

R&D Cooperation and Innovation Networks: Lessons From SME Participation in H2020

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Abstract: Portuguese SMEs are ‘catching-up’ to the European Commission’s goal of 20% for SME participation in H2020, representing 16,7% of allocated funds.. Previous R&D experience, and especially R&D cooperation, have been identified as key determinants of participation in Framework Programmes, such as H2020. Thus, it is important to know SMEs that engage in these experiences and the drivers that lead them to it. This paper seeks to identify why and how SMEs gain collaborative experience with HEIs; what are the organizational characteristics that foster collaboration; the types of experiences in which SMEs are engaged with HEIs; the obstacles they face when applying for FP funding, and how these can be overcome. Lastly, we aim to draw lessons that foster SMEs’ participation in Framework Programmes. To achieve these goals, we conducted a survey with SMEs that collaborate with HEIs (N = 26), including SMEs that participated in H2020 and SMEs that didn’t. We then complemented the survey with six in-depth qualitative interviews with both FP participants and non-participants.

Keywords: Small and medium enterprises, Higher education institutions, Framework programme, Collaborative R&D

1. Introduction

European Union Framework Programmes (FPs), such as Horizon 2020 (H2020) can create and strengthen research and development (R&D) networks and cooperation between higher education institutions (HEIs) and small and medium enterprises (SMEs), given the collaborative nature of participant consortiums. FPs thus contribute to innovation networks. For HEIs, FP funding can work as a strategy to tackle reduced national research budgets (Enger, 2018). Particularly for SMEs, FP funding can counter usually faced barriers relating to R&D, such as lack of financial resources for investment in technology and qualified human resources (Barajas and Huelgo, 2010; Lesáková, 2009).

SMEs are a key element of the European economy accounting for 99% of the companies operating in the non-financial business sector (European Court of Auditors, 2020). In 2019, 64,5% of enterprise workers were employed by SMEs (Eurostat, 2023). The importance of SMEs and their tendency for low participation in the FP has led the European Commission to work towards increasing their participation, having set a goal of 20% for H2020 allocated funds to SMEs. Although the goal has been met (24%) (European Commission, 2020), this is not the case for every Member-State. For example, SMEs account for 16,7% of H2020 allocated funds in Portugal (Agência Nacional de Inovação, 2020).

Discrepancies in participation come as no surprise taken the literature on European funding for R&D points to a ‘Matthew Effect’ (Merton, 1968 as cited in Enger and Castellacci, 2016; Enger, 2018). When looking at FP participants, it is possible to identify ‘oligarchic networks’ that prevent newcomers through cumulative advantages, such as more resources for R&D and/or central network positions that reinforce themselves overtime (Enger, 2018). This ‘Matthew Effect’ also translates geographically. Some instruments in previous FPs, such as Networks of Excellence and Integrated Projects, have increased the bias towards large consortia located in North-West Europe thus accentuating inter-regional differences (Amoroso et al., 2018; Marimon, 2004). Although this literature points to plausible arguments explaining low participation of small entities and particularly small firms in peripheral Member-States such as Portugal, it doesn’t focus on the specificities of such organizations. Most literature on FP participation focuses on HEIs. To address this gap, we turned to literature on corporate R&D, including focusing on SMEs’ participation in FP, asking what determines SMEs’ participation in European funding for R&D. Participation usually entails a successful application or project submission. Yet, participation can also be thought of as applying for funding, regardless of the application’s success. Since a successful application depends on the decision to apply, we are interested in what drives SMEs to apply. Thus,

we ask what drives SMEs to be interested and apply for funding and not necessarily what determines application success which we nevertheless briefly address.

2. Research Questions and Literature Review

SMEs' decision to participate in the FP is based on trade-offs between expected benefits of cost sharing and expected short-term costs of participation (Faber et al., 2016). The FP's administrative requirements are complex and demanding, often leading SMEs not to apply (Barajas and Huergo, 2010). This decision may be the result of an objective cost-benefit calculus, but it can also result from misconceptions about the FP, such as 'loss of control' of the company, a perceived inadequacy of the FP for the firm's needs, or simply a lack of information (Romero-Martínez et al., 2010).

Apart from the H2020's SME Instrument, FP projects entail R&D cooperation which turns R&D partners, partnerships, and respective perceptions into important variables to consider. Different entities may pursue different goals, preferring specific kinds of R&D outputs over others. Commercial products as R&D outputs are more valued by SMEs (Luukkonen, 2002) than HEIs (Grimpe et al., 2022). SMEs are more market-driven than research-driven (Hervás-Oliver et al., 2021). A perceived incompatibility of goals may then result in SMEs deciding not to form partnerships. Conversely, it doesn't come as a surprise that SMEs with prior experience of R&D cooperation are more likely to apply for the FP (Barajas and Huergo, 2010). Previous experience gives firms more confidence for future cooperation (Mora-Valentin et al., 2004 as cited in Catarino and Teixeira, 2009). This, of course, points to previous R&D experience in general as a key factor for FP participation. Additionally, previous collaborative experience fosters networking which makes it easier to find adequate partners for future participation (Barajas and Huergo, 2010).

Although the FP can in principle create research networks, previous R&D experience and, especially, collaborative R&D experience appear to be an important factor determining participation in the FP. This resonates with the 'Matthew Effect' pointed by Enger (2018) when researching about HEIs' participation in H2020. Hence, it is important to ask: how and why do SMEs gain collaborative R&D experience with HEIs? What are the characteristics of SMEs that engage in these experiences? What obstacles do these experiences help overcome when applying for European funding? What can we learn from SMEs that participate in the FP?

Most literature regarding the relation between organizational characteristics and participation in the FPs focuses on HEIs. We thus sought to combine the literature on corporate R&D, especially regarding SMEs, with some important characteristics that help predict involvement in collaborative R&D. This, however, requires further research to which we pretend to contribute with this paper. Additionally, to better grasp the reality of SMEs that are more engaged in R&D, we borrow the concept of 'academic firms' (Campbell et al., 2013; Campbell and Carayannis, 2016). The 'academic firm' is an ideal type of firm focusing on knowledge application but also on knowledge production, balancing profit generation with a goal of knowledge production. These firms encourage research work, value education and life-long learning for their employees, have cross-employment experiences, such as hosting PhD researchers in collaboration with HEIs, and value 'traditional' academic R&D outputs such as scientific publications. We thus analyze Portuguese SMEs engaged in collaborations with HEIs with this ideal type in mind, contributing to its empirical verification.

Organizational size, as measured by the number of researchers, is a determinant of HEIs' participation in FP (Enger and Castellacci, 2016). Similarly, Kelly and Arora (1996) as cited by Catarino and Teixeira (2009) refer that SMEs only engage in collaborative R&D when they have enough human resources to do so, suggesting a relationship between size and collaborative R&D. However, in their study of Spanish SMEs, Barajas and Huergo (2010) found a negative relation between firm size as measured by the number of employees and propensity to apply for FP funding, highlighting that this may be explained by specific Spanish policies towards increasing SMEs' participation in FP, and thus pointing to policy as an important factor. Besides enough human resources, another important factor is their stability. Work force turnover negatively impacts SMEs' engagement in R&D (Grego-Planer and Kus, 2020). On another note, internationalized SMEs, such as exporters, are more likely to engage in collaborative R&D (Lesáková, 2009) and apply for FP funding (Barajas and Huergo, 2010).

Still regarding human resources, professional qualification is a key factor for R&D activity (Aschhoff, 2010; Lepori et al., 2015). Education and professionalism increase 'boundary-spanning activity' (Damanpour, 1991). However, it is important that firms have specific employees dedicated to R&D (Wang et al., 2010). A R&D formal organization, such as a R&D department or manager, is an important factor for R&D and innovation (Damanpour, 1991; Terziovski, 2010). Additionally, 'academic firms' usually engage in cross-employment, such

as the employment of PhD students, which suggests partnerships with doctoral programs and thus with HEIs as an important factor (Campbell and Carayannis, 2016).

Based on this literature review, focusing on SME-HEI relations, SMEs' organizational characteristics that may determine their engagement in collaborative R&D and, hence, their participation in FP funding, we intend to answer the already outlined research questions, hoping to draw lessons from Portuguese SMEs.

3. Methodology

To answer these questions, we conducted a survey with 'Leader' Portuguese SMEs that engage in collaborative R&D with HEIs (N = 26). Amongst these, 15,4% haven't participated (N = 4) in H2020 and 84,6% have participated (N = 22). All surveyed SMEs share the 'Leader' 'seal of approval' of the Portuguese Agency for Competitiveness and Innovation for high performance SMEs, indicating that both groups constitute highly competitive SMEs. Additionally, when gathering the data base for the survey, we 'matched' H2020 participant SMEs' activity sector and district with non-participant SMEs to make sure both groups were as similar as possible. We then complemented the survey with in-depth semi-structured qualitative interviews with three H2020 participant SMEs and three non-participants. The interviews allowed us to explore more deeply the answers provided in the survey. The interviews were transcribed, categorized, and analyzed through a common analysis grid.

4. Data Analysis

This section is divided into four major themes that will shed light on the elements that influence, enable or hinder R&D cooperation involving SMEs and HEIs. First, we examine the key organizational characteristics of SMEs engaging in R&D, exploring their structure and priorities. Second, we examine the importance of human resources in the context of R&D in SMEs, highlighting the critical role of skilled individuals in driving innovation and, thus, participation in R&D programs such as FPs. Third, borrowing from the concept of 'academic firms' which, among other factors, entail a balance between profit goals and knowledge production (Campbell and Carayannis, 2016), we discuss different preferences of R&D outputs and R&D strategies of SMEs, providing a deeper understanding of their approach to collaborative R&D, and exploring the empirical relevance of this concept. Finally, we identify the obstacles that SMEs with partnerships with HEIs find when applying for European funding. By examining these challenges, we aim to provide recommendations for policymakers and stakeholders to improve the environment for successful collaborations between SMEs and HEIs within FP.

4.1 Organizational Characteristics of SMEs Engaging in R&D

Table 1: Organizational Characteristics of SMEs for R&D

	Yes	No
Hiring PhD students	46,2%	53,8%
Partnerships with doctoral programs	38,5%	61,5%
Department, section, or R&D group	96,2%	3,8%
R&D manager or person in charge	80,8%	7,7%

Source: Author's survey

Table 1 suggests that nearly half of the organizations recognize the value of having highly educated researchers on their teams, since 46,2% hire PhD students. However, only 38,5% of SMEs have partnerships with doctoral programs, indicating that on the one hand, SMEs that hire PhD students do not necessarily have a formal ongoing partnership with HEIs, and that on the other hand, most SMEs are not currently involved in such partnerships. In the qualitative semi-structured interviews, when asked about hiring PhD students and partnerships with PhD programs, most SMEs' representatives recognized the importance of having PhD researchers on their companies. Yet, only one of the interviewed SMEs has a formal PhD protocol to host researchers. Interestingly, this protocol is held with the HEI where the SME itself was created as a spin-off. Others claim not to have an organized or big enough structure to formally host researchers themselves nor availability to do so given their workflow. However, the interviews allowed us to explore the relation between human resources and HEIs established through internships. Some of these SMEs host bachelor and/or master level interns. When asked about the origin of these partnerships, most stated that these arose from personal connections to HEIs, such as being alumni.

In terms of R&D organization, Table 1 highlights that a vast majority (96,2%) of SMEs have a R&D dedicated department, section, or group, with 80,8% stating to have a R&D manager or a person in charge. This indicates a strong commitment to research activities and the importance of leadership and management in driving R&D efforts. Amongst the interviewees, the spin-off SME - closer to the ideal-type of 'academic firm' given the centrality of R&D in the company – who regards FP participation as a key activity of the firm, not only has an R&D department and R&D manager, but also a person in charge of FP projects within the department. Contrastingly, three interviewees do not have an R&D formal organization, but two of them engage in R&D, nonetheless. Interestingly, both are in the agricultural sector and claim to have been approached by HEIs to engage in collaborative R&D. This points to at least an R&D dedicated person as a driver for collaborative R&D initiative and, hence, FP participation.

Regarding other characteristics of SMEs, our sample of SMEs engaged in collaborations with HEIs also revealed that 76.9% of SMEs are exporters; 65.4% participate or have participated in FPs; 34.6% have 10-49 workers, 23.1% have 50-99 workers, and 30.8% have 100-249 workers. These results point to SMEs that engage in R&D partnerships with HEIs as having certain characteristics in common. Most of them have an R&D department, group or section, and a R&D manager; invest up to 9% of their turnover in R&D; have up to 100 workers; and are exporters. Furthermore, most of these SMEs are or have been participants of FPs, have official partnerships with doctoral programmes, and hire PhD candidates. Therefore, these SMEs may represent embryo examples of 'academic firms' driven by supporting and advancing knowledge production (Campbell & Carayannis, 2016). However, the below target allocation of H2020 funding to Portuguese SMEs suggests we look at other possible explanatory variables.

4.2 Human Resources in SMEs and R&D

Table 2: Importance of Human Resources in SMEs for R&D

	N	Minimum	Maximum	Mean	Std. Deviation
It is difficult to recruit qualified human resources for R&D	23	1	5	3,57	1,237
R&D activities are performed by human resources that are already in the company	23	2	5	4,13	0,694
For R&D activities, it is important to have stable human resources in the company	23	4	5	4,70	0,470

Source: Author's survey

Table 2 focuses on the role of human resources in R&D. The data shows a moderate level of difficulty in recruiting qualified R&D personnel, with a mean score of 3,57 (1,24). This finding suggests that SMEs face challenges in attracting and hiring the right talent for their R&D initiatives. The data also reveals that most SMEs (4,13 (0,69)) rely on their existing workforce for R&D activities, potentially due to the difficulties in recruiting new talent or a desire to leverage in-house expertise. Finally, the high mean score of 4,70 (0,47) for the statement 'for R&D activities, it is important to have stable human resources in the company' emphasizes the need for a stable workforce in R&D endeavours. In the interviews, all SME representatives stated to value human resources stability, especially in highly skilled functions, namely due to the long 'on the job training'/integration time in the company's activities. However, most of them admitted to struggling to find and maintain appropriate human resources for different perceived reasons: a younger and more willing to rotate generation of skilled workers; competing for human resources with other sectors or foreign companies offering better conditions – the latter enhanced with the possibility of remote work; but also, an increasing demand and scarce supply of highly trained professionals, especially in the IT sector. Regarding qualifications, most of the interviewees privilege at least a bachelor's degree, except for the spin-off SME that demands a master's degree for the R&D department. This was also the only interviewed SME that currently employs workers with a PhD.

Drawing a connection between Table 1 and Table 2, SMEs that have a dedicated R&D department or group and an R&D manager might be more likely to invest in stable human resources and engage in collaborations, such as hiring PhD students or partnering with doctoral programs. Encouraging firms to pursue this kind of organization can eventually create more potential FP participants. Additionally, encouraging organizations that already

present these characteristics to actively participate in the FP can contribute to the creation and strengthening of research networks, fostering collaboration between SMEs and HEIs.

4.3 SMEs Engaged in HEIs Collaborations as 'Academic Firms'

Table 3: Importance of R&D Outputs for SMEs as Characteristics of "Academic Firms"

	N	Minimum	Maximum	Mean	Std. Deviation
Publication of scientific articles	26	1	5	3,35	1,06
Submission of patents	26	1	5	3,35	1,13
Trademark registration	26	1	5	3,31	1,29
Creation of new products	26	3	5	4,58	0,76
Collaboration with partners	26	2	5	4,42	0,86
Skills acquisition and development	26	3	5	4,65	0,63

Source: Author's survey

Table 3 provides some support to the concept of 'academic firms', highlighting different activities commonly associated with the concept, such as the publication of scientific articles, submissions of patents, trademark registration, creation of new products, collaboration with partners, and skills acquisition and development. The surveyed organizations place a strong emphasis on the creation of new products, with a high mean score of 4,58 (0,76). This suggests that SMEs and HEIs working together are focused on driving innovation and delivering tangible results. Furthermore, SMEs also prioritize collaboration with partners and skills acquisition and development, with mean scores of 4,42 (0,86) and 4,65 (0,63), respectively. These high scores indicate the importance of effective partnerships and the continuous development of expertise within these firms. Conversely, the data also shows that activities such as publication of scientific articles, submission of patents, and trademark registration have lower mean scores of 3,35 (1,06), 3,35 (1,13) and 3,31 (1,29), respectively. While these activities are pursued by academic firms, their lower scores suggest that they may be of secondary importance when compared to more practical aspects of innovation and collaboration in the case of the surveyed SMEs. This resonates with statements made during the interviews. Most interviewees regard R&D activities as depending on their clients' needs and/or aim at improving processes or products. Only the spin-off SME is responsible for 'all its technology' and engages in R&D activities that are not necessarily client-oriented, namely FP projects that they use as a strategy to explore new possibilities aiming at technology transfers and enhancing their networks for future partnerships, providing an example of an embryonic 'academic firm'.

In conclusion, data from Table 3 only partially supports the notion of academic firms. Despite showing a strong focus on the creation of new products, collaboration with partners, and skills acquisition and development, more traditional academic activities, such as publications of scientific articles, submission of patents, and trademark registration appear to be less emphasized. This may be a sign that the 'traditional' valued outputs of HEIs do not echo SMEs', eventually hindering potential partnerships. For example, an interviewed representative whose SME has not participated in H2020, but nonetheless has worked with HEIs, expressed that HEIs apply for FP to fund their current expenses and that their research has 'no interest' since it's not close enough to the market. On the other hand, other interviewees regard their relations with HEIs as *quid pro quo*, or as complementary. This points to the need of policymakers and stakeholders to better understand the priorities and needs of SMEs, enabling them to tailor support mechanisms and strategies to foster successful collaborations between SMEs and HEIs, aiming at increasing SMEs' participation in the FP.

Table 4: Importance of R&D Strategies for SMEs

	N	Minimum	Maximum	Mean	Std. Deviation
Developing R&D through internal resources	26	2	5	4,65	0,745
Develop R&D through the contracting of external resources	26	2	5	3,81	0,939
Developing R&D continuously	26	3	5	4,73	0,533
Open new lines of research	26	3	5	4,58	0,703

Source: Author's survey

Table 4 shows that SMEs value the importance of developing R&D through internal resources (4,65 (0,75)), continuously developing R&D (4,73 (0,53)) and opening new lines of research (4,58 (0,75)). However, they acknowledge the need to contracting external resources (3,81 (0,94)) to reach R&D goals. These results indicate that SMEs are engaging in R&D partnerships with HEI to create new products, but also to develop internal skills, reflecting an interest in their employee's training – distinctive of 'academic firms'. From the interviews, we were able to conclude that while some SMEs mainly resort to HEIs to compensate their lack of internal resources, others – like the spin-off SME – regard partnerships with HEIs as a strategy to be up to date on the state of the art within their sector and, thus, be more innovative and competitive. As in the case of R&D outputs, Table 4 also only partially supports the notion of 'academic firms'. On one hand, SMEs seem interested in contributing to knowledge production by recognizing the importance of continuously developing R&D, valuing opening new lines of research, and wanting to develop internal skills. However, especially given their internal resources limitations, these firms seem more focused on commercial goals than balancing profit goals with knowledge production.

Overall, these findings contribute to understanding the motivations of SME-HEI collaborations and point the need of policies that can help inform and support/facilitate them, for example, instigating doctoral partnerships between SMEs and HEIs that allow SMEs to overcome their difficulties in acquiring human resources for R&D, enabling them to pursue a more balanced 'academic/commercial' R&D strategy. Thus, to inform these policies, it is especially relevant to also look at the obstacles SMEs perceive regarding collaborations with HEIs which, once overcome, may significantly increase FP participation.

4.4 Obstacles for SME-HEI Collaborations

Table 5: Obstacles of SMEs with HEI partnerships in applying for European Funding

	N	Minimum	Maximum	Mean	Std. Deviation
Different perceptions of cost, time and/or productivity among partners	15	3	5	3,93	,46
Difficulty in obtaining immediate results	15	2	5	3,67	,90
Sharing of information on intellectual property	15	2	5	3,47	,92
Lack of stability of R&D public policies	15	2	5	4,00	1,00
Difficulty in obtaining R&D funding	15	2	5	4,00	1,00
Difficulty in finding R&D partners	15	1	4	2,80	1,15
Abstract academic research topics	15	2	5	3,53	,99

Source: Author's survey

According to our data, difficulty in obtaining partners for R&D projects (2,80 (1,15)) and different perceptions of cost, time and/or productivity among partners (3,93 (0,46)) are two relevant obstacles. This indicates that partners may struggle to align priorities and expectations when working together, which could hinder the success of collaborative projects. This is especially relevant for FP participation in that previous experience is a key determinant of participation. Other obstacles include the difficulty in obtaining immediate results (3,67 (0,90)), sharing information on intellectual property (3,47 (0,92)) and abstract academic research topics (3,53 (0,99)). This suggests that organizations face some difficulties in achieving quick outcomes, dealing with intellectual property issues, and bridging the gap between academic research and practical applications. However, regarding confidentiality, the interviewed representatives stated that even though it poses problems, such as managing who can access the information inside the company, it doesn't refrain them from engaging in collaborative R&D. Interestingly, the two representatives from the agricultural sector claimed that there is no confidentiality in their collaborative experiences and perceive it as a positive factor, since the sector is volatile to collective problems such as pests. This indicates that exploring inter-sector differences may be important for future research. Additionally, these findings also highlight the importance of stable public policies and adequate

funding to support R&D collaboration, as well as the need for effective networking to identify suitable partners. For example, one of the interviewees perceives publicly funded R&D projects as sporadic and poorly funded, not taking into consideration a long-term business strategy for SMEs. On another note, H2020 participants stated that being connected to big organizations, such as prestigious HEIs is key to finding new partners. When asked about the origin of relations with HEIs, SMEs' representatives usually referred to personal connections. This, once again, points the need for other networking mechanisms that do not leave SMEs dependent on individuals' social background and path which can contribute to the already mentioned 'Matthew Effect'.

Interviewing SMEs' representatives allowed us to further develop the topic of obstacles and directly enquire them about possible improvements to be made through policy. Regarding FPs, but also other R&D funding schemes, SMEs' representatives complained about the administrative burden they represent. While some view partnering up with HEIs and other organizations, such as bigger firms, as a strategy to deal with this burden, since these tend to have more resources and experience, others point the need for available adequate human resources to manage these projects. For example, one of the interviewees suggested that business and entrepreneurial associations could play a central role if they provided these administrative services and that the State should facilitate this role.

5. Discussion and Conclusion

If policies are to be more effective in promoting collaboration between SMEs and HEIs, thus enhancing the propensity of SMEs to apply for FPs, it is important to understand the different aspects of collaborative practices between firms and HEIs. This means also better knowing the SMEs that engage in these practices.

Our findings underline the importance of specific organizational characteristics of SMEs to assume collaborative R&D activities. Most of the surveyed SMEs are exporters, pointing to internationalization as an important factor driving R&D cooperation; most invest up to 9% of their turnover in R&D, and most participate in the FP – confirming that previous experience in R&D and cooperation in R&D is a driver of FP participation. A formal R&D organization also seems like an important driver of collaborative R&D and, thus, FP participation: a specific department, or at least a R&D manager is key. Regarding size, the number of overall employees doesn't seem to make a difference in collaborative R&D, unlike the case of HEIs.

However, for SMEs to engage in R&D, it is important that they have qualified and stable human resources, which is difficult to attain. Engaging in partnerships with HEIs appears to be a strategy to compensate for the lack of internal resources. Hiring or hosting PhD researchers can reflect this strategy, but it is important to address the difficulties signaled in the interviews, such as an insufficient structure and heavy workflow that hinder availability to monitor PhD researchers. Even though a significant percentage of SMEs stated to hire PhD researchers, most SMEs do not have official partnerships with doctoral programs. Thus, the 'academic firm' cross-employment practice seems only embryonic in our sample of SMEs. Additionally, SMEs' connections to HEIs are mostly based on personal connections. Creating different networking platforms or strategies may instigate partnerships which, in turn, can help SMEs counter their lack of resources and instigate R&D cooperation and FP participation. Yet, our survey shows that SMEs value R&D activities performed through internal resources. These findings point the need for further research about SMEs' R&D strategies and concerns regarding human resources for R&D activity.

Furthermore, our findings indicate that SMEs and HEIs tend to prioritize different types of outputs. SMEs are more market-driven than research-driven (Hervás-Olivier et al. 2021) and therefore focus more on the creation of new products, collaboration with partners, and skills acquisition and development. HEIs, however, tend to emphasize traditional academic activities, such as publications of scientific articles. Nevertheless, spin-off SMEs or 'academic firms' reveal a tendency for more diverse R&D outputs, such as joint co-publications, coordinated and mutually supportive activities and a balance between profit goals and knowledge production. Yet, the difficulties of establishing collaborative partnerships between SMEs and HEIs remain significant. Our findings reveal difficulties between partners regarding different perceptions on cost, time, and productivity; difficulties regarding sharing information, obtaining funding and results. These difficulties need to be identified and faced so that the obstacles to collaboration and networking can be surpassed. However, to enhance SME-HEI collaborations, future research should also address this subject focusing on the perspective of HEIs.

Regarding the concept of 'academic firms', even though it proved to be a theoretically useful tool, guiding our analysis of SMEs, it doesn't translate empirically in the case of our sample of SMEs. In the case of the interviewed SMEs, the spin-off SME seems to fit into this ideal-type of firm. In general, the characteristics of 'academic firms' can only be observed as an embryonic tendency within our sample of SMEs. Future research aiming to explore

this concept should resort to a bigger sample of SMEs, whether for surveys or interviews. Future research could also draw on this concept in order to explore possible policy initiatives that bring SMEs closer to this ideal-type of firm, fostering corporate R&D and motivating SMEs to participate in the FP.

Lastly, the importance of participating, of learning by doing, of promoting learning behavior of SMEs concentrated on learning and network formation can help address the 'Mathew Effect' observed in FPs by promoting short-term exchanges that can lead to more long-term innovative capabilities of SMEs, and motivate them to participate in competitive research projects such as the FP.

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References

- Agência Nacional de Inovação. (2020) Portugal Exceeds One Billion Euro Target of European Funding in H2020. ANI. URL <https://www.ani.pt/en/news/ani-news/portugal-exceeds-one-billion-euro-target-european-funding-horizon-2020/> (accessed 2.20.23).
- Amoroso, S., Coad, A., Grassano, N. (2018) European R&D networks: a snapshot from the 7th EU Framework Programme. *Economics of Innovation and New Technology* 27, 404–419.
- Aschhoff, B. (2010) Who Gets the Money?: The Dynamics of R&D Project Subsidies in Germany. *Jahrbücher für Nationalökonomie und Statistik* 230, 522–546.
- Barajas, A., Huergo, E. (2010) International R&D cooperation within the EU Framework Programme: empirical evidence for Spanish firms. *Economics of Innovation and New Technology* 19, 87–111.
- Campbell, D.F.J., Carayannis, E.G. and Güttel, W.H. (2013) 'Academic Firm', in E.G. Carayannis (ed.) *Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship*. New York, NY: Springer New York, pp. 17–23.
- Campbell, D.F.J., Carayannis, E.G. (2016) The academic firm: a new design and redesign proposition for entrepreneurship in innovation-driven knowledge economy. *J Innov Entrep* 5, 12.
- Catarino, M., Teixeira, A.A.C. (2009) International R&D Cooperation: The Perceptions of SMEs and Intermediaries (Working Paper No. 344), FEP Working Papers. Faculdade de Economia da Universidade do Porto.
- Damanpour, F. (1991) Organizational Innovation: A Meta-Analysis of Effects of Determinant and Moderators. *Academy of Management Journal* 34, 555–590.
- Enger, S.G. (2018) Closed clubs: Network centrality and participation in Horizon 2020. *Science and Public Policy* 45, 884–896.
- Enger, S.G., Castellacci, F. (2016) Who gets Horizon 2020 research grants? Propensity to apply and probability to succeed in a two-step analysis. *Scientometrics* 109, 1611–1638.
- European Commission. (2020) Innovation in small and medium-sized enterprises (Horizon 2020, Work Programme 2018-2020 No. C(2020)1862).
- European Court of Auditors. (2020) The SME Instrument in action: an effective and innovative programme facing challenges (No. Special report 02/2020).
- Eurostat. (2023) Number of persons employed by enterprise size class, 2019.
- Faber, J., van Dijk, J., van Rijnsoever, F. (2016) Incentives and barriers for R&D-based SMEs to participate in European research programs: An empirical assessment for the Netherlands. *Science and Public Policy* 43, 414–428.
- Grego-Planer, D., Kus, A. (2020) Determinants of Innovation Activities in Small Enterprises: A Model Approach. *European Research Studies Journal* XXIII, 137–148.
- Grimpe, C., Sofka, W., Distel, A.P. (2022) SME participation in research grant consortia—the emergence of coordinated attention in collaborative innovation. *Small Bus Econ* 59, 1567–1592.
- Hervás-Oliver, J.-L., Parrilli, M.D., Rodríguez-Pose, A., Sempere-Ripoll, F. (2021) The drivers of SME innovation in the regions of the EU. *Research Policy* 50, 104316. h
- Lepori, B., Veglio, V., Heller-Schuh, B., Scherngell, T., Barber, M., 2015. Participations to European Framework Programs of higher education institutions and their association with organizational characteristics. *Scientometrics* 105, 2149–2178.
- Lesáková, L. (2009) Innovations in Small and Medium Enterprises in Slovakia. *Acta Polytechnica Hungarica* 6, 23–34.
- Luukkonen, T. (2002) Technology and market orientation in company participation in the EU framework programme. *Research Policy* 31, 437–455.
- Marimon, R. (2004) Evaluation of the effectiveness of the New Instruments of Framework Programme VI.
- Romero-Martínez, A.M., Ortiz-de-Urbina-Criado, M., Ribeiro Soriano, D. (2010) Evaluating European Union support for innovation in Spanish small and medium enterprises. *The Service Industries Journal* 30, 671–683.
- Terziovski, M. (2010) Innovation practice and its performance implications in small and medium enterprises (SMEs) in the manufacturing sector: a resource-based view. *Strat. Mgmt. J.*
- Wang, Yu-Lin, Wang, Yau-De, Horng, R. (2010) Learning and innovation in small and medium enterprises. *Industrial Management & Data Systems* 110, 175–192.