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EXPLORING TAXONOMIES AND GOVERNANCE CHALLENGES OF SPONSORED R&D CONSORTIA: EVIDENCE FROM THE EU FRAMEWORK PROGRAM

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Exploring Taxonomies and Governance Challenges of Sponsored R&D Consortia: Evidence from the EU Framework Program

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ABSTRACT

This paper aims to explore the taxonomies of EU-funded R&D consortia. Detailed taxonomies are needed to fully understand sponsored consortia features in order to better address their governance challenges. This study attempts to fill the gap in the literature by highlighting the implications of public sponsorship and involving a large set of features related to several aspects of the consortium. Adopting an exploratory approach, we use the cluster analysis method for data analysis. Based on a sample of 207 observations of firms engaged in R&D consortia formed under the EU framework program (Horizon 2020 & Eureka), the results identify four groups of EU-sponsored R&D consortia. The findings show the influence of public sponsorship on the consortium taxonomy as well as the organizational pitfalls and solutions related to each consortium type. This research provides public policy-makers with key features of recent EU-funded R&D consortia and important elements to understand how they influence, through bureaucratic and institutional mechanisms, the consortium governance.

KEYWORDS: R&D Consortia, Public Sponsorship, Innovation, Cluster Analysis, Europe.

JEL CODE: O320

In the context of increasing economic interdependencies between firms, relational strategies based on collaboration and alliances have become as important as competitive strategies based on competition and rivalry. These alliances can involve several functions of the value chain such as procurement,

logistics, production, marketing, etc. With regard to research and development (R&D), knowledge mobility as well as the cognitive division of labor (Baulant, 2015) have accelerated the shift to the open innovation paradigm (Chesbrough, 2012) as a form of R&D process based on collaboration and sharing. Since then, the firm's internal R&D department can no longer be considered as the only supplier of innovation (Ayerbe *et al.*, 2020).

In this context, R&D collaborations take place through several forms, especially innovation networks and R&D alliances. Innovation networks (clusters, business ecosystems, etc.) bring together various organizations (Assens, Courie Lemeur, 2014), while R&D alliances (joint-ventures, technology transfer agreements, etc.) are intended to be rather narrow and inter-firm (Mitchell *et al.*, 2002). In this regard, the R&D consortium appears to be a typical cooperative form of R&D collaboration as it involves a hybrid level of analysis that overlaps with the network and (dyadic) alliance.

The consortium consists of a collaboration between a group of organizations to develop R&D projects. It involves a broad variety of organizations (companies, universities, public bodies, institutions, etc.) of both competitors and non-competitors. Then concerns arise about interest convergence, spillover effects, ownership issues, opportunistic behavior, etc. (Yang, 2020; Kherrazi, 2021; Mannak *et al.*, 2020). Universities, for example, are motivated by time-to-journal publication, while industry members seek to deliver products to their customers (time-to-market). Non-competitors raise concerns about spillovers, while competitors face appropriation and opportunism concerns. Thus R&D consortia face more divergent concerns than dyadic R&D alliances. In addition, the concerns of the different partners should be addressed simultaneously within the consortium while they are managed and decentralized at the level of each dyadic relationship within the network. Thus, governance of multi-partner consortia may be more challenging than (dyadic) alliances or networks. This leads us to consider R&D consortia as a specific form of R&D cooperation which justifies its choice as the research object of this study.

However, the literature on R&D consortia is still less abundant than that devoted to R&D networks and alliances. Previous studies examine R&D consortia as a context or an empirical base to grasp other issues related to open innovation, R&D cooperation, public-private partnerships, R&D project management, etc. (Rampa, Agogu , 2020; Parrado, Reynaers, 2020; Ettien *et al.*, 2020). Instead, this paper attempts to examine the consortium in itself; its taxonomies, and associated pitfalls and solutions. It advances research in this field by addressing two gaps. First, the paper deals with the case of sponsored R&D consortia and focuses especially on the consortia founded

from 2014 to 2020 within the recent European framework program (Horizon 2020 and Eureka). In this regard, this study highlights the influence of public sponsorship on the consortium taxonomy and governance and discusses its implications. Second, while existing classifications are still limited to a few general characteristics or specific aspects of the consortium (Teubner *et al.*, 2021; Biddle, 2018; Pinto *et al.*, 2011; Majewski, 2008), this research involves a large set of variables related to several aspects of the consortium such as motivations, strategy, control, performance, leadership, and risks, etc. Bringing these aspects together is needed to better understand the taxonomies of public-funded consortia and therefore to address related organizational issues.

The paper is organized as follows. The first part presents a theoretical background on sponsored R&D consortia. Then the second part presents our research method, while the third part focuses on the presentation and discussion of the research findings.

Sponsored R&D Consortia

Main Characteristics and Motivations

The literature displays a large list of definitions of the R&D consortium. This is explained by the diversity of forms that R&D consortia can take. A review of these definitions leads us to classify them into two categories. In the first, the consortium consists of a legal entity established by a group of autonomous organizations conducting joint R&D activities (Doz *et al.*, 2000; Pinto *et al.*, 2011). The legal entity formed is similar to a research joint-venture in which the partners bring and pool their resources jointly. In the second category, the consortium is defined as a contractual agreement concluded between a group of independent organizations to assemble and share decision-making for associated R&D activities (Mothe, Quélin, 2001; Sakakibara, Cho, 2002; Hsu, Lin, 2014). In this analysis, the consortia studied fall rather into the second category as they don't involve joint research facilities.

According to Okamuro and Nishimura (2018), R&D consortia are an effective means to promote innovation. They have become an instrument for public policies and research programs to support technology and innovation in many countries such as Research Associations in the UK, VLSI in Japan, SEMATECH in USA and ESPRIT in Europe, etc.¹ (Aldrich, Sasaki, 1995;

1. VLSI: Very Large-Scale Integrated circuit; ESPRIT: European Strategic Program for Research and Development in Information Technology; SEMATECH: SEMiconductor MANufacturing TECHnology.

Sigurdson, 1998; Hagedoorn *et al.*, 2000; Sakakibara, 2002). These programs involve public agencies, industrial firms, national labs, and universities to pursue basic and applied research within medium and long-term projects. As a result, two types of public R&D consortia have emerged according to Kim *et al.* (2014). On the one hand, the government-sponsored R&D consortia in which government agencies get involved indirectly through funding or subsidy programs. The governance of these consortia is ensured by public and/or private members, based on a common agreement between the partners. On the other hand, the government-coordinated R&D consortia in which the government gets involved more directly as a member and coordinator of the consortium. Thus, the government chooses the partners, sets goals, and decides on the research programs to conduct.

This paper deals with the case of (government) sponsored R&D consortia. They consist of an agreement between a group of organizations, at least three², to develop R&D projects funded totally or partially by national or community (EU) agencies. To do so, the level of analysis of sponsored R&D consortia seems to be hybrid as it overlaps with that of the network and the (dyadic) alliance. On the one hand, the collaboration within a consortium is stronger and more direct as the members are linked by a single contract like an alliance. In the network, the members are linked by a multitude of dyadic relationships and may not collaborate directly with each other. Furthermore, sponsored consortia are temporary collaborations linked to specific research projects with deadlines in line with the alliance frame, while networks are intended to be permanent forms of organizations. On the other hand, sponsored consortia are multilateral and involve, in the same way as networks, different and large types of organizations including public bodies, private firms, research agencies, universities, etc. They are therefore different from alliances insofar as they can include direct competitors (Aldrich, Sasaki, 1995) and do not involve research joint-ventures or facilities. In addition, and in line with the network frame, they are dynamic as members since they can leave or join the consortium at any time (Evan, Olk, 1990), which makes their boundaries and size variable.

The literature suggests many incentives that explain why firms need to engage in R&D collaborations. In this article, we focus mainly on three elements that can be considered first-order motivations for the case of sponsored R&D consortia. The first motivation is related to institutional pressures. On the one hand, governments or public agencies provide grants through public calls to carry out specific R&D projects. To submit their project proposals, firms are requested to join or form a consortium. Thus, the

2. Within the EU framework program (Horizon 2020 and Eureka).

formation of sponsored R&D consortia is guided by institutional rules and norms, unlike private-funded consortia that are guided by rational choices of partners. On the other hand, sponsored R&D consortia are established to coordinate and promote institutional changes, especially technical standards in the public domain (health, security, climate, etc). Therefore, governments act as catalysts or facilitators of the institutional work (Lawrence, Suddaby, 2006) of a group of organizations that cooperate to create, maintain, or destabilize public standards.

This brings us to the second motivation which is related to market failure. The private market may lack incentives to invest in certain R&D types (precompetitive or non-market-oriented) given their high costs, associated spillovers (Matt *et al.*, 2012), and the intellectual property (IP) issues they raise (Katz *et al.*, 1990). Relying on the economic perspective, spillovers impede the ability of partners to internalize the positive externality of their investments and even to protect their related IP rights. Thus, spillovers, as well as appropriation hazards, affect the willingness of firms to engage in R&D collaborations. In this sense, public sponsorship corrects market failures in R&D investment (Hagedoorn *et al.*, 2000). It allows mitigating these hazards by avoiding wasteful R&D efforts and making, through triggering entities³, the economic benefits of collaboration visible to all stakeholders.

Third, the strategic perspective suggests that sponsored R&D can be determined by the firm's R&D strategy (Kherrazi, Saïd, 2020; Matt *et al.*, 2012). According to these authors, the choice between financing R&D investments with public grants or private funds depends on the exploitation/exploration dilemma. This refers to the exploitation and exploration orientations that can be defined, respectively, as the aim to exploit existing resources/capabilities or explore and create new ones (March, 1991). For exploitation, the return on investment is more visible and less distant over time, while it is uncertain and more distant over time for exploration (Matt *et al.*, 2012). The organizational patterns and inertias make it difficult to release resources for exploratory-oriented activities. As an alternative to these patterns and inertias, firms are pushed toward sponsored R&D consortia to conduct precompetitive R&D projects, especially since the public grants are mainly intended for exploratory (full funding) than exploitation (partial funding) R&D projects.

3. Triggering entities in the case of sponsored R&D consortia are government agencies that, according to Ring *et al.* (2005), “perceive the need for collaboration” (p.151) and “play several critical roles in getting an alliance started; making the benefits of collaboration visible to potential partners, helping them along the formation process, securing their various contributions in timely and harmonious fashion, and reassuring them about their respective motives. In addition, triggering entities help the parties to resolve differences or conflicts” (p. 143).

The Influence of Public Sponsorship

Although the government is indirectly involved in sponsored R&D consortia, it involves several implications influencing the management of these consortia. In the first place, strategic management of sponsored R&D consortia seems to be difficult to achieve due to many constraining factors in terms of goal setting. Goals, time horizons, and even the object of the collaboration are not necessarily stated at the beginning of the project and may be subject to political dictates (Bozeman, Rogers, 2001), which makes linkage to goals difficult. In addition, the structure of the public funding within the frame of calls for projects implies that partners in sponsored R&D consortia do not necessarily select each other. This may involve other challenges in terms of congruence of strategic goals and time horizons as the public members have non-profit goals and have different time horizons than their private counterparts. In terms of R&D strategy, Matt *et al.* (2012) argued that EU-sponsored collaborations, compared to the private-funded ones, are more exploratory-oriented and concerned with more peripheral competencies of partners than their core competencies. This appears to be a direct consequence of public sponsorship that funds fully precompetitive research, especially in the public domain. Moreover, the not-for-profit nature of this research does not fit into the core competencies of private for-profit entities. With respect to performance management, sponsored R&D consortia seek public-domain knowledge and technologies. The proof of success is not necessarily tangible such as commercial products or processes. This makes it difficult to assess the 'real' performance in terms of return on investment or internal rate of return.

In the second place, public sponsorship influences the innovation process and the flow of R&D activities. The innovation process within sponsored R&D consortia does not seem to follow the traditional path⁴ of private R&D collaborations. The sequence of activities corresponds rather to what Salerno *et al.* (2015, p. 64) called the "*Process started by a call*". This setting implies two specificities. On the one hand, pre-development activities and pre-allocation of resources occur before the contract is concluded. To dispute the call (for projects), partners prepare a technical and detailed analysis. This leads participants to perform earlier activities (feasibility, proof of concept, etc.) and commit expenditures and resources prior to the formal agreement. On the other hand, sales and diffusion (of outcomes) precede development and production. While sales and diffusion occur after production in the traditional process, in sponsored R&D consortia, partners define *ex-ante*,

4. According to Salerno *et al.* (2015), "the innovation process has traditionally been understood as a pre-defined sequence of phases: idea generation, selection, development, and launch/diffusion/sales".

during the establishment of the agreement, the final owner(s) as well as the market exploitation rules. As a result, the main stages of R&D activities are then performed after the sale/diffusion stage. Anticipating sales is needed to reduce market uncertainties and to provide enough incentives to participants to engage in the consortium (*cf.* figure 1).

Figure 1 - Innovation process of the sponsored R&D consortium



Source: Salerno *et al.* (2015, p. 64)

In the third place, public sponsorship influences the organizational control of sponsored R&D consortia in many ways. It influences the choice as well as the design of the control mechanisms (Kherrazi, 2021). Some formal mechanisms, such as legal contracts, must be implemented before receiving the funds (Haustein *et al.*, 2014; Matt *et al.*, 2012). Informal mechanisms, such as norms and trust, are influenced by the institutional environment with embedded norms and shared values that lead partners to rely on these practices. Other (organizational) mechanisms cannot be implemented such as joint facilities or research joint-ventures in the case of the EU Framework Program. In terms of IP mechanisms, sponsored R&D consortia have to disclose information and comply with pre-defined rules of ownership during the different stages of the collaboration, especially background and foreground IP⁵. Another factor constraining the control mechanisms is that sponsored R&D consortia are subject to external controls by third parties, especially a public arbitrator to solve problems and conflicts (Matt *et al.*, 2012) or a public supervisor to monitor and assess the performance. Taken together, these factors generate specific behaviors (fewer conflicts) and mechanisms (bureaucratic) as well as additional visible and non-visible costs to comply with the framework and monitoring procedures of public sponsorship.

To gain a better understanding of the implications of public sponsorship as well as the governance challenges it arises, we suggest exploring more detailed groups and taxonomies among sponsored R&D consortia. The existing classifications summarized in table A.1 (*cf.* appendix) are typically limited to a few general features (Teubner *et al.*, 2021) and include both sponsored and

5. They refer respectively to knowledge and/or IP provided by the members at the beginning of the project (background) and those produced during the project (foreground).

private R&D consortia, if not primarily private ones. The following sections will then focus only on EU-funded R&D consortia (FP8).

Method

Sample and Data Collection

The target sample for our research is European R&D consortia funded within the EU framework program for research and innovation for the period 2014-2020 (FP8). The target population comprises 963 firms involved in these consortia. These consortia are registered under the CORDIS contact portal (Community Research and Development Information Service). They are formed by three partners, at least, from three EU Member States to develop a joint technological project sponsored by the European Commission (Horizon 2020 program) or their respective governments (Eureka program). As the consortium involves various categories of partners (institutions, universities, public bodies, research organizations, associations, firms, etc.), the questionnaire was addressed only to the private for-profit entities category to get perceptions from entities sharing the same frame in terms of business models (*versus* university or association), profit-seeking (*versus* knowledge sharing), rational (*versus* political) choices, private (*versus* public) resources, etc. This allows avoiding the potential bias that would result from gathering data from various categories involving different business models and behavioral patterns. The questionnaire was sent through the CORDIS platform to three members within each consortium at the most in order to obtain responses from different sources, in line with Podsakoff *et al.* (2003) recommendations. We surveyed key members, mostly those with the status of “partner” and “main partner” (*i.e.* coordinator or project leader) as they are supposed to be well-informed about the consortium compared to third-party categories (subcontractors, etc.). As there is only one main partner per consortium, we consider that surveying only the main partner could result in a self-reporting bias (Podsakoff *et al.*, 2003). Similarly, focusing the analysis only on partners may not allow to obtain a full picture of the consortium’s functioning especially if the responding partners are not involved in the consortium staff.

The questionnaire was designed in two steps. In the first one, we designed a preliminary version based on a literature review (Mothe, 1997; Majewski, 2008, Pinto *et al.*, 2011). In the second step, we submitted the questionnaire

to experts for validation purposes⁶. Then, adjustments were made drawing on their feedback and a renewed final version was designed and sent to our targets.

Approach

Adopting an exploratory approach, we used the cluster analysis method for data analysis in line with Teubner *et al.* (2021) and Majewski (2008). We computed this method following two steps. Our study includes a large set of variables related to different themes and aspects of the consortium such as motivations, strategy, governance, performance, size, risks, etc. underpinned by theoretical references. Given that each theme includes many components, it was necessary, as a first step, to conduct a principal component analysis (PCA) (varimax rotation) to select the most relevant components for each theme as well as the most relevant items for latent variables. This allows to avoid redundant elements in the dataset and then the risk that clusters will be formed among overlapping items or items that are related to the same latent variable. Therefore, we selected the components with the highest factor loadings and removed those with factor loadings below 0.5. In the same way, we selected one item per latent variable according to the values of loadings. As a result, we obtained a first, and smaller, set of variables with reduced components for each theme. Table A.2 in the appendix presents the variables and their related themes and items.

In a second step, we ran a cluster analysis to group consortia according to their similarities and differences. We applied a K-means cluster analysis (non-hierarchical method). However, to compute this method, we need to specify in advance the number of clusters or groups desired. To identify how many groups are comprised in our data, we computed in the first step a hierarchical procedure to find the optimum number of clusters using agglomeration coefficients (*cf.* agglomerative procedure). Then, we specified in advance the desired number of clusters and applied the K-means cluster analysis (non-hierarchical method). Having a mixture of binary and ordinal variables in the data, it was necessary to standardize these variables before computing these analyses.

6. This includes three coordinators of EU programs from BpiFrance (French Public Investment Bank), ANR (French National Research Agency) and Université Paris-Saclay (France) as well as three professors/researchers from HEC Paris (France), Indian Institute of Management (India) and Anglia Ruskin University (UK).

Results

The study's sample contains finally 207 firms indicating a 21.49% response rate. Given the anonymity of the questionnaire in accordance with Podsakoff *et al.* (2003) recommendations, it was not possible to get information about the number of consortia represented in our sample and whether responding firms belong to the same consortia. As we surveyed three members per consortium at the most, the number of consortia should range between 69 (assuming three responses per consortium) and 207 (assuming one response per consortium) consortia.

To assess the representativeness of our sample, Miller and Smith's (1983) method was applied. By comparing the first and the last ten responses using t-tests, no significant differences at 5% were found between the responses of early and late respondents (table 1). Then the potential of non-response bias was excluded.

Table 1 - Non-response bias test

Item	t Stat	Sig (5%)
Informal exchange	0.2187	not significant (n.s)
Trust	0.8750	n.s
Formal exchange	1.1647	n.s
Legal contract	0.9070	n.s
Size	1.1511	n.s
Coop background	0.7770	n.s
Goal achievement	1.9231	n.s
Quality of relationship	2.0045	n.s
Results	2.1195	n.s
Leadership	1.6519	n.s
Learning	1.2091	n.s
Opportunism	1.8666	n.s
Dependence risk	1.4358	n.s
Interdependencies	0.2332	n.s
Exploration	1.5007	n.s
Exploitation	1.4501	n.s
Scope	1.3071	n.s
Time to market	1.6786	n.s
Tech distance	1.2029	n.s

*: *t critical* = 2.2621 (two-tailed)

The table below shows the international distribution of the sample as well as the size and sector of respondents.

Table 2 - Sample by country, sector and size of respondents

Country	%	Sector	%
Belgium	2.16	Agriculture	1.62
Finland	3.45	Aeronautics	5.47
France	11.64	Chemistry	2.58
Germany	14.66	Trade & logistics	5.31
Greece	5.60	Construction	3.62
Italy	11.21	Consulting	3.71
Netherlands	9.91	Energy	6.10
Spain	12.50	High-Tech	19.25
Sweden	2.59	Manufacturing	17.53
Switzerland	4.74	Health	12.26
United-Kingdom	10.78	Services	9.29
Other with % < 2 (11 countries)	10.76	Information and communication	13.26

Size*	%
Large	39%
Medium-sized	22%
Small	24%
Micro	15%
Partner category	%
Principal partner	18.37
Partner	80.19
Subcontractor	1.44

*According to the EU recommendation 2003/361

After 11 iterations, we obtained a good classification. The table below shows that the convergence is achieved due to no, or small, change(s) in cluster centers. The maximum absolute coordinate change for any center is .000. This suggests that four groups are appropriate.

Table 3 - Iteration history

Iteration	Change in cluster centers			
	1	2	3	4
1	4,950	4,868	5,285	4,570
2	,472	,572	1,173	,487
3	,334	,237	,396	,222
4	,447	,133	,276	,317
5	,332	,216	,191	,327
6	,163	,047	,000	,135
7	,141	,070	,000	,085
8	,122	,083	,000	,104
9	,134	,099	,000	,000
10	,138	,109	,000	,000
11	,000	,000	,000	,000

The results shown in the ANOVA table give us a general description of the relevance of each variable and its power of discrimination. Thus, some variables appear to be more relevant than others. However, the F test is used here only for descriptive purposes as the clusters have been chosen to maximize the differences among cases in different clusters.

Table 4 -ANOVA

	Cluster		Error		F	Sig
	Mean Square	df	Mean Square	df		
Trust	30,721	3	,572	203	53,676	,000
Formal process	17,914	3	,735	203	24,388	,000
Informal exchange	19,233	3	,747	203	25,733	,000
Contract	15,274	3	,829	203	18,426	,000
Performance	18,885	3	,727	203	25,965	,000
Quality relationship	30,983	3	,547	203	56,669	,000
Opportunism risk	16,012	3	,790	203	20,265	,000
Dependence risk	13,915	3	,816	203	17,059	,000
Size	5,215	3	,947	203	5,508	,001
Time to market	20,858	3	,760	203	27,454	,000
Learning	16,352	3	,807	203	20,250	,000
Interdependencies	16,386	3	,791	203	20,713	,000
Private leadership	3,530	3	,961	203	3,672	,013
Coop background	2,403	3	,934	203	2,572	,055
Scope	5,714	3	1,002	203	5,704	,001
Public results	4,375	3	,992	203	4,412	,005
Tech distance	4,600	3	,946	203	4,863	,003
Exploration	18,596	3	,740	203	25,131	,000
Exploitation	37,317	3	,463	203	80,548	,000

To check for significance, we computed a post-hoc analysis by applying Tukey's HSD test (Honestly Significant Difference). It consists of a multiple comparison test to investigate significant differences in group means using a t-test. It allows then to identify the most significant items in each group. Based on the final cluster centers, table 5 shows the key features for each group and reports significant differences resulting from the multiple comparison test.

Table 5 - Final cluster centers

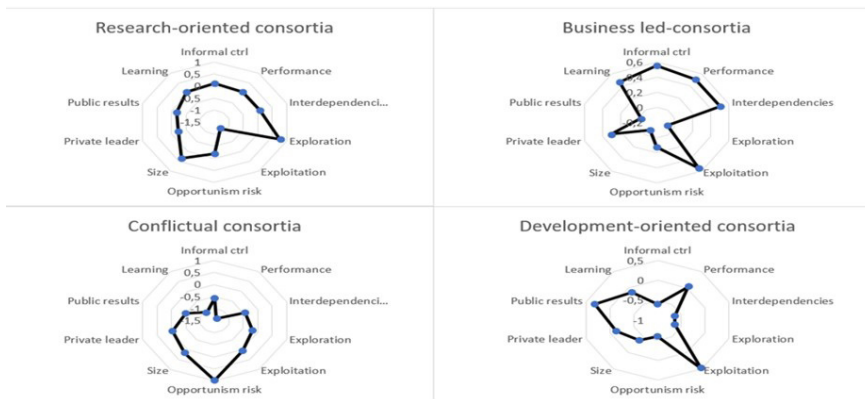
	Cluster			
	1	2	3	4
Trust	0,20	0,44*	-1,64**	0,09*
Inf Exchange	0,11	0,26	-1,33**	0,23
Ctrl Process	0,07**	0,58**	-0,66	-0,58
Contract	0,13*	0,52*	-0,49	-0,61
Goal achievement	-0,08	0,53**	-1,13**	0,09
Quality of relationship	0,23	0,48*	-1,62**	0,00
Dependence risk	-0,02*	0,48**	-0,37	-0,65*
Interdependencies	0,18*	0,52*	-0,52*	-0,63*
Opportunism risk	-0,18	0,13	0,98**	-0,60*
Size	0,35*	-0,08	0,17	-0,38*
Private leader	-0,24	0,30*	-0,05	-0,14
Public results	-0,17	-0,03	-0,49	0,32*
Exploration	0,78**	-0,08*	-0,18	-0,64*
Exploitation	-1,18**	0,55*	0,06**	0,48*
Coop background	0,25	0,09	-0,24	-0,16
Scope	-0,14	0,25	-0,57*	0,19
Tech distance	-0,42**	0,05	0,27	0,15
Time to market	-0,27	0,77*	-0,35	-0,48
Learning	0,07	0,46*	-1,07	-0,13

The table highlights the significant differences in group means, t-test, *p<.10, **p<.05

The results identified 4 clusters of EU-sponsored R&D consortia. Although the cluster analysis may place incorrectly some observations, especially when there is a large set of items (Majewski, 2008), our clusters appear to be consistent. However, the analysis of results should focus on the most discriminating and significant items with greater values to identify the general pattern in each cluster. It also requires careful consideration of the way in which items were worded (*cf.* table A.2 in the appendix) to gain a better understanding of the results⁷.

7. For example, a negative and significant value of "public results" does not mean that results were necessarily private. It may mean that outcomes were intangible or uncodified. In the same way, when the

Figure 2 - Radar graphs of consortia taxonomy⁸



The first group contains 56 firms. As shown in figure 2, the common feature within this cluster is the exploratory orientation of its members. A high proportion of consortia involved in this group perform upstream R&D activities involving a low technology readiness level such as fundamental research, feasibility, proof of concept, etc. The size of consortia contained in this cluster seems to be higher than it is in the other clusters. In addition, most of the consortia involved in this group are led by public entities. As a result, we label this cluster ‘research-oriented consortia’.

We label the second cluster ‘business led-consortia’. It represents the dominant group in our sample with 72 firms. The general pattern of the consortia involved in this group is that members are linked by common strategic interdependencies. They conduct market-oriented research involving downstream R&D activities (exploitation), which provides learning opportunities from tangible outcomes. They seem to be led mainly by private-for-profit entities. This cluster is the most performant in terms of technological goals achievement as well as relationship quality between partners. The management

technological distance (IP background) shows a negative and significant value, it does not mean necessarily that members were closer to each other or they shared IP rights. Instead, it could mean that members do not have IP rights at all (or, at least, specific IP rights related to the R&D project) such as public institutions or universities in some cases. Thus, the values of cluster centers should not be interpreted in a binary way (public vs private results). Many negative and significant values in cluster 3 should be interpreted as “the absence/lack of ...results, control mechanisms, leadership, etc)” instead of the opposite of the positive values.

8. For visualization and synthesis purposes, we have pooled some convergent items together by computing the (arithmetic) means of their final cluster center as reported in table A.3 in the appendix. We did not include in the radar graphs the following variable: time to market (which is reflected in, redundant with, interdependencies and exploitation items), cooperation background (not significant), technological distance (that involves a mitigated interpretation as highlighted in the precedent footnote) and scope (which does not seem to be relevant).

control of these consortia combines both formal and informal mechanisms such as social mechanisms, legal contracts as well as formal processes.

Almost all the 28 firms in group three entail a very high level of opportunism risk. They show any performance in terms of technological success, nor any level of relationship quality between members. The consortia included in this group appear to be medium-sized. There are no control mechanisms within these consortia or specific innovation dynamics (exploration and exploitation) behind their formation. As a result, we title this group 'conflictual consortia'.

The last cluster contains 51 firms. The common observation is the exploitation orientation of the consortia included in this group. Like group two, these consortia perform downstream R&D activities involving some technology readiness level such as applied research, prototyping, etc. However, they differ from this cluster as the partners are not linked by mutual industrial interdependencies. They seem to be very small-sized and their control management design appears to be mainly shaped by informal mechanisms. Furthermore, the consortia involved in this group show the highest level of disseminating outcomes and results to third parties. Accordingly, we label this cluster 'development-oriented consortia'.

The following table summarises the types of consortia comprised in our data.

Table 6 - Taxonomy of EU-sponsored R&D consortia (H2020 & Eureka)

	Label	Key features	Number
Cluster 1	Research-oriented consortia	-Exploration strategy -Large/medium size -Public leadership	56
Cluster 2	Business led-consortia	-Exploitation strategy -Mutual interdependencies -Private leadership -High performance -Mix of controls -Learning opportunities	72
Cluster 3	Conflictual consortia	-Opportunism risk -Poor quality relationship -Poor performance	28
Cluster 4	Development-oriented consortia	-Exploitation strategy -Public results -Informal control -Small-sized consortia	51

Discussion

This research aimed at grouping EU-sponsored R&D consortia into homogeneous groups, and the findings yielded a taxonomy that included four groups of consortia. In the following, the implications of the results are discussed with regard to the influence of public sponsorship and the organizational pitfalls related to these taxonomies.

Implications of Public Sponsorship

Although governments are not directly involved in sponsored R&D consortia, public sponsorship is a key determinant influencing the innovation dynamics (exploration and exploitation) as it shapes the governance mechanisms of these consortia. The innovation dynamics seems to be relevant as the exploration and exploitation orientations are dominant and significant for three groups. However, the choice of these strategies is influenced, by the framework of EU programs instead of the rational choices of partners. Thus, the logic of contests or calls for projects, which shape the public funding, implies that the exploration and exploitation strategies are pre-defined ex-ante during the call. While previous taxonomies (Kherrazi, Saïd, 2020; Matt *et al.*, 2012; Pinto *et al.*, 2011) distinguish two strategic choices within consortia, 'exploratory-oriented' versus 'exploitation-oriented' consortia, our findings highlight three strategic choices within sponsored R&D consortia. The results distinguish research-oriented (exploratory-oriented) consortia which is consistent with previous studies. However, they reveal the existence of two types of exploitation-oriented consortia, business led-consortia and development-oriented consortia, with specific features for each one. The former appears to focus on near-market R&D, whereas the latter appears to deal with applied research or other exploitation stages far from the market.

The existence of these two types of exploitation-oriented consortia tends to confirm the influence of the EU framework as there are two distinct funding programs (comprised in our sample) intended for exploitation. The Eureka program addresses near-market R&D projects with a high technology readiness level (TRL from 7 to 9) and provides partial funding, while the Horizon 2020 (Innovation Actions instrument) deals with R&D projects with a medium TRL (comprised between 4 and 6) involving more public funding. As a result, the business led-consortia are likely to be funded under the Eureka, while the development-oriented consortia seem to be likely funded under the H2020. Furthermore, this result does not support the assertion that EU-sponsored consortia should be more exploration-oriented as proposed by Matt *et al.* (2012). This may highlight a key difference between

previous EU programs, especially FP5 and FP6 studied by Matt *et al.* (2012), and the EU FP8 investigated in this study.

Another implication of public funding on strategic choices of R&D consortia is that the EU framework does not allow the formation of hybrid, or ambidextrous, R&D consortia. According to Pinto *et al.* (2011) and (Koza, Lewin, 2000), these consortia combine both exploration and exploitation orientations to simultaneously undertake pre-competitive and competitive R&D activities. In the EU framework, sponsored R&D consortia need to fit into a single type of strategy as the funding instruments and the programs intended for exploration and exploitation R&D projects are separated.

Moreover, the findings highlight that each innovation dynamics (exploration or exploitation) involves specific governance mechanisms, especially in terms of leadership, control practices, disclosure of outcomes, etc. When the strategy is 'exploratory-oriented' such as research-oriented consortia, it implies a high number of partners in order to stimulate novelty and creativity. The pre-competitive stage of R&D in these consortia leads often to general or uncodified outcomes which explains why there are no specific rules on IP dissemination (public vs. private) or control mechanisms (formal vs. informal) within this cluster. The university-industry consortia (Mannak *et al.*, 2020) may be an example of this cluster.

In the 'business led-consortia', the exploitation strategy is coupled with a high level of strategic interdependencies between members as well as a high level of TRL. In this case, these consortia need to control spillovers and reduce commercial risks as suggested by their private mode of leadership and outcomes. In this sense, the consortium sets a mix of informal and formal mechanisms to meet coordination requirements and mitigate appropriation hazards. As a result, these consortia appear to be the most performant both in terms of achieving technological goals and quality of relationship. One explanation is that the Eureka projects, in which these consortia fit, are funded both by public grants and (mostly) members' funds. Thus, private funding involves specific rules on IP ownership and control mechanisms in the same way as private R&D collaborations. An example of this case may be the vertical consortia, formed between suppliers and customers.

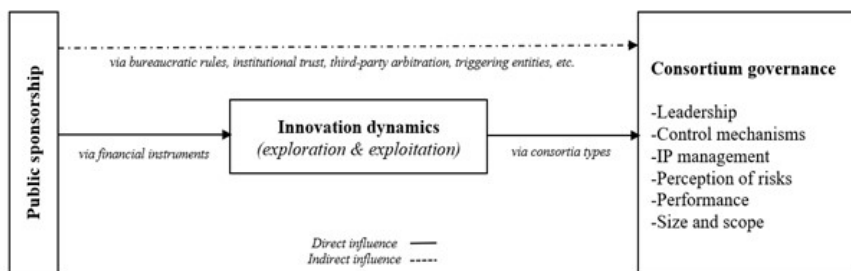
However, in the 'development-oriented consortia', there are no interdependencies among partners. In addition, the lack of private leadership, on the one hand, and the ability of third parties to gain access to outcomes (public results) on the other hand, suggest that these consortia do not face the same risks as the business led-consortia. One explanation is the funding of these consortia comes mostly from public funding (Horizon 2020 and especially the Innovation Actions instrument) as the R&D remains far from

the market. The institutional consortia, formed among private companies and public institutions, may serve as an example of these consortia which deal with applied research or other R&D stages involving a medium technology readiness level (TRL).

Our findings support the assertion that the innovation dynamics are associated with specific governance practices within R&D consortia (Kherrazi, Saïd, 2020). Based on the studies of two EU-sponsored R&D consortia (H2020 and Eureka), these authors highlight that each innovation dynamics is related to specific governance practices in terms of partners' selection, IP management, coordination tasks, and performance monitoring management. The features of each consortium highlighted in their study match to a large extent those we found for research-oriented consortia and business led-consortia. In line with our findings, the authors showed that the H2020 consortium (labeled research-oriented consortia in our study) was exploratory-oriented involving 18 members including eight private firms, four universities, and six public institutions, while the Eureka consortium (labeled, here, business led-consortia) was market-oriented involving six firms and one university led by a private firm.

Taking these findings together, it seems that the public sponsorship influences directly the innovation dynamics which, in turn, influences the consortium governance. It should be noted that all sponsored R&D consortia need to comply with some pre-defined rules or coordination mechanisms (Matt *et al.*, 2012). However, these rules provide general guidelines and standards that partners could tailor and customize depending, among others, on the innovation dynamics⁹. They are only minimal requirements not intended to exert a direct influence on the consortium governance.

Figure 3 - Influence of public sponsorship



9. For example, using the model contract of the European Commission (EC) as a consortium agreement for exploratory consortia, while it could be specified and highly customized when consortia are market-oriented.

Implications of Consortia Taxonomies

Once the taxonomy of EU-funded R&D consortia is defined, we can highlight some organizational pitfalls associated with each consortium type. Regarding the research-oriented consortia, they are intended to be pre-competitive and focus more on basic research. In this sense, the research object may be not well defined and sometimes may remain blurred and unclear as the outcomes cannot be predetermined at the beginning of the project. Given the size of such consortia, aligning goals and interests involves a complex process of (re)negotiation, deliberation, communication, conflict resolution, and interaction among partners to reach a (new) compromise. This implies additional transaction costs which may affect the consortium's performance. In such a situation, a consensus trap is likely to arise due to the lack of a well-established research agenda or linkage to specific goals which may result in unspecified objectives, high costs, and low efficiency.

To mitigate this trap, one could expect to promote informal exchanges and communication between members to stimulate idea generation and establish a consensus. However, such a solution could be very costly as the exploratory consortia are large or medium-sized. In this case, the consensus trap may be avoided by adopting a modular structure. It consists to divide the R&D project into independent work packages (Mothe, Quélin, 2000). The modular structure allows to reduce conflict and divergence between partners by dividing the project -and thus the major consensus- into sub-modules involving narrow members around minor consensus, *i.e.*, intended as part of the major consensus. In this line, Matt *et al.* (2012) highlight that EU-funded R&D projects would probably adopt a kind of this modular organization, with autonomous or independent modules dispatched between partners. However, the authors suggest that this structure may entail fewer exchanges and interactions within the consortium.

The business led-consortia seem to show the opposite features of the first group. They tend to operate as private R&D consortia. Thus, the members' commitment is strong and depends upon irreversible investments (private funds) and common strategic interdependencies. As a result, a dependency trap appears to be an issue since all partners' competencies are specific and needed to achieve the consortium's technological goals. The exit or defection of one member may cause disastrous consequences. In this regard, the control system within these consortia tends to manage dependency hazards by combining both formal (to meet coordination requirements) and informal controls (to meet learning and innovation needs). However, the combination of these controls in the same place, at the same time, may arise organizational

tensions between control practices (trust *versus* contract) which could affect the control effectiveness.

To deal with this issue, partners could switch to a control package approach (Van Der Kolk, 2019; Bedford, Malmi, 2016). The control package consists of a collection of both dependant and independent control practices that are loosely, or not at all, coupled with each other. This allows to benefit from the advantage of each control practice. Following this reasoning, a recent quantitative investigation (Kherrazi, 2021) shows that the control practices, outcome, behavior, and social controls, used within EU-sponsored R&D consortia are not interrelated with each other, which would match the package approach. The study concludes that the package approach could be more suitable for collaborative innovation projects that require independent and flexible controls than interrelated or system-based controls. With this respect, the package allows readjusting the control mechanisms depending on the level of dependence as well as other contingency factors.

The conflictual consortia suffer from a critical relational risk; opportunism. Opportunistic behavior refers to the proclivity of exchange partners to engage in deceptive and self-serving behavior (Williamson, 1979). It is seen as the opposite of trustworthiness and its perception may dampen the entire collaboration. This risk can be related to several organizational and managerial issues within the consortium such as asymmetric information, holdups, underinvestment (Binenbaum, 2008 cited by Pinto *et al.*, 2011), IP rights, etc.

In this regard, the transaction cost-based literature argues that opportunistic behaviors cause increasing costs, trust dilution, and cooperation failure. Thus, this type of consortia faces a failure trap. The fear of opportunism implies putting emphasis on formal and enforceable control mechanisms (Williamson, 1979; Poppo, Zenger, 2002). This may result in bureaucratic controls (research joint-venture) or formal controls to safeguard against perverse behaviors, which involve additional costs affecting the performance of the consortium. However, this group represents only 13.52% of our sample which tends to support Matt *et al.* (2012) proposition that EU-funded R&D consortia are less likely to experience destructive conflicts due to the existence of pre-defined rules and public arbitrators. As a result, public coordinators and government agencies involved in the formation process of these consortia play a critical role as creators of institutional trust which promote stability and mitigate ex-ante the propensity towards opportunism.

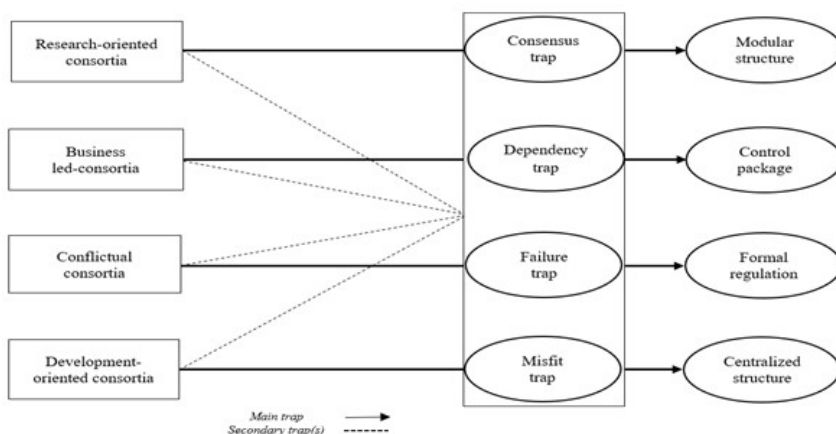
With respect to development-oriented consortia, they are likely to be formed among public institutions and private companies to perform R&D activities of medium TRL (applied research, prototyping, etc.). In such a situation, the governance of the consortium may face issues related to the

adequacy of each member's contribution. This alignment issue can be related to task coordination between members, *i.e.*, matching their competencies, assembling their separate outputs, monitoring their activities, etc. As a result, the partners in this type of consortia would be more likely to suffer from a lack of consistency or adequacy of their tasks and/or outcomes which implies a misfit trap.

To tackle this trap, it is needed to develop more structural linkages to meet coordination requirements and resolve internal inconsistency problems. As development-oriented consortia focus on advanced research involving more complementarities, they can implement a centralized organizational structure. Whereas under the EU framework joint facilities cannot be implemented, the centralized structure could be achieved through multi-level organizational linkages, frequent communication, strong coordination, formal monitoring, and centralized decision-making processes to reduce the misalignment risk of outputs or complementary tasks.

Although each trap is more likely to occur within a specific type of consortium, some consortia may raise many pitfalls at the same time. However, if the related solutions cannot be implemented together at the same time due to cost reasons or their exclusive nature (modular vs. centralized structure), then the consortium should adopt the solution that addresses the main trap. The following figure summarises the organizational pitfalls and solutions.

Figure 4 - Organizational pitfalls and solutions



Conclusion

This exploratory research contributes to a better understanding of sponsored R&D consortia taxonomies and challenges and yields some interesting findings. It brings more insights regarding the public sponsorship implications and sheds light on each consortium type and its associated organizational pitfalls. It advances the literature on public-funded R&D consortia by providing two conceptual models related to (a) the influence of public sponsorship on consortium governance and (b) the organizational pitfalls sponsored consortia may face as well as solutions to deal with. Based on these findings, research propositions or hypotheses could be derived and tested. In addition, the category of “conflictual consortia” that we identified seems especially novel and interesting as it was not revealed in previous studies. It may contribute to the management literature on the failure and instability of collaborations. Therefore, our study asserts that public sponsorship promotes institutional trust which acts as a mechanism promoting the stability and viability of consortia. In the same way, this study reveals the existence of two categories of exploitation-oriented consortia that were masked in previous taxonomies. Each category entails distinctive features as well as specific implications in terms of governance choices and organizational pitfalls.

With respect to the managerial implications, such detailed taxonomies are needed to help partners in their choices and decisions to form or join a consortium. They could also help to identify some key success/failure factors such as trust, opportunism, leadership mode, governance mechanisms, etc. In addition, it provides public policy-makers with dominant features of recent EU-funded R&D consortia (FP8) and key elements to understand how they influence, through bureaucratic and institutional mechanisms, the consortium governance. This could be helpful in improving public policies in terms of targeting and implementing new instruments to avoid or face consortia’s pitfalls and, thus, improve their performance.

Despite these contributions, this work has some limitations which trigger interesting future research avenues. The method of cluster analysis may classify incorrectly some observations, especially when it deals with a large set of variables. It could be also sensitive to the way in which the variables are measured as it does not provide specific tests to ensure the variable validity. It needs to be coupled with additional and/or informal methods (principal component analysis, interviews, other clustering algorithms, etc.) to deliver sensical clusters and consistent results. Given the exploratory approach of this paper, the cluster analysis method is used as a starting point toward understanding the influence of public sponsorship and the resulting taxonomies on

consortia governance and organization. In addition, we obtained data about consortia mostly from “partners”. If the responding partners are not assigned as consortium staff, they are likely not to have a full vision of the consortium. As a consequence, it would be better to have a balanced sample with equally weighted responses from main partners and partners and to distinguish partners from those who are involved in the consortium staff.

In this regard, future quantitative studies are needed to check for the robustness of our taxonomy. Further qualitative research could also address each consortium type to investigate more deeply the origins of its related pitfall (s) and how the suggested solutions could be implemented. Finally, it could be interesting to include other discriminating variables such as culture, nationality, industry, etc. or to survey other member categories (universities, research institutions, public organisms, etc.) in order to enrich our overview of public-funded consortia.

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Appendix

Table A.1 - Taxonomies of R&D consortia

Author(s)	Criterion	Taxonomy
Biddle (2018)	Legal status	<p>Contractual consortia: consortia based on a legal agreement between members.</p> <p>Incorporated consortia: consortia formed through a distinct legal entity or joint facility.</p> <p>Umbrella consortia: consortia founded by non-profit organizations that host other consortia.</p> <p>Large industry and technology influencers: they often focus on broad technological concepts combined with goals relating to furthering industry development.</p> <p>High-level concept developers: they focus on industry development as well as economic and societal goals, rather than technology development.</p>
Teubner <i>et al.</i> (2021)	Standardisation patterns	<p>Established standards developers: this group focuses on the maintenance and enhancement of mature technologies.</p> <p>Young technology specialists: they deal with novel technology including Open-Source organizations.</p> <p>Small industry and technology influencers: they pursue a mixture of industry development, economic and societal objectives.</p> <p>SSO-hosted industry drivers: they pursue various goals, such as industry development and early technology and standards development.</p>

Author(s)	Criterion	Taxonomy
Pinto <i>et al.</i> (2011)	Innovation dynamics	<p>Learning collaborative R&D organizations: established to explore territories where technologies are either immature or very expensive to develop.</p> <p>Business collaborative R&D organizations: concentrated more in applied research and commercialization stages.</p> <p>Hybrid or ambidextrous cooperative organizations: they connect companies that seek to simultaneously maximize opportunities for both value creation and value capturing.</p> <p>Dysfunctional or “stuck in the middle” cooperative R&D organizations: they suffer from an effort dispersion expressed in fragmentary activities and unfinished projects.</p> <p>Research-oriented consortia: they involve a TRL between 1 and 4.</p> <p>Market-oriented consortia: they address R&D projects with a TRL from 5 to 9.</p>
Kherrazi and Saïd (2020)	Technology Readiness Level - TRL (EARTO, 2014)	<p>Emergent consortia: formed due to strong mutual business interests.</p> <p>Engineered consortia: derived by triggering entities that make the partners aware of their mutual interdependencies.</p> <p>Embedded consortia: derived by relational ties and social relationships within a common social structure.</p> <p>Community builders: they emerge in response to the market and networking opportunities.</p> <p>Gamblers: they emerge specially to share risks by spreading R&D costs.</p>
Ring <i>et al.</i> (2005)	Formation process	<p>Visible hands: derived by a dominant player among members that leads the consortium by leading members to realize and be aware of mutual benefits in joining the consortium.</p> <p>Opportunists: engineered consortia in which there is a dominant player among partners that leads the consortium in order to maintain their competitiveness and viability.</p>
Eisner <i>et al.</i> (2009)	Motivations	

Author(s)	Criterion	Taxonomy
Matt <i>et al.</i> (2012)	Origin of funds	Public-funded consortia: sponsored consortia funded through public grants. Spontaneous or private consortia: formal agreements between independent firms which not involve any kind of public support.
Majewski (2008)	Collaboration mode	Specialized consortia: collaborations in which members conduct R&D, retain rights to their own IP, do not share profits or costs, do not engage in the exchange of personnel or IP, and do not restrict the licensing of each others' foreground IP. Learning via background IP licensing consortia: it consists of collaborations in which members license each other rights to background IP. Learning via personnel exchange consortia: this group entails employee visitation across firm members as a way to achieve learning. Spillover control-oriented consortia: they employ, veto power over third party licensing to restrict licensing of venture technology without unanimous approval by members. Outsourced R&D consortia: they outsource most of their R&D to a third party.
Hagedoorn <i>et al.</i> (2000)	Organizational structure	Formal agreements: they take the form of research joint-ventures which are mainly contractual arrangements. Informal agreements: When firms informally partner with universities, and, generally, in these relationships, the university serves as a short-term project-specific research subcontractor.

Table A.2 -Variables and measures

Variable	Description	Measurement scale
Theme 1: Management control		
Legal Contract	Extent to which the consortium agreement is specific, highly customized and required considerable legal work (Poppo, Zenger, 2002; Simon, 2009). Otherwise, the standard consortium agreement, like the EC contract-type, is very general acting as a charter of good conduct rather than a legal contract.	This item was selected among others (cf. principal component analysis) related to the corresponding latent variable and measured on a five-point Likert-type scale (ordinal)
Formal process	Extent to which exchanges between members within the consortium were governed by formal rules (Simon, 2009; Brulhart, Favoreu, 2006).	<i>/dem</i>
Trust	Extent to which members in the consortium shared a high degree of mutual trust (Mothe, 2001; Poppo, Zenger, 2002; Dekker, 2004).	<i>/dem</i>
Informal exchange	Extent to which exchanges between members within the consortium were characterized by informal exchange of reliable information between the partners (Poppo, Zenger, 2002; Woolthuis <i>et al.</i> , 2005).	<i>/dem</i>
Theme 2: Performance		
Results	Extent to which results were disseminated to third parties. According to Cassier (1995), we distinguish four (+1)* levels: results disseminated among members of a subproject, results disseminated among all members of the consortium, results disseminated with actors who are not members of the consortium but who pay a right of access to benefit from information before publication, results made public. (*): we added a 5th level "no results" to take into account the case of consortia that have not delivered results (failure, intangible or uncodified outcomes, etc).	Nominal modalities coded from 1 (no results) to 5 (results made public)

Variable	Description	Measurement scale
Goal achievement	Extent to which the consortium's technological goals were achieved (Blanchot, 2006; Pekkola, Juhani, 2016; Paswan <i>et al.</i> , 2017).	This item was selected among others (<i>cf.</i> principal component analysis) related to the corresponding latent variable and measured on a five-point Likert-type scale (ordinal)
The relationship quality	Extent to which members were satisfied regarding the quality of the relationship within the consortium (in terms of members' responsiveness to problems and involvement) (Poppo, Zenger, 2002; Blanchot, 2006).	<i>idem</i>
Theme 3: Risks		
Dependence risk	Extent to which the consortium project was important for the partner's technological or R&D strategy (Adapted from Mothe, 1997). Here, the emphasis is on unilateral dependence.	<i>idem</i>
Strategic interdependencies	Extent to which partners show mutual industrial interdependencies and form a strategic common destiny with each other (Ring <i>et al.</i> , 2005). The emphasis, here, is instead on common dependence.	<i>idem</i>
Opportunism risk	Extent to which partners perceive the level of opportunism, especially the risk of the partner's opportunistic behavior regarding its effective contribution to the project (Chen, Chen, 2002; Poppo, Zenger, 2002).	<i>idem</i>
Theme 4: Composition and membership		
Size	Number of members: very small (2-4 members), small (5-9), medium (10-19), large (20-29) and very large (+30)	Five-point Likert scale (ordinal) ranging from 1 (very small) to 5 (very large)

Variable	Description	Measurement scale
Scope (horizontal)	Extent to which partners perceive the level of heterogeneity of the consortium taking into account the profile of its members (Kherrazi, 2021). The (horizontal) scope of the consortium is high when it includes a variety of members including industrial, research institutions, universities, start-ups, associations, research firms, etc.	Five-point Likert scale (ordinal) ranging from 1 “very low” to 5 “very high”.
Cooperation background	Whether a member has previous R&D cooperation with at least one of its current partners in the consortium (Adapted from Mothe, Quélin, 2001).	Binary variable coded 1 if Yes, 0 otherwise.
Leadership	Whether the project leader is a private-for-profit entity	/dem
Tech distance	Extent to which members perceive the level of dissimilarity of their technological background (IP background). Adapted from Nootboom <i>et al.</i> , 2005).	Five-point Likert scale (ordinal) ranging from 1 “very low” to 5 “very high”.
Theme 5: Formation motivations		
Learning	Extent to which members sought learning and knowledge acquisition opportunities in their participation in the consortium (Pinto <i>et al.</i> , 2011).	Five-point Likert scale (ordinal) ranging from 1 “totally disagree” to 5 “totally agree”.
Time to market	Extent to which members sought acceleration of development processes and market access opportunities in their participation in the consortium (Pinto <i>et al.</i> , 2011).	/dem
Theme 6: R&D strategy		
Exploration	Whether a consortium is concerned with low Technology Readiness Level (TRL) projects. A TRL comprised between 1 and 4 includes upstream R&D activities such as: concept definition, fundamental research, proof of concept, etc. (EARTO, 2014)	Binary variable coded 1 if Yes, 0 otherwise.
Exploitation	Whether a consortium is concerned with medium/high Technology Readiness Level (TRL) projects. A TRL from 5 to 9 comprises near-to-market R&D activities like applied research, prototyping, development, etc. (EARTO, 2014)	Binary variable coded 1 if Yes, 0 otherwise.

Table A.3 - Aggregated final cluster centers

Variable	Item	Cluster			
		1	2	3	4
Formal ctrl	Trust	0,16*	0,35	-1,49	0,15
	Inf Exchange				
Informal ctrl	Ctrl Process	0,10	0,55	-0,57	-0,59
	Contract				
Performance	Goal achievement	0,07	0,50	-1,38	0,04
	Quality relationship				
Interdependencies	Dependence risk	0,08	0,50	-0,45	-0,64
	Interdependencies				
R&D Strategy	Exploration	0,78	-0,08	-0,18	-0,64
	Exploitation	-1,18	0,55	0,06	0,48
Opportunism risk	Opportunism risk	-0,18	0,13	0,98	-0,60
	Size	0,35	-0,08	0,17	-0,38
Private leader	Private leader	-0,24	0,30	-0,05	-0,14
Public results	Public results	-0,17	-0,03	-0,49	0,32

*: example; average of final cluster center of trust and informal exchange.