Portuguese SMEs: Strategies for Collaborative R&D and Participation in the Framework Programme

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Abstract: The European Union Framework Programme can create and/or strengthen research networks and cooperation, namely between SMEs and higher education institutions. However, in Portugal, SMEs represent only 16,7% of allocated funds, falling below the European Commission's target (Agência Nacional de Inovação, 2020). Low SME participation can result from factors particularly related to SMEs, such as organizational characteristics and past R&D experience. In fact, previous collaborative R&D experience is an important factor determining participation in Framework Programmes (Barajas & Huergo, 2010), suggesting a virtuous cycle. How and why do SME gain collaborative experience with HEI? In what kind of collaborative experiences with HEIs do SMEs engage? What are the characteristics of SMEs that engage in these experiences? What obstacles and risks do SMEs face when applying for the FP and which strategies do they adopt to face them? To answer these questions, we conducted an exploratory survey with SMEs that collaborate with HEIs (N = 26). Additionally, we conducted semi-structured interviews with three H2020 participant SMEs and three non-participants to further explore their collaborative practices and R&D strategies.

Keywords: SME; collaborative R&D; framework programme; H2020; higher education institutions

1. Introduction

European funding for collaborative research and development (R&D), such as the Framework Programme (FP) can encourage or strengthen collaborative R&D, such as between small and medium enterprises (SMEs) and higher education institutions (HEIs). It can thus work as a useful lens through which to observe SMEs' engagement and strategies in collaborative R&D. Nonetheless, as HEIs' participation increased over the years, that of enterprises registered a tendency to decrease (European Parliament and Directorate General for Internal Policies of the Union, 2013), and the goals set by the European Commission (EC) for SMEs' participation have seldom been met (European Parliament and Directorate General for Internal Policies of the Union, 2013). Given the importance of SMEs in the European economy, accounting for 99% of the companies operating in the non-financial business sector (European Court of Auditors, 2020), the EC has developed specific instruments in the FPs directed at SMEs. In Horizon 2020 (H2020) – the FP implemented between 2014 and 2020 – SMEs represented 24% of allocated funds. This means the EC's goal was finally met and even surpassed (European Commission, 2020). However, this is not the case for every Member-State, such as Portugal that registered a SME participation of 16,7% (Agência Nacional de Inovação, 2020).

Most literature on FP participation focuses on HEIs, and already points to possible explanations for low participation by peripheral States such as Portugal. Enger and Castellacci (2016) and Enger (2018) have signaled 'closed clubs' that make it difficult for new organizations to participate in the FPs. 'Club' participants enjoy cumulative advantages – more resources for R&D from the start, and central network positions – that reinforce themselves overtime creating a virtuous cycle that results in 'bias', or a Matthew Effect (Merton, 1969 as cited in Enger and Castellacci, 2016; Enger, 2018). This 'bias' also translates geographically favoring large consortia located in North-West Europe (Amoroso, Coad and Grassano, 2018). Although this 'bias' seems like a plausible explanation for lower SME participation, significant organizational differences between SMEs and HEIs must be considered, namely different R&D strategies and motivations to apply for the FP.

When mentioning participation, we refer to organizations applying regardless of their applications' outcome. For HEIs, FP funding can work as a strategy to tackle reduced national research budgets (Enger, 2018). In turn, 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 (Lesáková, 2009; Barajas and Huergo, 2010) – the latter being a crucial difference between SMEs and HEIs. Differences in motivation are central since participation

depends on self-selection. Thus, we are interested in what drives SMEs to be interested in collaborative R&D and applying for European funding.

2. Research questions and literature review

Overall, 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, van Dijk and van Rijnsoever, 2016). Costs of participation involve demanding administrative requirements that discourage SMEs from applying (Barajas and Huergo, 2010). However, beyond an objective cost-benefit analysis, their decision can also result from perceptions about the FPs, such as 'loss of control' of the company or a perceived inadequacy of the FP (Romero-Martínez, Ortiz-de-Urbina-Criado and Ribeiro Soriano, 2010). Given the focus on collaborative R&D, perceptions about R&D partners, R&D goals, such as R&D outputs, R&D strategies and different risk-taking patterns should also be considered. For example, SMEs tend to value products as R&D outputs (Luukkonen, 2002) as market-driven organizations, whereas HEIs are more research-driven (Hervás-Oliver *et al.*, 2021; Grimpe, Sofka and Distel, 2022). A perceived incompatibility of goals and/or strategies may hinder cooperation. Hence, previous collaborative R&D experience is a key factor determining FP participation, inspiring confidence and making it easier to find adequate partners (Barajas and Huergo, 2010). We henceforth ask: how and why do SMEs gain collaborative experience with HEIs? In what kind of collaborative experiences with HEIs do SMEs engage? What are the characteristics of SMEs that engage in these experiences? What obstacles and risks do SMEs face when applying for the FP and which strategies do they adopt to face them? To answer these questions, we draw on literature regarding the relation between organizational characteristics and FP participation, which focuses mainly on HEIs. We combine this literature with literature on corporate R&D, especially respecting SMEs, hoping to better understand this specific type of organization in the context of the FPs and collaborative R&D.

Organizational size, as measured by the number of researchers, is considered a determinant of HEIs' participation in the FPs (Enger and Castellacci, 2016). Similarly, Kelly and Arora (1996) as cited by Catarino and Teixeira (2009) point that SMEs only engage in collaborative R&D when they have sufficient human resources (HR) to do so, suggesting a positive relation between size and collaborative R&D and, thus, a possible relation between size and FP participation. However, Barajas and Huergo (2010) found a negative relation between the number of employees and propensity to apply for FP funding amongst Spanish SMEs. Notwithstanding, the authors point that this may be explained by specific Spanish policies directed at increasing SMEs' participation in the FP. Besides size, HR stability is another important factor. Work force turnover negatively impacts SMEs' engagement in R&D (Grego-Planer and Kus, 2020). Additionally, the level of professional qualifications in the firm is also a key factor for R&D (Aschhoff, 2010; Lepori *et al.*, 2015). It is also important that firms have specific employees dedicated to R&D (Wang, Wang and Horng, 2010) - a formal R&D organization, such as a department or manager, is an important factor for R&D activity (Damanpour, 1991; Terziovski, 2010). Additionally, cross-employment practices, such as hosting PhD candidates through partnerships with doctoral programs, is a characteristic of R&D driven firms, pointing to partnerships as eventual factors. Finally, exporter SMEs are more likely to engage in collaborative R&D (Lesáková, 2009) and apply for FP funding (Barajas and Huergo, 2010). Based on this literature review, we analyze a sample of Portuguese SMEs to assess collaborative R&D practices, strategies, risks, and obstacles, against the background of FP participation, by answering the already outlined research questions.

3. Methodology

We conducted a survey with 'Leader' Portuguese SMEs that engage in collaborative R&D with HEIs (N = 26). Amongst these, 15,4% have not participated in H2020 (N = 4), 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 a sample of highly competitive SMEs. Additionally, we interviewed three H2020 participant 'Leader' SMEs and three non-participants, regardless of them engaging in collaborative R&D or not, to further understand their practices and perceived R&D obstacles. The interviews were fully transcribed, answers were sorted and analyzed through a common analysis grid.

4. Data Analysis

This section is divided into five subjects: 1) organizational characteristics and practices of SMEs engaging in collaborative R&D; 2) importance of HR related factors; 3) specific R&D strategies of SMEs; 4) different risk profiles associated with SMEs' R&D practices; 5) obstacles perceived by SMEs that already engage in

collaborative R&D with HEIs when applying for FP funding, and related counterstrategies. Finally, we outline recommendations that policymakers and stakeholders can draw on to improve and foster collaborative R&D, especially considering the FPs.

Table 1:Organizational characteristics of SMEs with collaborative 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: authors' survey

Table 1 suggests the importance of a formalized R&D department, section, or group, with 80,8% stating to have a R&D manager, indicating a strong commitment to R&D and the importance of leadership in driving R&D efforts. Amongst the interviewees, besides a R&D department and manager, the only spin-off SME had a person in charge of FP projects, since FP participation is the key strategy of the firm to engage in 'riskier' R&D projects with uncertain results. This points to at least a R&D dedicated person as a driver for collaborative R&D initiative.

Table 1 also shows that nearly half of the surveyed SMEs recognize the value of having highly educated researchers on their teams, since 46,2% hire PhD candidates. However, only 38,5% are involved in such partnerships with doctoral programs, suggesting that hiring does not result from formal partnerships. When asked about hiring PhD students and partnerships with doctoral programs, most interviewed SMEs' representatives recognized the importance of these practices. Nevertheless, only one had a formal PhD partnership to host PhD researchers - the spin-off SME. The other interviewed SMEs pointed a small structure combined with a heavy workflow as an obstacle to hosting PhD candidates. However, several representatives highlighted internship protocols with HEIs at the bachelor and/or master level. When asked about the origin of these partnerships, most pointed to personal connections to HEIs.

Our sample of SMEs engaged in collaborative R&D with HEI revealed that 76,9% are exporters; 84,6% 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 with R&D partnerships with HEIs as sharing some characteristics. Most of them have a R&D department, group, or section, and a R&D manager; more than half have up to 100 workers; and are exporters. Most of them are, or have been, FP participants, have official partnerships with doctoral programs and/or hire PhD candidates.

Table 1: Importance of human resourses strategies 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	1,24
R&D activities are performed by human resources that are already in the company	23	2	5	4,13	0,69
For R&D activities, it is important to have stable human resources in the company	23	4	5	4,70	0,47

Source: authors' survey

The data shows a moderate level of difficulty in recruiting qualified R&D personnel, with a mean score of 3,57 (1,24). This 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 regarding HR stability emphasizes the need for a stable workforce in R&D endeavours. All interviewed SMEs value stability, taken the 'long' period of adaptation of new employees for demanding activities such as R&D. However, they also struggle to find and maintain appropriate HR, which they perceive as being the result of a younger generation of workers more willing to rotate; competing for HR with other sectors, and foreign companies offering better conditions – aggravated by the possibility of remote work

– but also an increasing demand and scare supply of talent, especially in the IT sector. Two of the interviewees stated to hiring very young professionals and offering incremental salaries over the years to achieve stability. However, both admitted that this strategy is no longer effective and lack alternatives. In general, the interviewed SMEs perceived collaborations with HEI also as a HR strategy, allowing them to get in contact with young professionals at a very early stage in their careers.

Based on Table 1 and Table 2, SMEs that have a formal R&D organization might be more likely to invest in stable human resources and engage in collaborations, such as partnering with doctoral programs. Encouraging these organizations to actively participate in the FP can contribute to the creation and strengthening of collaborative R&D.

Table 3: Importance of R&D strategies for SMEs

	N	Minimum	Maximum	Mean	Std. Deviation
Developing R&D through internal resources	26	2	5	4,65	0,75
Develop R&D through the contracting of external resources	26	2	5	3,81	0,94
Developing R&D continuously	26	3	5	4,73	0,53
Open new lines of research	26	3	5	4,58	0,70

Source: authors' survey

Table 3 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 contract external resources (3,81 (0,94)) to reach R&D goals. These results indicate that SMEs are engaging in R&D partnerships with HEIs to acquire and develop new internal skills and create new products. From the interviews, we were able to conclude that while some SMEs resort to HEIs to compensate for their lack of internal resources, others regard partnerships with HEIs as a strategy to be up to date within their sector and, thus, be more innovative and competitive. These findings contribute to understanding the motivations of SME-HEI collaborations and point to the need of policies that can help inform and support/facilitate them.

Table 4: Risk Profiles in SMEs' R&D Strategies

	N	Minimum	Maximum	Mean	Std. Deviation
The company develops high-risk projects with the possibility of high profits	26	1	4	3,08	0,98
The company adopts a cautious stance to minimize the likelihood of making costly choices	26	2	5	3,58	0,81
The company explores its context gradually in order to make incremental progress	26	3	5	4,04	0,60
The company tends to support projects with certain results	26	2	5	3,50	0,81

Source: authors' survey

Table 4 explores the risk profiles of SMEs in their approach to R&D and their impact on decision-making. The data reveals varying attitudes towards risk-taking, which can influence their strategies for innovation. On the one hand, the data shows that SMEs are somewhat open to pursuing high-risk projects that offer potential for high profits (3.08 (0.98)). On the other hand, the data also indicates that SMEs tend to adopt a cautious stance to minimize costly choices (3.58 (0.81)). This can be interpreted as a balancing act between seeking new opportunities and mitigating potential downsides. Furthermore, the highest mean score of 4.04 (0.60) is attributed to companies gradually exploring their context to make incremental progress. This indicates a preference for an iterative approach to innovation, which can help manage risks and ensure steady growth. Lastly, the data suggests that companies tend to support projects with assured outcomes, scoring a mean of

3.50 (0.812). This shows a tendency towards risk-averse decisions, indicating a focus on projects with predictable results. In sum, while SMEs appear to be open to taking on high-risk and high-reward projects, they also demonstrate a cautious approach that prioritizes incremental progress and projects with predictable outcomes. Policymakers and stakeholders can use this understanding to design support mechanisms that respect this risk profile and encourage R&D activities within SMEs.

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	0,46
Difficulty in obtaining immediate results	15	2	5	3,67	0,90
Sharing of information on intellectual property	15	2	5	3,47	0,92
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	0,99

Source: authors' 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, which hinders the success of collaborative projects. 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 SMEs stated that even though it poses problems, it doesn't refrain them from engaging in collaborative R&D. 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 SMEs' R&D strategies. 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.

In the interviews, regarding FPs, SMEs complained about the administrative burden they represent. While some view partnering up with HEIs as a strategy to deal with this burden, others point the need for adequate in-house HR to manage these projects. For example, one of the representatives suggested that business associations could play a central role if they provided these services.

5. Discussion and conclusion

Our findings underline the importance of specific strategies and organizational characteristics of SMEs that engage in collaborative R&D with HEI. The existence of a formalized R&D organization is critical to drive research and collaboration (Damanpour, 1991; Terziovski, 2010). Most firms seek skilled personnel able to perform in-house R&D activities (Aschhoff, 2010; Lepori *et al.*, 2015), but qualified personnel seem limited. Collaborative R&D with HEIs seems like a strategy to counter this difficulty. However, some conditions are necessary to undertake these collaborations, namely access to HEI, which seems dependent on personal connections from previous collaborative R&D experiences (Barajas & Huergo, 2010), pointing to the need for better networking arrangements and better-defined strategies. Collaborations with HEIs are valued and can lead to hiring PhD students or partnering with doctoral programs. However, this trend is still embryonic. Addressing difficulties such as lacking resources to properly host PhD students can be crucial to enable this strategy. Additionally, our findings reveal difficulties between partners such as different perceptions on cost, time, and productivity;

difficulties regarding sharing information, obtaining funding and results (Faber, van Dijk and van Rijnsoever, 2016). These difficulties need to be better identified and faced so that the obstacles to collaboration and networking can be surpassed. When taking these difficulties into account, it is also important to bear in mind SMEs' R&D strategies and their risk profile, which as market-driven organizations differs from HEIs. SMEs appear to be interested in taking on high-risk and high-reward projects. However, they tend to be cautious, prioritizing incremental progress (Luukkonen, 2002). This interested countered with cautiousness should inform new support mechanisms that encourage SMEs to pursue this interest, engage in collaborative R&D and apply for the FP.

Lastly, the importance of participating, of learning by doing, of promoting learning behavior of SMEs and network formation can help address the 'bias' observed in FPs by promoting short-term strategies that can lead to more long-term innovative capabilities of SMEs. To know and consider current SME experience is key to promote this behavior and motivate SMEs to participate in competitive research projects such as the FP.

In sum, this study enriches academic discussion by providing a detailed examination of small and medium enterprises' (SMEs) collaborations with higher education institutions (HEIs) within the European Union FP. It highlights the crucial role of structured R&D systems, skilled human resources, and effective partnership formation in SMEs' R&D participation, while also discussing the complexities of managing diverse risk profiles

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