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MANAGERIAL PRACTICES WITHIN MULTILATERAL AND PUBLIC-FUNDED R&D COLLABORATIONS

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This paper addresses the issue of managerial practices within multilateral R&D collaborations subject to public sponsorship. The aim is to design a model of organisational, economic and social-based practices to manage public-funded consortia, while taking into account the interaction among these practices as well as the moderating effects of relational risks. Relying on a sample of 232 firms involved in European public-funded consortia, our findings show that the selected managerial practices improve the consortium's performance. However, the influence of public sponsorship influences the occurrence of relational risks and thereby the benefits of each practice. The implications of these findings are then discussed.

Keywords: Managerial practices; R&D; collaboration; consortium; public sponsorship.

Introduction

The knowledge division has intensified interdependencies between firms. Innovations can no longer be based on firms' internal R&D capabilities to sustain

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innovation (Ayerbe *et al.*, 2020). Consequently, sponsored R&D consortia have become a strategic tool of public policies to support and accelerate R&D processes and technologies. A sponsored consortium is a multilateral agreement between partners to develop a joint research or technology project funded totally or partially by public funds.

Managing R&D consortia implies a set of managerial practices and control mechanisms intended to ensure that partners' behaviours and actions are consistent with the alliance goals (Dekker, 2004, 2016). Unlike dyadic alliances, managing public-funded consortia appears to be specific and raises many challenging issues. On the one hand, management within R&D consortia may raise organisational tensions of competing demands between innovation needs and coordination requirements. These inherent pressures need to be dealt with simultaneously (Löfstål and Jontoft, 2017) without raising conflicting tensions. On the other hand, R&D consortia are multilateral and involve a large number of members as well as a broad variety of organisations which increases concerns about goal congruence, task coordination as well as spillover and ownership issues. Moreover, public sponsorship may influence or shape the choice of managerial practices or control mechanisms. According to Haustein *et al.* (2014), public funds need some specific formal controls, like legal contracts, that must be implemented before receiving the grants. They may imply also some constraining factors in terms of goal setting, time horizons and innovation dynamics (exploration or exploitation) (Matt *et al.*, 2012).

In addition, managerial practices used within R&D consortia are complex to address since they tend to rely on a 'negotiated compromise', i.e., a complex process involving deliberation, negotiation, communication, conflict resolution and interaction among partners to reach a compromise (Dekker, 2004). In this regard, previous work has mainly considered these practices in isolation both at intra and interfirm levels (Van Der Kolk, 2019; Bedford and Malmi, 2015). Furthermore, when these questions are addressed, they mainly examine ex-ante determinants of such practices (Otley, 1980; Fisher, 1995) assuming that the value of each practice is only affected by ex-ante contextual factors.

This paper attempts to fulfil the gap in management literature by addressing three points. First, we examine R&D managerial practices within an interfirm level. According to Chenhall and Moers (2015) opening the boundaries of R&D has implications for the design of managerial practices. In addition, Davila (2000) and Haustein *et al.* (2014) stress that managerial practices need to be addressed differently when dealing with innovation. R&D management raises conflicting pressures between innovation needs and control requirements that need to be resolved at the same time (Löfstål and Jontoft, 2017).

Second, the case of public-funded consortia has received very scant attention in research on R&D alliances. This research aims to extend the literature by

examining managerial practices within the framework of EU-sponsored consortia to highlight some of the implications of public sponsorship for R&D management.

Third, unlike prior studies which used ex-ante determinant factors (Haustein *et al.*, 2014), we investigate the impact of ex-post¹ relational risks on the consortium's performance in line with Donada *et al.* (2019a). As these consortia are subject to external influences (external control, public coordinator, public arbitrator, etc.), perception of relational risks may differ in such a context.

The paper is divided into three parts. The first part presents our theoretical background and hypotheses. The second part focuses on the research protocol adopted, while the third part is devoted to the presentation and discussion of our results.

Theoretical Background and Hypotheses

R&D management in the consortium setting

Interfirm collaborations involve sharing the partner's resources and knowledge and making investments to pursue common objectives. This implies several problems the collaboration might face. Under uncertainty and relational risk conditions, partners may tend to adopt self-serving behaviour to attain their own objectives.

In this sense, interfirm alliances need to introduce mechanisms to safeguard their interests and manage behaviour (Williamson, 1985) and co-operation (Van der Kolk, 2019) problems. Here, we will focus more on managerial problems and relational risks that are likely to arise within sponsored R&D consortia. Managerial problems refer to transactional concerns such as goal alignment, task coordination, performance monitoring and rewarding, etc., while relational risks refer to behavioural concerns like dependence and opportunism that consist of engaging respectively in abusive and self-serving behaviours.

To identify these problems and risks, we need to highlight how consortia organise R&D activities and plan resource allocation.

The innovation process within public-funded R&D consortia does not seem to follow the traditional process.² The sequence of activities is initiated with a call (Salerno *et al.*, 2015, p. 64) which is a direct consequence of public sponsorship. In this configuration, governments or public agencies provide grants through public

¹ Ex-ante and ex-post factors are intended with respect to the implementation of managerial practices. Ex-ante factors are those factors studied in an upstream stage as determinants of managerial practices (Factor → Managerial practice). Ex-post factors refer to those factors examined after the managerial practices are implemented in order to examine how they affect the effectiveness of each managerial practice (Managerial practice → Performance).

² From previous literature that proposes a sequential process: idea generation, selection, development and sales/diffusion/market.

calls to carry out R&D projects. To win the call, partners need to submit a project proposal that details functional and technical aspects. Once the call is won, partners conclude a consortium agreement and, then, carry out the stages of development and delivery.

Public sponsorship influences the innovation process in two ways. First, to submit the project proposal, partners need to perform some pre-development activities and technical analyses involving the pre-allocation of resources prior to the establishment of the consortium agreement. Second, sales precede the development stage. If sales occur after development in the traditional process, public-funded consortia need to define *ex-ante* the final user(s) and ownership rules during the agreement drafting (Diffusion and Sales in Fig. 1). Thus, the sale occurs prior to the development and delivery stages in order to reduce market uncertainties and thereby provide incentives to partners to join the consortium.

As a result, managerial problems and/or relational risks are associated with this process in several ways. At the beginning of the process, managerial issues can be related to partner (adverse) selection. In the context of co-operation, partner adverse selection describes the situation in which partners misrepresent the value of the resources and skills they bring to the co-operation. Thus, each party needs to ensure that its counterparts meet the co-operation requirements and goals. Other relational issues may arise when partners need to perform, prior to the consortium agreement, some pre-development tasks in order to dispute the call. Opportunistic behaviours are likely to occur due to multiple sources of asymmetric information. In addition, there are no formal safeguards at this stage, which makes it difficult to initiate the co-operation.

Second, once the call is won and the grants are obtained, a second concern is related to moral hazard risks, i.e., the need to ensure that partners are operating in

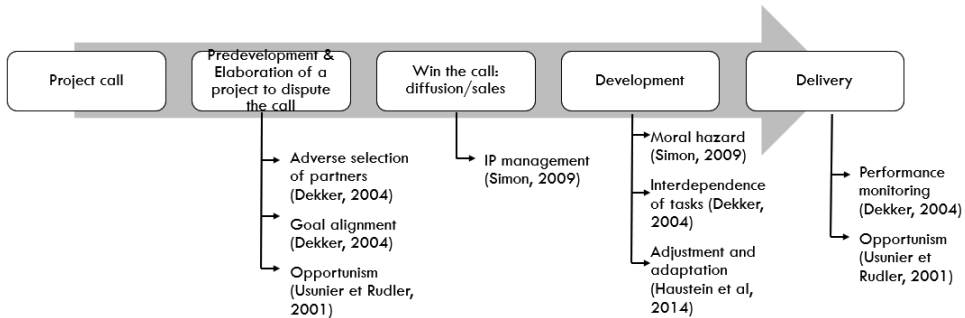


Fig. 1. Innovation process and associated concerns.

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

the interests of the consortium. The risks of cheating (opportunism) and dependency are likely to emerge during the development stage. In addition, other managerial problems could be linked to the consortium's capability to adapt to technological uncertainties and to allow organisational adjustment and flexibility to meet innovation needs.

Finally, at the end of the process, the consortium needs to assess the performance of partners for accounting, monitoring and rewarding purposes without arising conflictual and opportunistic behaviours between members. With respect to the consortium's performance, partners need to tailor its measurement according to the consortium characteristics (goals, innovation dynamics—exploration and exploitation, size, scope, etc.). In the case of public-funded consortia, partners seek often public-domain knowledge and technologies. The proof of success is not necessarily tangible (prototype, product, patent, etc.) and could consist of intangible outcomes such as scientific knowledge, proof of concept, technical knowledge, etc. In addition, the performance measurement could be enlarged to include organisation-related aspects of the collaboration like longevity, learning, quality, experience, etc.

The following figure illustrates the main managerial problems and relational risks associated along the innovation process (Fig. 1).

In this regard, the choice of managerial practices within R&D consortia needs to take these managerial and relational issues into account by considering a broader set of practices rather than considering these practices in isolation or in a single way. In this sense, many authors have supported a mix of managerial practices within collaborations (Dekker, 2016; Assens and Baroncelli, 2004; Ouchi, 1979).

In the consortium setting, R&D managerial practices can be implemented as flows. First, the creation of an organisational mechanism such as (research) joint ventures can help partners to set goals and standards, coordinate interdependent tasks and assess the consortium's performance. However, the European framework programme does not allow such joint research facilities within sponsored R&D consortia. Instead, partners need to rely, in a more decentralised way, on their own structures to align their goals and tasks. In this regard, an alliance function including a set of activities, tasks and roles involving a constant allocation of resources (Kale *et al.*, 2002; Desreumaux, 1992) could be implemented within each partner firm. Donada *et al.* (2019a) propose a similar concept called collaborative structure which refers to a set of actions within each member firm and allows to monitor its activities and tasks. This, alliance function is needed throughout the innovation process of the consortium to meet organisational requirements (alignment and coordination).

Second, the use of economic mechanisms such as formal contracts aims to ensure that partners' behaviours comply with the consortium's goals and predetermined outcomes (Ouchi, 1979; Dekker, 2004). This leads partners to set up a common and formal agreement that delineates the rights and obligations of each member and defines procedures for dispute resolution and ownership (Klein Woolthuis *et al.*, 2005; Simon, 2009). Thus, the consortium agreement allows to reduce those relational concerns related to moral hazard and appropriation risk. In the framework of EU public-funded consortia, the consortium agreement is necessary and must comply with some pre-defined rules on IP ownership, data/outcomes disclosure, etc. However, these rules provide general standards and minimal requirements that partners can customise depending on the consortium characteristics (goals, innovation dynamics—exploration or exploitation, size, scope, etc.).³

Third, we need also to consider a social-based mechanism such as trust to include informal practices such as self-regulation, norms, values and institutions, social and cultural context (Ouchi, 1979; Macneil, 1980; Dekker, 2004; Assens and Baroncelli, 2004). Trust is needed at the beginning of the innovation process to select the partners and perform pre-development activities prior to the consortium agreement. It is also needed during the development stage to cope with technological uncertainties and to meet adjustment and adaptation requirements.

We shall consider these three elements when we refer to R&D managerial practices within consortia (Table 1).

Table 1. R&D management design within the consortium.

R&D managerial practices	Location in the innovation process	Managerial problem addressed	Relational risk addressed
<i>Ad hoc</i> alliance function (organisation-based mechanism)	- Predevelopment - Development - Delivery stages	- Goal alignment - Task Coordination - Performance monitoring	- Mainly dependence risk
Consortium agreement (economic-based mechanism)	- Diffusion and sales stage	- Behaviour compliance - IP management	- Asymmetric dependence - Opportunism
Trust (social-based mechanism)	- Predevelopment - Development - Delivery stages	- Partner selection - Adjustment - Reciprocity	- Symmetric dependence - Opportunism risks

³For example, the European Commission (EC) provides a contract type as a standard for the consortium agreement. The EC contract type remains very general and serves as a charter of good conduct rather than a legal agreement. However, partners could customise the contract with highly specified rules involving considerable legal work.

Hypotheses

Managerial Practices and Performance

We develop the core assumption that adequate R&D managerial practices drive the consortia's performance by managing the managerial problems in terms of appropriation hazards, coordination requirements, as well as adaptation to change. With respect to performance and given that sponsored consortia may not deliver tangible or codified outcomes, we focus on a subjective approach to performance in line with Poppo et Zenger (2002), Blanchot (2006), Pekkola and Ukko (2016) and Paswan *et al.* (2017). Moreover, subjective measures have the advantage to be common to all consortia whether they deliver tangible or intangible outcomes.

According to Brulhart and Favoreu (2006), complex contracts reduce information asymmetry and spillover risks likely to arise in inter-firm collaborations. Through an alliance function, on the one hand, and a consortium agreement, on the other hand, partners can monitor each other, coordinate their interdependent tasks and exchange information and knowledge while reducing the appropriation and opportunism hazards (Williamson 1985; Dekker 2004). Within the framework of public-funded consortia, the alliance function is particularly relevant at the beginning of the innovation process to perform pre-development activities when formal safeguards (contract) are not yet implemented as well as during the downstream stages. Meanwhile, the consortium agreement protects the interests of each partner, specifies the ownership rules and, thus, provides incentives to members to increase their commitment to the consortium, which will enhance the performance of the overall cooperation.

However, technological uncertainty and environment complexity inherent to R&D consortia make it difficult to rely only on formal managerial practices (Hagedoorn, 1990). With detailed agreements and formal structures, it is slow and costly to modify terms or adapt organisational structures when contingencies change. Other authors have argued that formal practices may prevent the development of trust, generate additional transaction or organisation costs and become inefficient under high uncertainties (Macneil, 1978). As a result, formal practices are not enough as a basis for co-operation. Since one party cannot fully monitor the partner's behaviour, there is a need to rely on other managerial practices.

In this regard, a certain level of informal interaction is needed to stimulate learning and adapt to change (Boisier, 2013). In addition, social-based control allows the transfer of tacit outputs which are difficult to codify or transfer via the market (Maskell and Malmberg, 1999). Furthermore, the consortia formed within the EU framework is influenced by previously established relationships forged during past EU programmes leading partners to rely on common norms as well as institutional and relational trust (Zucker, 1986) to complete the formal practices. Thus,

the development of trust and informal interaction between members is likely to meet the innovation needs and adjustment requirements and thereby contribute to the consortium's performance (Donada *et al.*, 2019a; Van der Meer-Kooistra and Scapens, 2015).

Based on the above development, we formulate hypothesis 1 related to the positive impact of R&D managerial practices on performance:

H1a: *Ad hoc alliance function has a positive effect on consortium's performance*

H1b: *Formal contract has a positive effect on consortium's performance*

H1c: *Trust has a positive effect on consortium's performance*

As a *post hoc* analysis, we will attempt to explore the interactions among these practices when used together and how they affect performance. Indeed, when issues on managerial practices are addressed, authors often examine the structuring mode of these practices and whether they are linked with each other (Bedford *et al.*, 2016; Bedford and Malmi, 2015; Malmi and Brown, 2008). Many authors have argued that managerial practices within alliances need to be used together (Donada *et al.*, 2019a; Van der Kolk, 2019; Bedford *et al.*, 2016) in order to benefit from the advantage of each one.

Moderating Effect of Relational Risks

To further examine the effectiveness of R&D managerial practices, we investigate how relational risks impact the association between these practices and performance.

Using the contingency reasoning framework, the effectiveness of R&D managerial practices depends on their fit with the alliance context. In this line, authors have studied the impact of ex-ante factors, i.e., prior to the implementation of MC mechanisms such as business strategy, competition, uncertainty, etc. (Haustein *et al.*, 2014). The aim of these studies was to select the practices that best match the alliance context. We consider, here, ex-post factors that occur after managerial practices are implemented, especially the relational risks as moderating factors.⁴

In alliances, partners need to select mechanisms that best mitigate the transaction costs related to relational risks such as dependence and opportunism. Relying

⁴These risks have also been studied as determinant factors of MC setting in prior research (Chenhall, 2003). Here, we examine rather their impact after the managerial mechanisms are implemented and how they influence the relationship between management control and performance.

on the transaction economic theory, these risks are considered to be the result of “lock-in” due to the transaction-specific investments made by one or more partners. Dependence describes a situation when one or more partners are not easy to replace. Within our framework, the dependence is likely to be asymmetric. The consortia studied here involve a multitude of partners coming from various business sectors and having different strategic goals. An increase in the consortium’s size and heterogeneity may result on more asymmetric positions and vice versa. Furthermore, there are different partners’ roles and statutes within a consortium depending on their investment and commitment (project leader, partner, subcontractor, etc.). This implies an asymmetric dependence among the consortium members that makes the cooperation vulnerable to the risk that the less dependent partner leaves the consortium or engages in abusive behaviours (hold up).⁵ This may also destabilise the relationship between partners and lead to consortium failure (Souidi, 2012) due to the specific dynamics of the entry and exit strategy of its members.

The consortium members shall rely more on formal practices when dependence risk is present to secure the co-operation. According to Souidi (2012), dependence may also jeopardise the common social capital making social control unnecessary or meaningless. Thus, the dependence risk implies the use of formal practices and thereby alters the development of trust between partners. Thus, hypothesis 2 posits the following:

H2a: *Dependence risk moderates positively the relationship between ad hoc alliance function and consortium’s performance*

H2b: *Dependence risk moderates positively the relationship between formal contract and consortium’s performance*

H2c: *Dependence risk moderates negatively the relationship between trust and consortium’s performance*

Opportunistic behaviour refers to the proclivity of exchange partners to engage in deceptive and self-serving behaviour (Williamson, 1985). Considering Usunier and Rudler’s (2000, p. 154) analysis of opportunistic behaviour along a transaction, we can consider that opportunism within the framework of public-funded consortia may occur at different stages of the innovation process. At the beginning, it could be related to the adverse partner selection and/or predevelopment stage. One partner may have better information about how he or she can take advantage

⁵The risk that one member exploits the transaction-specific investments against the other members.

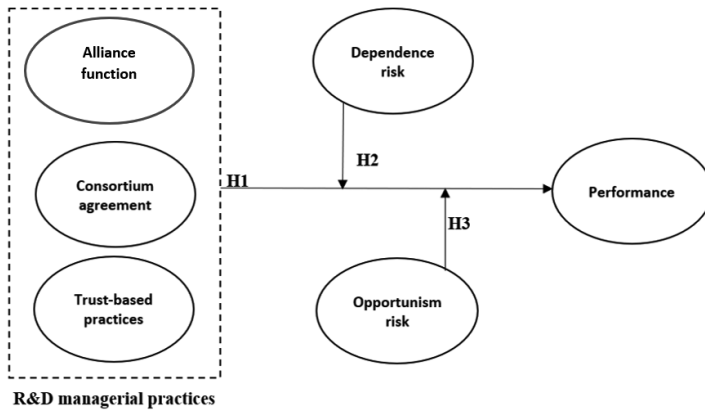


Fig. 2. Conceptual model.

from the R&D project and, thus, do not disclose information about some aspects of the alliance. In the downstream stages of the process, opportunism occurs when one party behaves against the common interest of the alliance.

The presence of opportunism risks leads partners to reduce this risk by relying more on formal practices and enforceable mechanisms (Williamson, 1985; Poppo and Zenger 2002). At the same time, since the opportunism is seen as the opposite of the trustworthiness, its perception may damp the development of trust between the parties (Brousseau, 1989). Based on this, hypothesis 3 posits the following:

H3a: *Opportunism risk moderates positively the relationship between ad hoc alliance function and consortium's performance*

H3b: *Opportunism risk moderates positively the relationship between formal contract and consortium's performance*

H3c: *Opportunism risk moderates negatively the relationship between trust and consortium's performance*

Or Figure 2 summarises the conceptual model and the related hypotheses.

Research Method

Sample

The target sample for this study is R&D consortia sponsored by European framework program for research and innovation for the period 2014–2020. A consortium is an agreement between a minimum of three partners from three EU Member

Table 2. Sample by country and category of respondents.

Country	%
Finland	3.45%
France	11.64%
Germany	14.66%
Greece	5.60%
Italy	11.21%
Netherlands	9.91%
Spain	12.50%
Switzerland	4.74%
United-Kingdom	10.78%
Other % < 3 (13) countries	15.51%
Category*	%
Large-sized	40.09%
Medium-sized	20.26%
Small-sized	22.84%
Micro-sized	16.81%

*According to the EU recommendation 2003/361

States to develop a R&D project funded by the European Commission or their respective governments. Given that a consortium may include different categories of partners, we surveyed only private for-profit entities category. The target population comprises 963 firms involved in these consortia. The study's sample contains finally 232 firms (Table 2), i.e., valid questionnaire returned indicating a 24% response rate. To assess the representativeness of our sample, Miller and Smith's (1983) method was applied to compare the first and the last ten responses using *t*-tests (5%). No significant differences were found which excludes the potential of participation bias.

To avoid the Common Method Biases (CMB), we followed Podsakoff *et al.*'s recommendations (2003) regarding the separation of measurement, the protection of respondent anonymity as well as counterbalancing question order, using different response formats, etc. We also surveyed multiple independent consortia and multiple participants within each consortium.

Variables

The measurement items used in this research are based and/or adopted from previous studies. R&D managerial practices consist of three constructs considered as

independent variables: *ad hoc* alliance function, consortium agreement and trust. To measure the alliance function, we used a binary variable related to the existence or not of an alliance function in charge of the company's collaborations (Kale *et al.*, 2002; Donada *et al.*, 2019a). As there are no joint facilities within sponsored R&D consortia, task coordination and monitoring take place within each member firm. Establishing a dedicated alliance function results in control practices such as planning, coordination, monitoring, etc. Based on this, we asked the respondents if there was within the firm partner a dedicated alliance function that manages all alliance-related activities (adapted from Kale *et al.*, 2002).

Consortium agreement was measured relying on transaction cost studies on contracts (Simon, 2009) and adapted with respect to the framework of public-funded consortia. As highlighted earlier, the consortium agreement can serve as a legal contract when it is highly formalised and customised by members with considerable legal work. Otherwise, it serves as a charter of good conduct when members use general rules (EC contract type) and which would therefore be considered an incomplete contract in the sense of Simon (2009).

Thus, the consortium agreement was assessed through four dimensions: (1) degree of completeness of the consortium agreement, (2) degree of legal complexity of the consortium agreement (to what extent it was highly customised and required considerable legal work), (3) degree of exchange formalisation within the consortium and (4) degree of defining conflict resolution procedures.

Trust consisted of two survey items regarding (1) the level of informal exchange of reliable information and (2) the level of mutual trust between partners (Macneil, 1978; Dekker, 2004).

We have chosen the consortium's performance as a dependent variable. Given that sponsored R&D consortia deal often with public-domain knowledge and technologies leading to intangible outcomes, it is difficult to assess the 'real' performance in terms of new products, patents, return on investment. Instead, subjective measures are needed in contexts in which the innovation process takes place (Hoppe and Moers, 2011; Chenhall and Moers, 2015). In this line, the respondents were asked to provide their perceptions with regard to four performance aspects common to all consortia with tangible and intangible results (Poppo and Zenger, 2002; Pekkola and Juhani, 2016; Paswan *et al.*, 2017); (1) the level of technological success, (2) the impact on firm business, (3) the quality of relationship and (4) the level of global partners' satisfaction.

Relational risks were considered moderating variables in the model. The dependence risk (adapted from Mothe, 1997; Souidi, 2012) was assessed through two items: (1), the level of partner's perception regarding the overall level of its investment in the consortium and (2) the level of partner's perception regarding the

importance of the R&D project to its innovation or technological strategy. The opportunism risk measure was based on Chen and Chen (2002), Poppo and Zenger (2002) and Souidi (2012). The items were related to (1) the level of the partner’s perception of the difficulty of anticipating the actions of other partners and (2) the level of the partner’s perception of the risk of opportunistic behaviour of other partners.

We added also two control variables. First, we controlled for consortium size, as captured by the number of partners in each consortium. Second, we controlled for consortium (horizontal) scope. This refers to the degree of heterogeneity of the consortium’s partners in terms of their profile (industrial, academic, institutional, research, firms, SMEs, start-ups, etc.) (Pinto *et al.*, 2011). We captured this variable by asking the respondents to assess the heterogeneity level of the consortium (adapted from Nooteboom *et al.*, 2005). The consortium is heterogeneous when it includes a broad variety of members.

The variables are measured using five-point Likert-type scale categories, except for the alliance function which is a binary variable. We used, then, the structural equation modelling, especially The PLS approach for hypothesis testing. This approach is suitable for both building and testing theories (Lowry and Gaskin, 2014).

Results

Confirmatory factor analysis

Before testing our hypotheses, we conducted CFA tests. For internal consistency, we measured the composite reliability (CR) and rho coefficient. We then conducted a test of Construct validity, especially convergent and discriminant validity. The results in Table 3 indicate that all the constructs show a good reliability as: rho and CR are all higher than 0.7 (Fornell and Larcker 1981).

Table 3. Construct reliability.

	rho_A	CR
Agreement	0.780	0.844
Dependence risk	0.835	0.894
Opportunism risk	0.893	0.870
Performance	0.861	0.872
Trust	0.857	0.880

Table 4. Convergent and discriminant validity.

	AVE	Behaviour Ctrl	Dependence risk	Opportunism risk	Performance	Social Ctrl
Agreement	0.578	0.760				
Dependence risk	0.808	0.183	0.899			
Opportunism risk	0.771	-0.009	0.096	0.878		
Performance	0.633	0.371	0.308	-0.220	0.796	
Trust	0.787	0.302	0.161	-0.298	0.638	0.887

Note: Factor correlation matrix with the square root of AVE on the diagonal.

Table 5. Common method bias's tests.

	Theoretical value	Effective value
Harman's single Factor	< 0.50 (Podsakoff and Organ, 1986); < 0.40 (Guide and Ketokivi, 2015).	0.23 (unrotated, first factor)
Marker variable Approach (AVE .58 & CR .72)	< 0.30 (Lowry and Gaskin, 2014)	0.24
Maximum Shared Variance	Low (Lowry and Gaskin, 2014)	0.06
Common Factor Latent (CLF) approach	< 0.2 (Gaskin, 2012)	<0.12
VIF test	< 3.3 (Kock, 2015)	1 < VIF < 1.38

Validity tests were assessed for each construct both convergent and discriminant validity by computing the Average Variance Extracted (AVE). The results in Table 4 show that the AVE is higher than 0.5 and greater than the corresponding inter construct correlation, thus establishing respectively convergent and discriminant validity (Fornell and Larcker, 1981).

To complete the CFA, we tested for CMB to establish that such bias did not distort our data (Podsakoff *et al.*, 2003). For this purpose, we computed several tests to detect any common variance. The results suggested that our data did not suffer from common variance, hence the possibility of a common method bias is rejected (Table 5).

Hypothesis testing

Our findings seem to support the first hypothesis that posits that R&D managerial practices enhance the consortium's performance. As shown in Table 7 (PLS 1), the path coefficients (>0.1) and the explained variance R^2 (> 0.2) are all statistically significant (Chin, 1998). All managerial practices have a positive impact on performance. Then the first hypothesis is supported.

In a second step, we attempted to explore the associations between managerial practices. In this regard, we estimated a production function in line with Grabner and Moers (2013) and Bedford *et al.*, (2016) to assess interactions among these practices and how they affect performance. The findings reveal that no significant effects are found regarding the interactions among managerial practices (Table 6, PLS2).

To test hypotheses 2 and 3, we conducted a moderating effect test. Our findings (Fig. 3) revealed that dependence risk strengthens the relationship only between the consortium agreement and performance, while it damps the relationship between trust and performance. This seems to confirm the sub-hypotheses H3b and H3c (SM1-PLS1, Table 7).

Regarding the opportunism risks, the results show (Fig. 4) that it moderates positively both consortium agreement and trust which confirms only the sub- hypothesis H3b (PLS-3B, Table 7).

Table 6. Regression estimates.

Variables	PLS1		PLS2	
	B	<i>p</i>	B	<i>p</i>
<i>Ad hoc</i> function -> Perf	0.169	**	0.137	**
Agreement -> Perf	0.225	***	0.198	***
Trust -> Perf	0.381	***	0.575	***
<i>Ad hoc</i> function × Agreement			-0.069	
Trust × <i>Ad hoc</i> function			-0.028	
Agreement × Trust			-0.019	
Size -> Perf	0.011	n.s	0.007	n.s
Scope -> Perf	-0.076	n.s	-0.032	n.s
R²	0.435		0.501	
Delta R²			+0.066	

One-tailed test: **p* < 0.10; ***p* < 0.05; ****p* < 0.01. n.s: not significant.

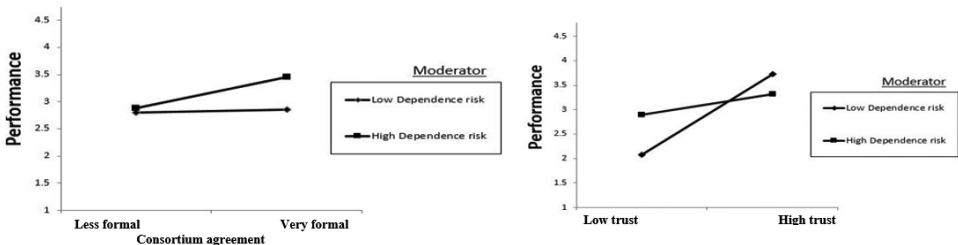


Fig. 3. PLS-3A (dependence risk).

Table 7. Moderating effects of relational risks.

Indep. Variables	PLS-3A		PLS-3B	
	B	p	B	p
<i>Ad hoc</i> function	0.114	**	0.158	**
Agreement	0.156	***	0.161	***
Trust	0.515	***	0.517	***
Dep risk	0.17	***		
Opp risk			-0.06	*
Moderator 1				
Dep risk * <i>Ad hoc</i> function	0.023	n.s		
Dep risk * Agreement	0.128	*		
Dep risk * Trust	-0.105	*		
Moderator 2				
Opp risk * <i>Ad hoc</i> function			0.101	n.s
Opp risk * Agreement			0.073	*
Opp risk * Trust			0.100	n.s
Size -> Perf	0.032	n.s	0.031	n.s
Scope -> Perf	-0.022	n.s	-0.023	n.s
R²	0.504		0.512	
Delta R²	+0.01		+0.018	

Note: One-tailed test: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. n.s: not significant.

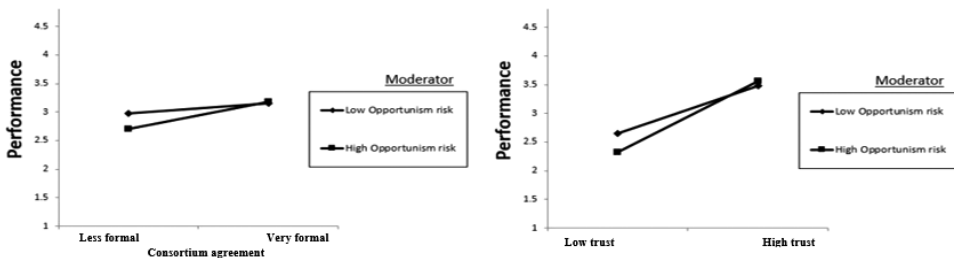


Fig. 4. PLS-3B (Opportunism risk).

Discussion

The research contributions are discussed as follows. First, previous studies have examined the upstream stages of collaboration with ex-ante mechanisms, while others have focused more on downstream stages with ex-post mechanisms (Donada

et al., 2019b). This research considers the entire life cycle of the consortium while taking into account relational risks that might occur during this life cycle. Our results are consistent with previous research findings regarding the purpose of R&D managerial practices and their impact on performance (Donada *et al.*, 2019a; Cao and Lumineau, 2015; Simon, 2009).

In addition, by relating each R&D managerial practice to a set of measurable variables, we obtain a closer analysis of the mechanisms through which each practice affects performance. As discussed by transaction costs and organisational theories, the organisational (*ad hoc* alliance function) and economic (contract) mechanisms allow, *ex-ante*, to align partners' goals and, *ex-post*, to monitor their achievement, while meeting the coordination of different interdependent tasks during the collaboration (Donada *et al.*, 2019a).

Our results support also the relational theory by emphasising the role of social norms to meet the adjustment requirements. In this context, parties will share information frequently, learn from each other more accurately and jointly solve problems and contingencies in a mutually advantageous way (Macneil, 1987; Ouchi, 1979).

Second, our findings show that R&D managerial practices are not coupled with each other. They tend to act as a collection of independent practices which refers to the package approach. Such funding is important in the management field as the package approach is still mainly applied in accounting-based studies and intrafirm settings (Van Der Kolk, 2019; Bedford *et al.*, 2016). Moreover, managerial practices or control mechanisms are supposed to form governance or control systems, *i.e.*, a set of interrelated and interdependent practices or mechanisms. This research suggests that the package approach could be more appropriate in the context of R&D alliances, especially within multilateral collaborations. As there are no strong interdependencies among R&D managerial practices, this allows more flexibility for partners to face environmental changes or technological uncertainties. Thus, the package approach allows to readjust the configuration of managerial practices depending on the consortium context (risk perception, innovation dynamics, consortium life cycle, institutional context, etc.).

Third, contextual variables may act as moderating factors, especially relational risks which affect the relevance of managerial practices (Donada *et al.*, 2019a). Moreover, our findings indicate that formal agreements are needed when the dependence risk is high. This supports previous research based on transaction costs theory. The dependence among partners seems to be asymmetric since there are many partners and different statutes of partners (project leader, partner, subcontractor, etc.) within each consortium. In asymmetric dependence, the dependent party lacks private ordering mechanisms like mutual dependence or hostages that could replace the contractual safeguards. In this case, members tend to customise

the consortium agreements going beyond the EC contract type to include legal safeguards against dependence risks. In addition, one could expect that trust is needed to best mitigate such a risk. However, the finding does not support this claim.

Considering opportunism risks, our findings show that formal agreements may be a good ordering mechanism to safeguard against opportunism. This seems to be consistent with transaction costs reasoning. However, our results contradict the transaction costs theory as they claim that opportunism moderates positively the effect of trust on performance which suggests that trust becomes effective even if opportunism risk is present. A sociological explanation would be useful.

Nooteboom (1995), combining insights from economics and sociology, identifies two key dimensions related to opportunism. The first refers to “opportunities for opportunism” (i.e., opportunities to act against some-one’s interest in a way that he cannot control), while the second refers to “propensity towards opportunism” (i.e., the possibility of opportunistic conduct which is the opposite of trustworthiness). There is a propensity towards opportunism even when there are no opportunities to opportunism, depending on the social context (trust, values, norms, ethics, etc.). The partner’s opportunities for opportunism can be reduced through contract mechanisms. “However, to mitigate the partner’s propensity towards opportunism, there is a need to develop trust in time, build friendship and further joint ethics, norms or values (Nooteboom, 1995). In this regard, the socio-relational system (norms, values, institutional trust, relational trust, etc.), formed within the EU framework programmes leads partners to rely on common norms against opportunism. This might explain why opportunism involves also an increase in social-based practices. In sum, as supported by our findings, we might conclude that opportunism risk strengthens the relevance of the use of both formal agreements to close opportunities for opportunism, as well as trust to mitigate propensity towards opportunism which remains when all opportunities for opportunism are contractually closed.

An alternative explanation also consists to take the consortium’s innovation process into account. As highlighted earlier (Fig. 1), each stage of the process may induce a different opportunistic behaviour. In the upstream phases, prior to the consortium agreement, the partners need to negotiate and establish a consensus on the project formulation. This could induce some opportunistic behaviours like taking benefits from asymmetric information and, thus, transferring risks to the other party less-informed. During the development and delivery stages, opportunism may concern the partner’s effective contribution to the project. Partners may provide the alliance with skills or outcomes of lower quality than they promised or performed. They may also not disclose all the data and results obtained.

In such contexts, trust makes it possible to mitigate ex-ante opportunistic behaviours at the beginning of the process as it implies reciprocity. Given the

public sponsorship of European R&D consortia, the institutional context seems to play a critical role in reducing such risks as it promotes institutional and relational trust (Zucker, 1986). The institutional trust is likely to serve as a basis at the beginning of the consortium. Moreover, the implication of external controls and arbitrators in public-funded consortia discourage partners from adopting such behaviours.

Once the agreement is established, any opportunistic behaviour in downstream stages should be handled and addressed referring to the formal arrangements between partners. This may also explain why the presence of opportunism can increase both the importance of relying on contract and trust and, thus, improve their effects on performance.

Conclusion

This paper contributes to management research by addressing the issue of R&D managerial practices within public-funded R&D consortia. We provide a model of R&D managerial practices with a range of organisation, economic and social-based mechanisms. We have also examined the moderating effects of ex-post relational risks on the relationships between these managerial practices and performance. Our findings confirmed the relevance to use a mix of managerial practices. The exploratory *post hoc* analysis allowed us to highlight the need for a package approach to balance several requirements and risks simultaneously. Furthermore, the results highlight the influence of public sponsorship on some aspects of sponsored consortia, especially the innovation process, the choice of managerial practices as well as the perception of relational risks. In this regard, some of our findings could not be extended to the context of private consortia. On the one hand, private consortia would not benefit from the institutional ecosystem in terms of institutional trust, public arbitrator, external control, etc. to reduce relational risks and enforce contractual safeguards. On the other hand, private consortia follow a different innovation process which could result in different managerial problems and/or relation risks and, thereby, different managerial practices.

Despite these contributions, this work has some limitations which indicate future research avenues. In this regard, future research could include additional MC mechanisms as well as specific measures of performance. Given the characteristics of our sample, we approached performance in broader terms, which may not be sufficient for other types of consortia, especially private ones. Furthermore, future qualitative studies are needed to test the package approach and understand how the package articulates several MC mechanisms at the same time and resolves optimally tensions between control and innovation. Finally, some MC practices could be independent in relation to one managerial problem/risk, but interdependent for

other managerial problems/risks. Future research could examine the impact of a combination of relational risks on a combination of MC mechanisms using a macro process method (Hayes, 2018).

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