

## EFFECT OF CONTEXTUAL FACTORS ON SCIENCE–INDUSTRY R&D COOPERATION. A FUZZY-SET ANALYSIS

Anna KWIOTKOWSKA

Silesian University of Technology, Gliwice; akwiotkowska@polsl.pl, ORCID: 0000-0001-5204-1259

**Abstract:** This study examines the different contextual factors (previous cooperative experiences, the partners' reputation, attraction capacity, a clear definition of objectives, proximity between partners and institutionalization) that, according to the literature, affect the performance of science-industry R&D partnerships. These factors are the preconditions of the contract that are the reference framework in which future relations between the partners are planned. The purpose of this paper is to discuss these factors and to present a causal model to explain how these contextual factors lead to the success of science-industry R&D cooperation. The analysis uses fs/QCA methodology, which allows identifying a combination of causes that lead to the outcome. Results support the argument that different causal paths (combinations of contextual factors) explain profitable R&D contracts.

**Keywords:** science-industry partnership, R&D contracts, contextual factors, fuzzy-set Qualitative Comparative Analysis (fs/QCA).

### 1. Introduction

Science-industry R&D cooperation has been made one of the strategic trends in recent years, and both parties can benefit from the cooperation process (e.g. Perkmann, Neely, and Walsh, 2011; De Fuentes, and Dutrenit, 2012; Soh, and Subramanian, 2014). According to the literature on issues of open innovation (Chesbrough, 2003) and joint technology initiatives, research joint ventures, as well as communities of practices, companies must open up to external relationships with competent knowledge-generating organizations (e.g. research institutions) to gain new and fresh ideas that will allow them to innovate and take advantage of market opportunities. In today's world, the ambition of policymakers and leading research units such as Poland's universities is to develop 'third missions' in addition to the two traditional core missions of research and teaching, and by doing so, to commercialize academic knowledge, for instance through patenting, technology transfer offices, science parks or incubators (Perkmann et al., 2013).

There are many reasons for science-industry R&D cooperation: companies profit from highly qualified human resources (Myoken, 2013); they gain access to technology and knowledge (Barnes, Pashby, and Gibbons, 2002) and they can use expensive research infrastructure (Ankrah, and Al-Tabbaa, 2015). Collaboration with industry has become an inevitable part of science-based institutional funding and the funds from international organizations and business enterprises for R&D in the higher education sector nowadays represent a 'significant source' of income that is funneled into the other two missions (Odagiri, 2003).

For the purpose of this paper, this type of R&D cooperation between companies and research organizations can be defined as the connection between basic research (performed at universities, laboratories, research centers) with applied research (carried out in industries) in such a way that, as a result of a joint operation of both parts, synergies can be created that will improve the economic and technological potential of a country, and consequently, increase its level of competitiveness.

The multiple objectives in the relationships between companies and research organizations, not to mention their complexity and diversity, make it difficult to analyze of this phenomenon and its success. Some of the most common limitations in the literature on science-industry R&D cooperation are the lack of integration regarding the variables, dimensions and measures employed, the definition of the unit of analysis and the shortage of empirical evidence. Therefore, new studies must be carried out to analyze and evaluate this type of relationship and to identify the multiple paths of the determining factors of success.

A number of key factors important to the success of this science-industry R&D cooperation have been identified. These are focused around contextual factors that include specific functions each partner brings to the table and the agreement that must be considered before starting relationships, that is, previous links, partner reputation, proximity between partners, the need to define the objectives clearly and to make the relationship institutionalized at the time the cooperation begins (Hemmert, Bstieler, and Okamuro, 2014; Kayser, Schmidt, and Dal Ri, 2018; Wit-de Vries, et al., 2019).

In the literature, these factors are generally defined as the initial contractual terms – the reference framework in which future relationships between partners are planned. Of equal importance in the early stages of cooperation are the contextual factors. Accordingly, this study examines how the contextual factors that the literature lists as the initial conditions for R&D cooperation (namely, previous cooperative experiences, the partners' reputation, attraction capacity, a clear definition of objectives, proximity between partners and institutionalization) affect the performance of such agreement.

To overcome the methodological challenges of testing the multiple paths of the combinations of selected, contextual factors, the current research used fuzzy set qualitative comparative analysis (fs/QCA). Woodside (2013) emphasizes the importance of a whole view for exploring actual phenomena, and the appropriateness of fs/QCA for analyzing data, which

focuses on a causal recipe for explaining the influence of all ingredients, rather than the unidirectional net effects of the variables. It is worth noting that the previous studies use statistical methods to establish causal relations in varieties of models to examine individual factors that affect outcome of events. Rather than estimating the average net effect of particular contextual factors, the study assesses how multiple, alternative combinations of selected, contextual factors explain the success of science–industry R&D cooperation.

The aim of the study is to identify by using fs/QCA, the combinations of contextual factors that lead to successful science–industry R&D cooperation. By using fs / QCA, it is possible to better understand the combinations of initial conditions that successively lead to productive R&D collaboration.

In this paper, Section 2 develops the theoretical background and propositions. Section 3 describes the research method, variables, measures, data collection process, and analysis method. Section 4 presents the empirical results. Section 5 discusses these results and offers conclusions and highlights some limitations.

## **2. Theoretical background**

In terms of contextual factors, previous cooperative relationships are relevant. These factors relate to what may be called ‘learning in a cooperative relationship’, so organizations which have collaborated in the past will have some experience in cooperation. As indicated by Reuer, Zollo and Singh (2002), contextual factors have a two-fold dimension: the nature of an earlier cooperative agreement, i.e. the type of activities carried out as part of a previous relationship, and the current features of the cooperating partner. It can, therefore, be concluded that previous links affect current links.

Literature on science-based collaborative R&D partnerships suggest certain common contextual factors that lead to the success of such alliances (e.g. Schartinger et al., 2002; D’Este, and Patel, 2007; Arza, 2010; Perkmann, and Salter, 2012). An in-depth description and discussion of each of these factors follows.

There are many studies postulating that the result of cooperative relationships would be better if partners have had previous cooperative experience that could help develop effective strategies. This situation applies both to interorganizational relationships in general, as well as within the framework of cooperation between particular companies and research organizations (Laursen, Reichstein, and Salter, 2011; Soh, and Subramanian, 2014). In the context of science–industry alliances, a firm's decision to ally with a university depends on the measure of academic and research performance displayed by the institute. Furthermore, agreement will have a greater level of success if the activities involved in previous cooperative relationships are related to those of the current cooperative agreement, or if there has been some kind of

positive collaboration in the past between the parts cooperating at the present time. In accordance with previously conducted research, in this current study, it is argued that experience in the form of records of achievements and historical successes is the key to attracting funds and partners. Hence, previous positive cooperative experience contributes to more profitable R&D partnerships. In this study, previous cooperative experience refers to the number of publications that capture the quality of research and also stimulate future research activities. According to Kao and Hung (2008), publications in well-known indexed journals not only reflect quantity, but also quality aspects of research. The role that bona fide, peer-reviewed research write-ups play in advancing cooperation is possible because scientists send articles to reputable journals that follow a double-blind peer review system, and all articles must meet academic quality standards that are set quite high. Thus, restricting the research productivity search to only those scientific articles appearing in top journals is a suitable approach.

The second of the contextual factors analyzed was the partners' reputation related to the particular features of the partners who intend to cooperate. This applies to information about the mentioned partners that may disclose the organization's management characteristics, the quality of their products, or their financial status. If this information is positive, the partner's image will be positive, and consequently his reputation will be beyond dispute. It is important that both the company and the research organization must have sufficiently good industrial and research qualifications.

The partner's reputation also depends equally on previous achievements and the prestige of those currently involved in the organization (Hemmert, Bstieler, and Okamuro, 2014; Bstieler, Hemmert, and Barczak, 2015). Thus, although organizational reputation refers to the past achievements and performance of the organization as a whole, that is to its technological, production or commercial excellence, personal reputation is characterized by the professional experience of members currently working for the organization. It can, therefore, be concluded that the reputation of the partners is a key factor affecting both the success of cooperative relations and the success of cooperation agreements between companies and research organizations.

In the process of seeking new partners for cooperation between industry and science, marketing and promotion of research activities are also of great importance. Units specially established for this purpose in research centers together with scientists participate in this. To achieve this goal, research institutions can use different formulas. Publication and patenting are the first step; however, research institutions must develop appropriate marketing strategies to communicate, deliver and exchange offers of potential value to partners. Although earlier studies suggests that informal networks are sufficient to trigger future successful science–industry relationships, complementary strategies are needed to attract potential partners (Batonda, and Perry, 2003; Rivers, and Gray, 2013). By scanning the environment and targeting potential partners, studies suggest that further strategies must focus on generating organizational awareness and transforming that awareness into new relationships. Studies show

that the combination of different communication channels, including social networks and transactional marketing, are effective methods for identifying potential partners. Hence, these methods are appropriate mechanisms for disseminating the activities of research institutions and, more importantly, for making their offer publicly available. Efforts are effective if they translate into new productive partnerships, but maintaining long-term partnerships is the ultimate goal within the factor related to specific attraction capacity.

In science-industry R&D cooperative relations, another important factor in the literature is the provision of a clear definition of objectives. A clearly defined set of goals mean a plainly and accurately formulate of the objectives pursued in the cooperation agreement, both individually, for each of the partners involved, and comprehensively, for the association itself (Jones-Evans et al., 1999). The literature emphasizes that the goals and objective set in the framework of interorganizational relationships must be known and accepted, and must be clear, accurate, flexible, well-defined, real and relevant (e.g. Jones-Evans, et al., 1999; Barnes, Pashby, and Gibbons, 2006).

There are at least two reasons why a precise definition of the tasks and responsibilities of cooperating partners is needed (Davenport et al., 1999a, 1999b). First of all, achieving goals requires the correct identification of the tasks and responsibilities of each partner. Secondly, if the goals are not achieved, the reasons for this state of affairs can be analyzed by checking whether the participants failed in their tasks, which in the case of identification and definition of these tasks seems basic. As previous research shows, flexibility in formulating objectives, clearly defining the responsibilities and tasks of all partner parties, as well as the existence of common goals, contributes to the success of cooperative relationships between companies and research organizations.

As third contextual factor, that of proximity between partners has some relevance. This factor refers to the physical distance between cooperating partners, that is, the location of one part relative to the other. In the literature, this factor is usually equated with the term ‘geographical proximity’ in such a way that, if the partners are physically close together, their geographical proximity will be closer (e.g. Berbegal-Mirabent, García, and Ribeiro-Soriano, 2015). Several aspects or dimensions relating in particular to this factor may be mentioned such as location or geographical point where the cooperating partners are located, physical distance between partners and travel time spent by partners. The geographical proximity facilitates knowledge flows and, as a result, learning processes because closeness has a positive effect on the number of interactions (Torre, and Gilly, 2000). Since tacit knowledge plays an important role in innovation processes and frequent and repeated face-to-face contacts are key to its transmission, proximity is a facilitator. Moreover, geographical proximity reduces uncertainty and contributes to the building of trust which reduces the transactions costs involved in joint projects and results in more stable and longer lasting relationships (Bennet, Bratton, and Robson, 2000; Love, and Roper, 2001). Longer relationships, in turn, encourage sharing of more valuable knowledge, which leads to better alignment between expectations and results,

greater trust and growing profits from cooperation (Abramovsky, and Simpson, 2011), especially in relation to intangible results (Barge-Gil, and Modrego, 2011). It can be concluded that higher effectiveness in the relationships between partners is, among others, a consequence of reduced expenses on travel, communication and information, as well as time-consumption. In addition, proximity between partners has a positive effect on the productivity of the firm-research organization collaboration.

Another, contextual factors concerns institutionalization – the level of formalization of relations between the cooperating parties. The institutionalization dimensions can include the level of systematization, planning and organization. The greater the number of rules, procedures governing relationships and mutual agreed-upon arrangements, legal issues and administrative procedures (Barnes, Pashby, and Gibbons, 2002; Muscio, and Vallanti, 2014), the more institutionalized the cooperative relations will be. The development of mutually accepted mechanisms and processes, including the roles taken up in research teams and the use of common terminology, can improve the collaboration (Canhoto et al., 2016). Indeed, positive effects and success in cooperation are reported when responsibilities and roles are clarified from the very beginning of the partnership (Barnes, Pashby, and Gibbons, 2002). Thus, the better planned, organized and institutionalized the cooperation, the better will be the results achieved in the process of technology transfer.

The following proposition is consistent with this theoretical framework. Proposition: Different combinations of previous cooperative experiences, the partners' reputation, attraction capacity, a clear definition of objectives, proximity between partners and institutionalization lead to the success of science-industry R&D cooperation.

### **3. Data collection, measures and analysis method**

Data collection took place through in-house surveys in organizations and face-to-face interviews with Senior Managers, Project Leaders, and Project Team Members of 131 R&D projects. The research area was cooperation agreements in the field of research and development, in which at least two partners participate: a private business and an external organization specializing in research and technological services. The sample was based on selected contracts – projects carried out by technology centers in Poland that meet the following requirements: (1) the contract was concluded between January 2018 and January 2019; (2) two types of participating partners are involved: private enterprise and public/semipublic research institutions. Since a company can participate in more than one project, the total number of sample companies is 53. Regarding the type of partner cooperating with the company, 76% correspond to universities, 24% to technology centers. Finally, these contracts must last

for an average of three years, and include the performance of activities related to cutting edge information and communication technologies, as well as application of the latest technologies.

Each survey had a structured part based on earlier validated questionnaires, the aim of which was to gain quantitative input data to define the value on every condition (contextual factors) and outcome. The next part of the survey was semi-structured that, in combination with the document study, enabled the author to develop full understanding of the case – the selected projects. Thorough understanding of the cases is key in fsQCA (Rihoux, and Ragin, 2009), as it allows the researcher to develop case-comparative expertise, to validate and motive each case score, and to interpret the outcomes of the analysis. Given between-case comparison rather than within case analysis was the aim of this research, and was done by conducting one or two interviews per case complemented with additional secondary data. This is a common data collection strategy for QCA-studies.

All measures stem from established scales in the management literature. In most cases, scales consisting of a set of items were used, which were assessed in a range from 1 to 7. As for the outcome, that is, the success of the R&D cooperation, one measure used refers to the level of global satisfaction of the parts of the agreement (Cronbach's  $\alpha = 0.92$ ). Most studies consider satisfaction as an acceptable indicator of the achievement of objectives in a cooperative agreement. Therefore, satisfaction with the perception of partners was identified on some aspects of the cooperative relationship. Hence, three items were proposed that relate to specific global aspects of the project. These are partner performance, contract development and global project results (Mohr, and Spekman, 1994).

Previous cooperative experiences are measured through prior links, common prior business or previous cooperation in specific projects. The measure of cooperative experience (Cronbach's  $\alpha = 0.84$ ) is based on two items related to the nature of the prior agreement and to the features of the partner with whom the collaboration took place (Reuer et al., 2002). The measure for partner reputation (Cronbach's  $\alpha = 0.87$ ) is formed by a three-item scale which rates organizational reputation and the reputation of those people taking part in the partnership (Martínez, and Pastor, 1995; De Laat, 1997). The measure of attraction capacity is based upon the proposal of Berbegal-Mirabent and Llopis-Albert (2016) and is the number of new partnerships established per year of the study. The measure for the definition of objectives (Cronbach's  $\alpha = 0.81$ ) is made up of three items which rate whether the objectives are clear and precise, whether they are known and accepted by the partners and, whether the tasks and responsibilities of the parts undertaken are known and accepted by the partners (Jones-Evans, et al., 1999). To measure the impact of distance (Cronbach's  $\alpha = 0.93$ ) between partners on the success of cooperation agreements, two indicators were proposed, namely distance and time (Beise, and Stahl, 1999). Finally, a two-item scale was used to measure the degree of institutionalization (Cronbach's  $\alpha = 0.79$ ) that results from the stems from the measures proposed in the studies by Bonaccorsi and Piccaluga (1994). All item loadings are higher than 0.7. The reliability of the scale used in these studies is therefore acceptable.

This study uses fuzzy-set qualitative comparative analysis (fs/QCA), a set-theoretic analysis technique, to analyze the causal conditions that lead to success of science-industry R&D cooperation. The aim of fs/QCA is not to prove the existence of causal relationships, but rather to reveal patterns that support the existence of causal relationships (Schneider, and Wagemann, 2010). Set-theoretic analysis examines causal patterns, focusing on relationships among subsets. This study first uses fs/QCA to evaluate the group of attributes comprising the subsets of contextual factors and then identifies the combinations of conditions (contextual factors) that relate to science-industry R&D cooperation. Fs/QCA uses Boolean algebra and algorithms to reduce a large number of complex causal conditions to a small set of configurations that lead to a certain outcome. The fs/QCA 2.5 software provides an output consisting of a complex solution, a parsimonious solution and an intermediate solution (Mas-Verdú, Ribeiro-Soriano, and Roig-Tierno, 2015). Rihoux and Ragin (2009) argue that the intermediate solution is superior and has considerable benefits over the other two solutions.

According to Ragin (2008), and Schneider and Wagemann (2012), fs/QCA has three phases. The first phase involves calibrating the conditions (contextual factors) and the outcome. Calibration consists of determining whether a condition is fully in a set (1), fully outside a set (0), or at the point of maximum ambiguity (0.5) (Ragin, 2008). For each outcome and conditions (contextual factors namely: previous cooperative experiences, the partners' reputation, attraction capacity, a clear definition of objectives, proximity between partners and institutionalization), those observations falling in the percentile-90 are considered to represent full set membership. Percentile-10 is the threshold value for indicating full non-membership. The crossover point is defined by the median. Table 1 shows the calibration process and indicates the transformation into fuzzy terms of both the outcome – the success of the R&D cooperation and the conditions – contextual factors.

**Table 1.**  
*Distribution of each factor and its corresponding set*

Factor	Coding	Membership threshold values		
		Full non-membership (0.05)	Crossover point (0.5)	Full membership (0.95)
Success of the R&D cooperation	Success	0.16	1.50	2.91
Previous cooperative experiences	Experience	0.23	2.36	4.29
Partners' reputation	Reputation	0.24	2.49	4.81
Attraction capacity	Capacity	0	4.5	19.5
Clear definition of objectives	Objective	0.34	3.46	6.79
Proximity between partners	Proximity	0.25	2.33	4.29
Institutionalization	Institution.	0.30	3.07	5.83

The second phase consists of performing an analysis of necessary conditions to determine whether a condition is necessary to cause the outcome. A condition is necessary when its consistency score exceeds the threshold value of 0.9 (Schneider, Schulze-Bentrop,



and Paunescu, 2010). In this study no necessary conditions were found. The third phase is to perform an analysis of sufficient conditions to determine which conditions or combinations of conditions are sufficient to cause the outcome.

#### 4. Findings

Table 2 presents results from the analysis of sufficient combinations of conditions. As mentioned earlier, this study reports the intermediate solution. Notation for the solution table follows the Ragin and Fiss (2008) approach. Herein, black circles (●) indicate the presence of a condition, white circles (○) denote its absence, and blank cells indicate ‘don't care’ conditions. Four causal configurations lead to the success of the R&D cooperation. No single condition appears consistently across all recipes. In this table, each row represents a combination of causal conditions with their corresponding raw coverage, unique coverage and solution consistency. The numbers at the bottom of the table represent the coverage and consistency of the solution as a whole. The figure provides coverage scores, a measure of the importance of a configuration that indicates how many cases take this path to the outcome – the success of the R&D cooperation.

**Table 2.**

*Combinations for achieving outcome – the success of the R&D cooperation*

Conditions (contextual factors)	Combinations			
	1	2	3	4
Experience	●		●	●
Reputation	●	●		
Capacity		○	●	●
Objective	●	●		●
Proximity		●	●	
Institution.	○	○		○
Consistency	0,92	0,94	0,95	0,91
Raw Coverage	0,42	0,41	0,32	0,23
Unique Coverage	0,08	0,07	0,05	0,08
Overall Solution Coverage	0,66			
Overall Solution Consistency	0,89			

Note. Filled circles indicate above-threshold levels of the respective condition. Empty circles indicate below-threshold levels. Blank cells indicate ‘don't care’ conditions. Experience – Previous cooperative experiences; Reputation – Partners' reputation; Capacity – Attraction capacity; Objective – Clear definition of objectives; Proximity – Proximity between partners; Institution – Institutionalization.

Regarding overall coverage, the intermediate solution accounts for 66% of membership in the outcome and, thus, presents acceptable fit. Further, all combinations show high consistency values between 0.91 and 0.95, with the overall solution consistency at 0.89. The intermediate solution consists of four combinations, namely combinations number 1, 2, 3, and 4. The first combination of the solution (solution term 1 in Table 2) represents the combination of

factors that lead to success of the R&D cooperation: presence of previous cooperative experiences, partners' reputation, clear definition of objectives and absence of institutionalization. The second combination (solution term 2 in Table 2) show that a sufficient condition for success of science-industry R&D cooperation is the combination of presence of partners' reputation, clear definition of objectives, proximity between partners with absence of attraction capacity and institutionalization. The third configuration (solution term 3 in Table 2) that emerges from the analysis indicates that a combination of previous cooperative experiences and attraction capacity with proximity between partners also lead to success of the R&D cooperation. The fourth and the least configuration of conditions (solution term 4 in Table 2) combine the presence of previous cooperative experiences, attraction capacity and clear definition of objectives with absence of institutionalization.

One key advantage of using set-theoretic analysis is that this approach allows for the formal expression of theoretical statements using Boolean notation, and researchers can later evaluate such formal expressions against observed configurations. In the current study, the outcome of interest is the success of the R&D cooperation (S), and the conditions of interest are previous cooperative experiences (E), partners' reputation (R), attraction capacity (C, with "c" indicates a lack of specific attraction capacity), clear definition of objectives (O), proximity between partners (P) and institutionalization (I, with "i" indicates low level of formalization of relations between the parties). Using this notation, where the "+" sign presents the logical "or" and the arrow is the logical implication sign, the set of obtained results (X) expression is as follows:

$$(X): EROi + RcOPi + ECP + ECOi \rightarrow S$$

When analyzing the effect of experience, the additive effect of this factor is important in a causal recipe, that is, experience always positively contributes to explaining the outcome. A similar situation occurs in the case of three further, contextual factors, i.e. reputation, clear definition of objectives and proximity between partners. When it comes to the attraction capacity, the results are imprecise. Although the presence of this condition occurs in two combinations, its absence is significant in one recipe. As for the attraction of new customers, the underlying rationale behind this result may owe to the fact that research units aim at establishing trustworthy relationships with knowledge-seeking partners. Because trust builds a flexible working environment that contributes to the free exchange of information, partners show a higher commitment to the agreement, higher motivation to achieve their joint goal, and higher willingness to sustain the alliance in the long term, thus resulting in the consolidation of the list of clients. In addition, the results indicate that the relationship between the institutionalization factor and success of the R&D cooperation on the other can be rejected. Thus, the absence of this contextual factor in combination with other factors leads to the success of cooperation agreements between research companies and organizations. It can be concluded that all the analyzed contextual factors, instead of having an individual effect, are part of a set of sufficient configurations (both their presence and absence) leading to the success of science-industry R&D cooperation.

## 5. Conclusions and discussion

Due to the fact that science and technology must serve society, the use of science- industry R&D cooperation is now becoming one of the main mechanisms by which companies gain access and acquire significant knowledge. The purpose of this paper is two-fold. The first is to identify the combinations of contextual factors that lead to cooperative success, namely previous cooperative experiences, the partners' reputation, attraction capacity, a clear definition of objectives, proximity between partners and institutionalization that lead to success of science-industry R&D cooperation. The second is to demonstrate the value of using fs/QCA in studying R&D cooperation. The achieved results indicate that four different causal paths (combination number 1, 2, 3 and 4) explain profitable R&D contracts.

The current study sheds light on the possibility of achieving profitable R&D contracts by showing the complex configurations of selected, contextual factors with the success of science-industry R&D cooperation. Particularly, the findings reveal that previous cooperative experiences and clear definition of objective are sufficient conditions because they appear in at least three of the five configurations that result from the analysis. These findings are congruent with empirical evidence of previous studies.

Following Ragin's (2008) recommendation, the two causal paths with greater raw coverage (combinations number 1 and 2) deserve further attention. In both cases, the impact of partners' reputation and clear definition of objectives on success of science-industry R&D cooperation has been highlighted. Herein, configuration number 1 presents these previous conditions in combination with the presence of cooperative experiences and absence of institutionalization, while in configuration number 2, this is done in combination with presence of distance between partners and absence of institutionalization.

Research on management can benefit from the approach and methodology that this study adopts. Although information science and operations research apply fs/QCA, this methodology is largely absent from the management literature, especially in Poland. The few examples written-up are the works of the author of this publication or research related to employee job satisfaction (Gębczyńska, 2019). The application of fuzzy set methodology in an area dominated by regressions can offer multiple research opportunities to business and management scholars. This study thus contributes to widening the scope and application of new quantitative techniques.

This research has some noteworthy limitations. First, the findings draw on a single study. The robustness of the results reported here, therefore, requires replication studies. Further, the current study uses subjective measures rather than actual data to assess contextual factors and outcome – the success of the R&D cooperation. Although this is a limitation, some studies report such measures to be satisfactory reflections of actual firm-institute conditions. In addition, informants provide the data. Moreover, while multiple informants may enhance

reliability of the data, single-informant studies are common and effective, and extensive tests for common method bias in the present study do not suggest this to be a major problem.

The results cast a series of practical recommendations that may be useful for the running and management of cooperative agreements. More specifically, the research notes that the initial stages of the agreements are basic to develop agreements with a clear definition of objectives, while previous cooperative experience helps develop effective strategies. To conclude, it must be said that this study represents a starting point for future research studies intended to widen theoretical and empirical evidence about the success of cooperative agreements between firms and research organizations. Future studies could include other contextual or organizational factors to examine the possible mediating or moderating roles of such variables in successful science-industry R&D cooperation.

## References

1. Abramovski, L., and Simpson, H. (2011). Geographic proximity and firm–university innovation linkages: evidence from Great Britain. *Journal of Economic Geography*, *11*, 949-977.
2. Ankrah, S., AL-Tabbaa, O. (2015). Universities–industry collaboration: a systematic review. *Scandinavian Journal of Management*, *31*(3), 387-408.
3. Arza, V. (2010). Channels, benefits and risks of public – private interactions for knowledge transfer: conceptual framework inspired by Latin America. *Science and Public Policy*, *37*(7), 473-484.
4. Barge-Gil, A., and Modrego, A. (2011). The impact of research and technology organizations on firm competitiveness. Measurement and determinants. *Journal of Technology Transfer*, *36*, 61-83.
5. Barnes, T., Pashby, I., Gibbons, A. (2002). Effective university–industry interaction: a multi-case evaluation of collaborative R&D projects. *European Management Journal*, *20*, 272-285.
6. Barnes, T.A., Pashby, I.R., and Gibbons, A.M. (2006). Managing collaborative R&D projects development of a practical management tool. *International Journal of Project Management*, *24*(5), 395-404.
7. Batonda, G., and Perry, C. (2003). Approaches to relationship development processes in inter-firm networks. *European Journal of Marketing*, *37*(10), 1457-1484.
8. Beise, M., and Stahl, H. (1999). Public Research and Industrial Innovations in Germany. *Research Policy*, *28*, 397-422.
9. Bennet, R.J., Bratton, W.A., and Robson, P.J. (2000). Business advice: the influence of distance. *Regional Studies*, *34*(9), 813-828.

10. Berbegal-Mirabent, J., García, J.L.S., Ribeiro-Soriano, D.E. (2015). University–industry partnerships for the provision of R&D services. *Journal of Business Research*, <http://dx.doi.org/10.1016/j.jbusres.2015.01.023>.
11. Berbegal-Mirabent, J., Llopis-Albert, C. (2016). Applications of fuzzy logic for determining the driving forces in collaborative research contracts. *Journal of Business Research*, *69*, 1446-1451.
12. Bonaccorsi, A., and Piccaluga, A. (1994). A theoretical framework for the evaluation of university-industry relationships. *R&D Management*, *24/3*, 229-247.
13. Bstieler, L, Hemmert, M, and Barczak, G. (2015). Trust formation in university-industry collaborations in the US biotechnology industry: IP policies, shared governance, and champions. *The Journal of Product Innovation Management*, *32*, 111-121.
14. Canhoto, A., Quinton, S., Jackson, P., Dibb, S. (2016). The co-production of value in digital, university-industry R&D collaborative projects. *Industrial Marketing Management*, *56*, 86-96.
15. D’Este, P., and Patel, P. (2007), University-industry linkages in the UK: what are the factors determining the variety of interactions with industry? *Research Policy*, *36(9)*, 1295-1313.
16. Davenport, S., Davies, J., and Grimes, C. (1999a). Collaborative research programmes: Building trust from difference. *Technovation*, *19/1*, 31-40.
17. Davenport, S., Grimes, C., and Davies, J. (1999b). Collaboration and organizational learning: A study of a New Zealand Collaborative Research Program. *International Journal Technology Management*, *18/3-4*, 173-187.
18. De Fuentes, C., and Dutrenit, G. (2012), Best channels of academia–industry interaction for long-term benefit, *Research Policy*, *41(9)*, 1666-1682.
19. De Laat, P. (1997). Research and development alliances: Ensuring trust by mutual commitments. In M. Ebers (ed.), *The formation of interorganizational networks* (pp. 146-173). New York: Oxford University Press.
20. Gębczyńska, M. (2019), Constellations of conditions affecting employee job satisfaction in small and medium Polish enterprises A qualitative comparative analysis. *Organization and Management*, *2*, 33-61.
21. Hemmert, M., Bstieler, L., and Okamuro, H. (2014). Bridging the cultural divide: trust formation in university–industry research collaborations in the US, Japan, and South Korea. *Technovation*, *34*, 605-616.
22. Jones-Evans, D., Klofsten, M., Andersson, E., and Pandya, D. (1999). Creating a bridge between university and industry in small European countries: the role of the Industrial Liaison Office. *R&D Management*, *29(1)*, 47-56.
23. Kao, C., and Hung, H.T. (2008). Efficiency analysis of university departments: An empirical study. *Omega*, *36(4)*, 653-664.

24. Kayser, A., Schmidt, S., and Dal Ri, R. (2018). University-industry collaborative projects: analysis and proposal of management practices, *Revista de Gestão e Projetos – GeP*, 9, 24-38.
25. Laursen, K., Reichstein, T., and Salter, A. (2011). Exploring the effect of geographical proximity and university quality on university-industry collaboration in the United Kingdom. *Regional Studies*, 45(4), 507-523.
26. Lin, J.Y. (2014). Effects on diversity of R&D sources and human capital on industrial performance. *Technological Forecasting and Social Change*, 85, 168-184.
27. Love, J., and Roper, S. (2001). Outsourcing in the innovation process: Locational and strategic determinants. *Papers in Regional Science*, 80, 317-336.
28. Martínez, A., and Pastor, A-C. (1995). University-industry relationships in peripheral regions: The case of Aragon in Spain. *Technovation*, 15/10, 613-625.
29. Mas-Verdú, F., Ribeiro-Soriano, D., and Roig-Tierno, N. (2015). Firm survival: The role of incubators and business characteristics. *Journal of Business Research*, 68, 793-796.
30. Mohr, J.J., and Spekman, R.E. (1994). Characteristics of partnership success: Partnership attributes, communication behavior, and conflict resolution techniques. *Strategic Management Journal*, 15/2, 135-152.
31. Muscio, A., and Vallanti, G. (2014). Perceived obstacles to university–industry collaboration: results from a qualitative survey of Italian academic departments. *Industry and Innovation*, 21, 410-429.
32. Myoken, Y. (2013) The role of geographical proximity in university and industry collaboration: case study of Japanese companies in the UK. *International Journal of Technology Transfer and Commercialization*, 12, 43-61.
33. Odagiri, H. (2003). Transaction costs and capabilities as determinants of the R&D boundaries of the firm: A case study of the ten largest pharmaceutical firms in Japan. *Managerial and Decision Economics*, 24(2-3), 187-211.
34. Perkmann, M., and Salter, A. (2012), How to create productive partnerships with universities, *MIT Sloan Management Review*, 53(4), 79-88.
35. Perkmann, M., Neely, A., and Walsh, K. (2011). How should firms evaluate success in university-industry alliances? A performance measurement system. *R&D Management*, 41, 202-216.
36. Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D’Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., Sobrero, M. (2013). Academic engagement and commercialization: a review of the literature on university–industry relations. *Research Policy*, 42, 423-442.
37. Ragin, C.C. (2008). *Redesigning social inquiry: Fuzzy sets and beyond*. Chicago: University of Chicago Press.
38. Reuer, J.J., Zollo, M., and Singh, H. (2002). Post-formation dynamics in strategic alliances. *Strategic Management Journal*, 23/2, 135-151.

39. Rihoux, B., and Ragin, C.C. (2009). *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques*. London: Sage Publications Inc., Thousand Oaks, CA.
40. Rivers, D., and Gray, D.O. (2013). Cooperative research centers as small business: Uncovering the marketing and recruiting practices of university-based cooperative research centers. In C. Boardman, D.O. Gray, and D. Rivers, (Eds.), *Cooperative research centers and technical innovation* (pp. 175-198). New York: Springer.
41. Schartinger, D., Rammer, C., Fischer, M.M., and Frohlich, J. (2002), Knowledge interactions between universities and industry in Austria: sectoral patterns and determinants. *Research Policy*, 31(3), 303-328.
42. Schneider, C.Q., and Wagemann, C. (2010). Standards of good practice in qualitative comparative analysis (QCA) and fuzzy-sets. *Comparative Sociology*, 9(3), 397-418.
43. Schneider, C.Q., and Wagemann, C. (2012). *Set-theoretic methods for the social sciences. A guide to qualitative comparative analysis*. Cambridge: Cambridge University Press.
44. Schneider, M.R., Schulze-Bentrop, C., and Paunescu, M. (2010). Mapping the institutional capital of high-tech firms: A fuzzy-set analysis of capitalist variety and export performance. *Journal of International Business Studies*, 41(2), 246-266.
45. Soh, P.H., and Subramanian, A.M. (2014). When do firms benefit from university–industry R&D collaborations? The implications of firm R&D focus on scientific research and technological recombination. *Journal of Business Venturing*, 29(6), 807-821.
46. Torre, A., and Gilly, J.-P. (2000). Debates and surveys: On the analytical dimension of proximity dynamics. *Regional Studies*, 34(2), 169-180.
47. Wit-de Vries, E., Dolfsma, W., Windt, H., and Gerkema, M.P. (2019). Knowledge transfer in university–industry research partnerships: a review. *The Journal of Technology transfer*, 44(4), 1236-1255.