances the company's profile. I often worked with other organizations to share SNCF's cases and practices. People think of SNCF as trains running late and gravel. We show them there's so much more*.' (R4, Expert SNCF)

In the context of **epistemic communities** problem-solving needs also often emerge, but unlike individual cases, they are discussed and approved by a number of departments and experts in order to draw up the research programs in which the theses will be included. For example, as R5 at SafranTech described: '*On this particular issue, we're missing an answer. Which lab could help us with this? Let's approach them. Would you be interested in supervising a PhD on this topic?*' This highlights how communities facilitate collaboration by identifying expertise and aligning research efforts with organizational needs. Additionally, there is a focus on ensuring the continuity and integration of research beyond the completion of the PhD. As R9, at SNCF said, '*It's important to share the topics being addressed and ensure that once the PhD* *is completed, it's not just 'goodbye' or 'forget everything we did for three years*.' *Instead, the work should continue to be integrated into ongoing projects and practices. It should also have an impact beyond the specific department involved, particularly as more of our topics are system-based, making it worthwhile to share them across the organization*.' This emphasizes the long-term value and the expansion of knowledge beyond individual projects, contributing to broader organizational learning.

4.2.3 Cifres strategies according to past experiences

What's interesting is that, if we take the 3 initial situations (1) the single individual in a business department who initiates a cifre on his own; (2) the individual in R&D who uses a cifre as part of a routine ; (3) the individual in a epistemic community; the strategies put in place by the supervisor will differ fundamentally according to whether or not he or she is a doctor, and more particularly according to the degree of past exposure to the academic ecosystem.

These different strategies are outlined below for these three groups and can also be seen in the Figure 5 Supervisory strategies according to his/her profile and facotrs of performance sought in the industrial PhD project.

Individual with unique project in business direction

Supervisors with significant exposure to the academic ecosystem continue to engage in mixed practice communities, such as public interest grouping (GIP), even after leaving formal research activities. This involvement allows them to maintain academic-like serendipity long after their Cifres projects. For instance, R21, at La Poste, who left a department of prospective studies, still engages in academic readings, similar to R16, at Saint-Gobain, who maintains a strong focus on methodology development.

Supervisors with minimal exposure to the academic world—those without a PhD or formal research experience—tend to be integrated into PhD supervision either through their professional interests or intrinsic curiosity. For example, R15 at SNCF who became interested in research through previous roles that involved think tanks and collaborations with researchers, transitioned into innovation-focused roles, eventually leading to the initiation of a Cifre. The flexibility of such positions allows him to pursue and drive the Cifres projects.

R&D department

Highly exposed individuals aim to simplify and routinize the process (accelerating by simplifying, avoiding tripartite contracts, using interns, dedicated budgets…). Their role often supports research and prepares for the future (e.g., employer branding). "*[The scientific director] played a major role, it was part of his mission. He worked hard to make the PhD*

process less of a battle. Having colleagues who had gone through this helped. For example, when creating a research topic, I could refer to how they structured their topics. It immediately gave me an example. It was much easier than if I had started from scratch, I might have done it wrong." (R7 R&D engineer at STM)
Those with less exposure, even if they are in R&D for intrinsic reasons, benefit from peer learning. Some even pursue PhDs and adopt the same practices of the supervisors that are PhD graduated : "When I joined RATP in 89, I wasn't directly involved with the PhD itself, but that's when I discovered these rather unusual programs." (R4, SNCF expert) and "*There's a secretary who participates in the administrative part, and they've created some educational materials to provide the elements needed to prepare the file, etc. And often, or in a decentralized way, we send each other old PhD projects for inspiration, to look at the format, etc.*" (R3, R&D engineer at RTE).

Epistemic communities

The highly exposed individuals engage in research programs co-defined with business departments, which may condition the CIFRE projects. Positioning multiple people on the same project allows for co-supervision (emphasizing the project more than the individual who initiates it). Internal validation committees and conference strategies are often used. '*To avoid this issue, we have a committee structure to validate that the PhD candidate is coming, and that the topic aligns with the department's roadmap. This goes beyond the project itself. Sure, the project may stop, but there could be many reasons for that—HR issues, budget matters, results not meeting expectations. So, the goal was to determine if it was feasible or not. If not, we shift direction, but the initial problem remains important for the department and will be addressed from a different angle later. This ensures that the PhD's role is firmly established within the department for the long term*." (R9, SNCF innovation coordinator)
The least exposed are more likely to be involved in identifying and describing the problem and have generally become experts in the field. This is what we see at the post office, they restricts the number of PhDs in these communities to three maximum and ensures there are people from business departments to guide the research towards relevant topics. Those without a PhD often find themselves supervising PhD candidates, as was the case with R22 PhD.
According to their degree of exposure, industrial supervisors embark on distinct strategies to frame cifres and capture its value. The value of the latter will a priori be relative to their anchorage in the organization: theses in R&D serving rather the exploration and retention of skills, those in communities of practice the resolution of collective problems and the need for

legitimacy of the company and the others being at the service of more diverse motivations such as professional recognition or single problem solving.

5 DISCUSSION

This study investigates the micro-foundations of industry engagement. Specifically, we examine the profile and strategies employed by industrial PhD supervisors in the context of CIFRE PhD. The aim is to understand who these supervisors are and how they reach performance factors from the academic ecosystem based on their prior exposure to it.

5.1 Contributions

This research contributes to the literatures on industrial engagement and absorptive capacity. First, it introduces a conceptual framework that mirrors the well-established notion of academic engagement(Perkmann et al., 2021) by proposing its counterpart: industry engagement. We highlight the heterogeneity of individual profiles involved, as well as the diversity of their organizational anchoring—ranging from R&D departments and epistemic communities to individuals operating in units disconnected from formal research activities. Second, we extend the absorptive capacity framework by showing that industrial actors engaged with academia pursue performance factors beyond innovation alone. Our findings document how these actors leverage collectives—built individually or within their firms—to sustain engagement, particularly through the experience of PhD supervision. Figure 4 Performance Factors Sought in Industrial PhDs - illustrates how performance factors vary depending on the supervisor's position within the company, while Figure 5 Supervisory strategies according to his/her profile and facotrs of performance sought in the industrial PhD project - outlines the different pathways used to generate these factors.

5.1.1 A frame for industry engagement

In our effort to conceptualize a counterpart to academic engagement, we identified both similarities and differences in the nature of industry engagement.

Peer effects—well-documented in the academic engagement literature (Tartari et al., 2014)—also emerge in industrial contexts, particularly within R&D departments. There, non-PhD employees may become de facto supervisors, either by inheriting doctoral candidates from colleagues or by benefiting from supervision routines previously established by PhD-holding peers.

In contrast to academic engagement, which is often explained by prior academic experience (Tartari & Breschi, 2012), industry engagement appears to follow a different logic. Although supervisors with substantial exposure to academia—typically PhD holders—are more likely to recurrently supervise industrial PhDs, particularly when embedded in R&D departments where such collaborations directly support their research agendas, prior academic experience alone does not account for sustained engagement. All interviewed supervisors had some form of exposure to the academic ecosystem, but when these connections are weak and not supported by collective routines, the relationships with academic partners are unlikely to persist or be transferred to peers. Rather than relying on traditional academic credentials (e.g., publications or prior academic positions), these ties are often built through more heterogeneous forms of exposure. While weak ties can play a role, long-standing collaborations (Bengtsson et al., 2015) appear particularly effective for achieving performance outcomes typically sought in R&D settings.

Academics engaged in collaborations are motivated by opportunities that complement their research, providing access to resources or learning opportunities (D'Este & Perkmann, 2011; Lee, 2000; Perkmann et al., 2021). While it is well-established that industry engagement can enhance innovation within companies (Arora et al., 2023; Durand et al., 2008; Gambardella, 1995; Stephan, 1996; Zucker et al., 2002), we extend this understanding by demonstrating that industry engagement can also contribute to the achievement of additional performance factors, as illustrated in Figure 4 Performance Factors Sought in Industrial PhDs.

Research on industry engagement often highlights the boundary-spanning role of engaged industrial actors (Baba et al., 2010; Ryan et al., 2018; Williams & Allard, 2018), a characteristic clearly evident in R&D departments, where supervisors replicate the laboratory format by specializing in the supervision of CIFRE PhDs. However, other profiles exist that do not exhibit the boundary-spanning traits, and these individuals are able to leverage CIFRE for alternative performance factors, as listed in Figure 4 Performance Factors Sought in Industrial PhDs. As a result, they do not require the same cognitive proximity as their counterparts in R&D, who are focused on exploration and innovation. These findings complement those of Afcha et al. (2023), which suggested that S-I collaborations survive the departure of doctoral graduates from companies but that non-doctoral employees struggle to initiate new collaborations. Companies often establish collectives that enable non-doctoral supervisors, particularly those outside R&D, to engage with academic ecosystem actors and mobilize them when they later initiate the supervision of industrial PhDs.

5.1.2 Industrial engagement and absorptive capacity strategies

The field of industrial PhD has enabled us to grasp the **diversity of UIC outcomes** (Ankrah & AL-Tabbaa, 2015; Locatelli et al., 2021) and suggests explanations for this diversity of values and the ways in which these values are captured.

The results suggest a strong **entry cost** for using the Cifre industrial PhD system. Supervisors needs to have been exposed (more or less strongly), or to have peers who teach you, or a lab that supports the project if they're lucky enough to come across researchers in their professional network. R**&D departments** invest in peer learning mechanisms(Chan et al., 2014). Enabling members with little connection to the academic ecosystem to familiarize themselves with the system and get to grips with it. Routines are also put in place to facilitate organizational learning (Argote et al., 2021) within management and communities of practice. Defined as a repetitive pattern of interdependent tasks performed by several members of an organization (Feldman & Pentland, 2003) they enable the dissemination of supervision practices beyond a one-off project and a single individual, and maximize the potential use of the results of the PhD. We have also observed exploratory uses of PhD theses within R&D departments, which aligns with the findings of F. Rossi et al. (2022), T. Thune and Børing (2015), and B. Cabanes et al. (2024), who similarly noted the exploratory use of industrial PhDs or UICs.

This exploratory practice of the CIFRE becomes a means of renewing epistemic communities (Cohendet & Llerena, 2003) in which some researchers in R&D departments are involved. In these communities, we also find other supervisors who are not in R&D. In these settings, supervisors act as boundary spanners, but not with academic labs. They bridge the gap between the research department and the company, identifying business needs and helping to define enduring research problems in the form of use-inspired basic research (Stokes, 1997). They may also use these communities for problem-solving on more applied research topics.

We observe that scientific expertise is not concentrated in specific departments, there are individuals capable of bridging the gap even though they have not specialized in a hybrid career. These profiles have not yet been described in the literature and are instead associated with performance factors distinct from innovation.

Figure 5 Supervisory strategies according to his/her profile and facotrs of performance sought in the industrial PhD project - summarizes the levers that allow supervisors to harness the performance factors of the industrial PhD, that are outlined in Figure 4 Performance Factors Sought in Industrial PhDs.

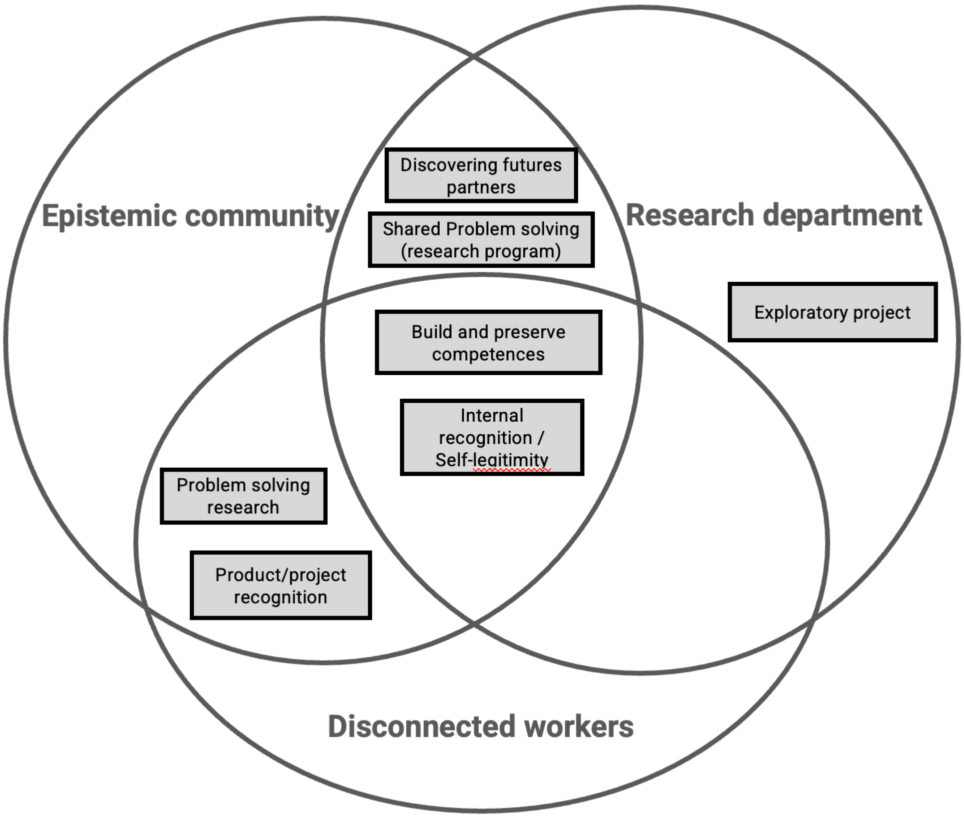


Figure 4 Performance Factors Sought in Industrial PhDs

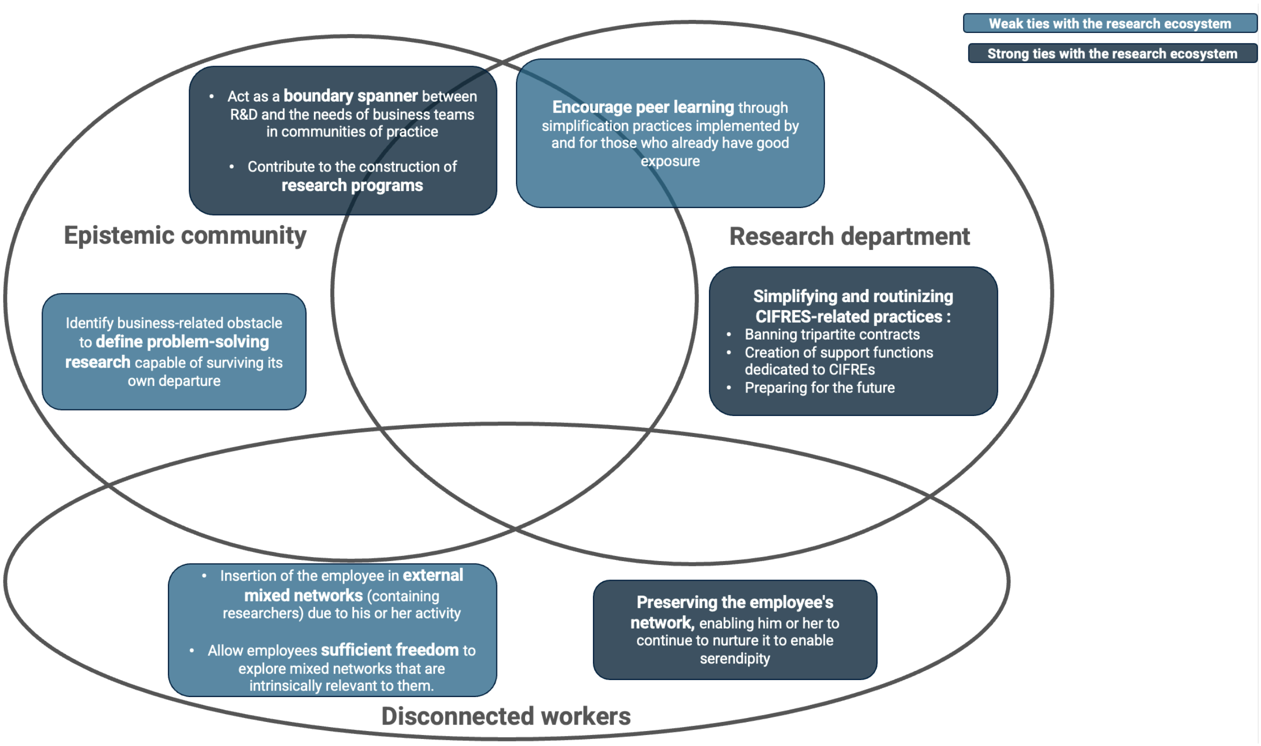


Figure 5 Supervisory strategies according to his/her profile and facotrs of performance sought in the industrial PhD project

5.2 MANAGERIAL IMPLICATIONS

This study offers several managerial insights, particularly for companies engaged in industrial PhD projects, such as CIFRE PhD programs. First, it underscores the importance of recognizing the distinct strategies employed by supervisors based on their past exposure to the academic ecosystem. Managers can better leverage the unique capabilities of industrial PhDs by understanding how their previous experiences influence their approach to research and innovation.

Furthermore, this research highlights the value of fostering epistemic communities within organizations. For firms looking to integrate academic research into their business operations, it is essential to create environments where knowledge-sharing can thrive, particularly in R&D departments. Encouraging cross-disciplinary collaborations and ensuring that the PhD research aligns with both the company's strategic objectives and the academic framework can enhance the value generated by these projects.

Finally, this study suggests that companies should consider not only the technical skills but also the exposure of their salaries to academic ecosystem. They can enhance the diversity of serendipity related to the academic ecosystem by exposing more employee to it (through professional community, conferences or by hiring more PhD people in several department of the company).

5.3 LIMITATION AND FUTURE RESEARCH

While this study addresses endogeneity concerns to some extent, there are still some limitations that should be acknowledged. The focus on France and large French companies implies that these results should be compared with studies conducted in other countries. Since France is the only country with aggregated national data on industrial PhDs, such studies would likely be qualitative in nature. It could be interesting to explore panels of large Swedish, Australian, or Norwegian companies, which have a significant number of industrial PhDs (Abu Sa'a & Yström, 2024; Gustavsson et al., 2016; Harman, 2004; Thune et al., 2012).

Future research could extend this work by investigating the dynamics in small and medium-sized enterprises (SMEs) and mid-cap companies. These organizations often make very instrumental use of UICs (Cao et al., 2024) and capitalize less on the collective to systematize their relationship with the academic ecosystem, R&D departments and communities of practice are less common. It would be interesting to investigate the construction of a lasting relationship with the academic ecosystem in some PME. Understanding these dynamics would deepen our comprehension of the strategies and impacts of industrial-academic collaborations in diverse organizational settings.

6 CONCLUSION

This article adopts a micro-foundational perspective to analyze the profile and experiences of industrial supervisor of industrial PhD projects. The study highlights that the past exposure of supervisors plays a crucial role in shaping the factor of performance sought in overseeing the projects, and in determining the strategies implemented as a result.

Our findings reveal that doctoral graduates are more likely to specialize in several PhD supervisor-related roles, becoming scientific experts within the organizations they join. However, the responsibility of supervision is not exclusive to PhDs; non-PhDs can also engage with academics. These individuals often pursue PhD supervision experiences that align more with their personal career goals, legitimizing unique projects or addressing specific challenges.

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