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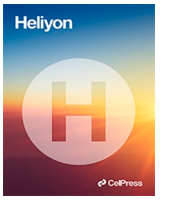

A new perspective for European SMEs' innovative support analysis: Does non-financial support matter?☆

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ABSTRACT

Most of the previous research focused on the effects of public support for SMEs' innovative activities dealt with the effects of financial incentives, while non-financial support was considered a kind of "black box". This research therefore aims to fill this gap by exploring the role non-financial support systems play in triggering SMEs' collaborations and innovativeness in Europe. We show that non-financial support (framework condition) significantly facilitates collaboration and innovation of European SMEs, by using partial least squares structural equation modelling (PLS-SEM) and 216 sampled datasets of the 27 EU countries from 2012 to 2020 European Innovation Scoreboard (EIS). Our expectation was confirmed about the SMEs' collaboration significant effects on their innovative activities, which subsequently translate into innovative outputs. We also found indirect significant effect of the non-financial support on SME's innovation output. This study serves several practical implications and contributes to the ongoing debate on the effects of non-financial support for cooperation and innovation activities of European SMEs.

1. Introduction

In recent years, innovations, as economic growth drivers, were anchored on small and medium enterprises' (SMEs) activities. These enterprises play an important role in the European Union's (EU) innovation progress in the creation of jobs while serving as a medium to promote economic development [1,2]. Despite their contribution, SMEs are mostly deprived of skilled workers and lack the needed skills to take advantage of the opportunities of the modern economy unlike large companies. EU innovation support programs aim to assist small and medium-sized enterprises in their research and development efforts, especially in non-R&D innovative activities [3,4]. This support includes training and digital upgrading, crucial for SMEs to thrive in competitive international markets [5], ultimately driving economic growth, at the same time, enabling firms to create human resource competences that is capable of collaborating in creating and sharing knowledge for innovation.

Past analyses have focused on financial support, its consequences [6,7], and alignment with innovation goals [8,9]. Some studies explored how firms strategize with public innovation support [10], and strategic collaborative partnership for innovation through government support [11] however, De Marco et al. [12] argue that not all achieve their intended objectives. Moreover, limited attention is given to non-financial support, which enhances SMEs' innovative and collaborative capabilities [13]. Our research

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addresses this gap in the EU context, a topic largely unexplored until now, as previous studies have mainly focused on different regions, such as sub-Sahara Africa and Vietnam see Refs. [5,14]. These scholars explored the government non-financial support for SMEs (in line with Nguyen et al. [5]), including human capital development through training, scientific contributions, and fostering an entrepreneurial environment.

In bridging the apparent lacuna in literature regarding the non-financial support systems of EU policies, the research employs an exploratory quantitative method while partial least squares structural equation modelling (PLS-SEM) is used on EIS data 2012–2020 comprising 216 panel dataset of the EU 27 countries for the empirical analysis. Hence, the aim of the research is to explore the role non-financial support systems play in triggering SMEs' collaborations and innovativeness in EU member states.

This study offers valuable insights into non-financial support for SMEs' innovation and collaboration in the EU. It contributes to both Resource-Based View (RBV) and Human Capital theory by highlighting the impact of government non-financial support on the education and training of SME employees, driving innovation and competitive advantage. Additionally, it underscores the link between SMEs' open innovation activities and government support in fostering collaborative traits among employees. From a practical standpoint, this research suggests that European policymakers should focus on efficient public support systems to enhance SME innovation. Proper monitoring and coordination of these programs can promote economic growth and competitiveness, creating a conducive business environment [15]. This highlights the crucial role of public support policies and the need for active government involvement in SMEs' innovation efforts.

The structure of the rest of this study is as follows. Section two delineates the prior literature and theoretical background of the framework conditions for SMEs' innovation activities and collaboration. In section three, the research describes the approach and methodology used to conduct the research, while section four outlines the research findings and results of the empirical analysis exploring the role non-financial support systems play in creating SMEs' collaborative innovation ecosystems. Section five presents the discussions of the results. Finally, section six outlines the implications, followed by concluding remarks, limitations, and proposals for future research directions.

2. Literature review and hypothesis development

2.1. Non-financial support effect on innovativeness of SMEs

Public sector support systems around the world aim to provide both financial and non-financial support for the innovations of private and public firms. With the various forms of innovation policies, the overarching idea, which has seen a lengthy scrutiny is to induce firms to innovate [16,17]. This is associated with the provision of financial support in one hand in various forms like direct R&D subsidies, and indirect support of tax breaks for private sector R&D expenditures [13]. These financial supports are offered to SMEs with the believe that they offer the highest marginal social returns from research expenditures for the SMEs and to correct market failures [18,19]. However, this financial support to SMEs also gets misappropriated, which creates issues of non-compliance [20].

The role of the public sector also encompasses the facilitation of non-financial support of SMEs at the macro level, which may include 1.) creating a conducive environment and training to develop quality human resources and capital while creating the necessary conditions for their involvement in the economic activities [21], 2.) creating an institutional environment that fosters collaboration in the innovation processes such as scientific contribution of the collaborating SMEs [13]. The non-financial support of the public support system for innovation includes the support of creating human resource competences through learning and digital upgrading and the assurance of effective research system in an innovative friendly environment, which helps to facilitate SMEs' innovativeness (which is the proportion of SMEs' that have introduced product and process innovation as well as those pioneering innovations in marketing and organizational practices into the marketplace or within their organizational structures) and collaboration activities.

2.2. The interplay between non-financial support, human capital theory and the resource-based view of the firm

In assessing a SME's innovativeness, two key theories come into play: human capital theory and the Resource-Based View (RBV) of the firm. According to these theories, especially RBV, having a diverse and unique set of resources gives a firm a competitive advantage. Education, skills, experience, and employee capabilities are identified as crucial resources that enhance a SMEs' competitiveness. Therefore, the skills, attributes, and capabilities of employees are vital factors influencing a SMEs' competitiveness and their ability to innovate, aligning with the principles of the human capital theory.

General knowledge research has confirmed that SMEs are unable to purchase external knowledge due to financial barriers [22]. Hence, government indirect support is much needed. The human capital of the firm is the epitome of the knowledge for whose education (training and learning) is crucial as an enabling factor for the achievement of innovation. This is due to the transfer of knowledge from the corridors of teaching institutes to the SMEs as the graduates who double as workers and serve as conduits to the knowledge and technology flow [3].

Njinyah, Asongu & Adeleye [14] indicate in their analysis of the moderating effect of non-financial government support on firm innovativeness that government support of training and R&D facilitates innovation through knowledge sharing and expert knowledge acquisition. Empirically, their research found government non-financial support to influence the innovativeness regulatory compliance of firm in Sub- Sahara Africa.

Based on the prior theoretical assumptions, the current research focuses on how government support of training and scientific contribution through co-publication of scientific research can impact the innovativeness of SMEs within the EU. This can be complemented by the assurance of opportunity driven entrepreneurship through public policy or institutions [23,24]. Also, the use of

effective educational programs (Lifelong learning) helps to engender mutual trust and social exchange relations between SMEs, their employees, and the government. This notion is widely accepted in the human resources literature about employee's high performance work attitudes towards innovation [25,26]. It is assumed that forging such support and knowledge networks and creation of the knowledge base of the country with the abundant human capital will be positively associated with SMEs' innovation capacity [27] hence we hypothesis as follows.

H1. Non-financial support from the public sector has direct and significant effect on SMEs' innovativeness.

2.3. Firm open innovation and the effect of non-financial support on SMEs collaborative innovation activities

SMEs' collaborative ecosystems signifies the interrelationships among SMEs and their environment of industry, consisting of the government and its public support systems as well as all industrial actors, and the society for the purposes of creating innovation. A widespread notion exist that R&D activities are mostly undertaken by large firms due to abundant slack resources [13]. However, SMEs can leverage on innovation activities to create niche and competitiveness and are able amenable to openness [28]. The evolution of the open innovation paradigm dictates to SMEs to leverage on the meagre internal R&D to sources outside of the firm for knowledge and technology for innovation [29].

However, SMEs are unable to forge collaboration networks for reasons such as trust and capacity. We argue that with government support such as those geared towards the creation of human resources in the form of improving employee capacities and skills, scientific contribution, and an opportunity driven entrepreneurship environment can help SMEs to innovate. On the other hand, it helps to facilitate SMEs' absorptive capacity to enable SMEs' source knowledge outside of the firm's internal knowledge stock for innovation. Chun & Mun [30] found that such external sources of knowledge impact positively on SMEs' R&D collaborations decisions as the open innovation literature has shed light on. However, public support from the government has concentrated on the organizational collaborations among firm, industry, and government since its inception by Leydesdorff and Etzkowitz [31,32]. Leydesdorff [31] posits the influence of innovation policy (public support) on the synergistic effect arising out of these collaboration arrangements.

Most often than not, key factors that hinders successful collaboration has been trust and cultural differences [33]. Employees likewise managers serve as conduits in forging collaboration. Investment in lifelong learning, especially in science, technology engineering and mathematics create among employees' certain cultural traits and a social capital while acquiring knowledge for innovation. The government can function as a promoter to instigate collaboration among these participants of a lifelong learning program who work in the SMEs creating local or regional innovation collaborative ecosystems [34,35]. The above assertion has been researched empirically about the surge in the community of innovators created around different geographies, which is creating a 'cult' of information and technology transfers for innovation purposes [36]. Based on the above assumptions, we hypothesis that.

H2. Non-financial support of the public sector has positive and significant effect on creating SMEs' collaboration.

2.4. Indirect effect of non-financial support on SMEs' innovation output

Ultimately, forging network among SMEs offer them knowledge sources for innovation and it positively influence innovation. An

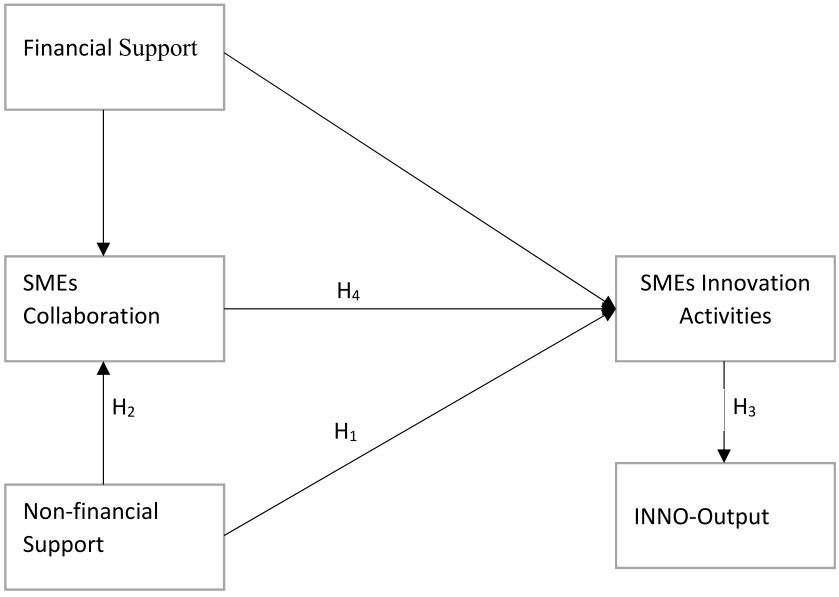

Fig. 1. Conceptual framework and hypotheses.

improvement in the framework conditions by public policies also provides potential for SMEs to innovate. Those necessary conditions offer SMEs' absorptive capacity, which promotes the use of external knowledge and technology arising from collaborations [37]. In their case study analysis, it was revealed that barrier exists in organizing interest groups to facilitate continuous engagement for information sharing.

In bridging the gap, this research avers that public support policy can be used to influence lasting linkages among SMEs for innovative collaborations. All things being equal, innovation activities arising from concerted cooperation among SMEs should lead to effective innovation outcomes for SMEs. The expectation is that the support these SMEs gain from the public or government translate to their innovation activities, which then transcend to final output to the supported SMEs. Hence, we hypothesize as follows.

H3. SMEs' innovation activities has positive and significant effect on their innovation output.

Consequences of government non-financial support systems towards innovation and collaboration of SMEs is their innovation outputs. Anwar & Li [38] found government non-financial support to facilitates the innovation performance of firms. Hu & Liu [39] researched on the non-financial support of the Chinese government showed a positive and significant effect on the regional innovation performance. We take inspiration from the above findings to indicate that the non-financial support of the government, can have indirect influence on the SMEs' innovation output through the creation of SMEs' collaboration and innovation activities. We consequently hypothesize that.

H4. Non-financial support of the public sector has indirect and significant effect on SMEs' innovative activities.

Fig. 1 shows the conceptual framework and summary of the formulated hypotheses.

3. Data and methodology

3.1. Data sources and variable description

The empirical analysis used European Innovation Scoreboard (EIS) 2020 normalized data which was collected based on the EIS data 2012–2020 comprising 216 panel dataset of the EU 27 countries. EIS provides annual and composite indicators for the comparative evaluation of EU member states-related research and innovation performance while simultaneously offering relative strengths and weaknesses in the analysis of these research and innovation systems of the EU nations. Just like the European Community Innovation Survey (CIS), EIS captures key innovation performance framework conditions (non-financial support) external to the firm and distinguishes among three variables, such as the human capital base measured by the population that has completed tertiary education, research systems' attractiveness and scientific contribution measured by international scientific co-publications, and an environment that is friendly for firm innovation, thereby creating an opportunity-driven entrepreneurship environment. In our view such framework conditions affect the firm's innovation activities and influence SMEs' collaborative innovative ecosystem [40–42].

Variables used to construct the SMEs' collaboration innovative ecosystem included innovative SMEs' collaborating with other innovating SMEs and collaboration for research and scientific contribution with both the private and public sectors [43]. In addition, the extent to which the private sector finances R&D activities of SMEs with public sector complementary R&D expenditures and private co-funding of public R&D was used to measure the financial support of SMEs' innovation activities. R&D expenditure in public sector have an effect on SME innovation in that government expenditure to the sciences (university) and public research organization provide a business environment which support SME innovation activities. This contributes to both knowledge and technology spillover, necessitate collaboration and market opportunities while aiding in the establishment of new standards and quality control for SMEs' compliance. Such leads to SMEs' innovation activities as found by [4].

Table 1
Variable description.

Latent Variables	Manifest Variables	Descriptions	References
Non-financial Support	LLE	Percentage population aged 25–64 involved in lifelong learning	Anderson & Stejskal (2019) Nasierowski & Arcelus (2012)
	ISCP	International scientific co-publications	
	ODE	Opportunity-driven entrepreneurship	
	TR-ICT	Enterprises providing training to develop or upgrade ICT skills of their personnel	
Financial Support (Control construct)	R&D-Exp (PS)	R&D expenditure in the public sector	Filippetti et al. (2009) & Zygiaris (2010)
	R&D-Exp (BS)	R&D expenditure in the business sector-R&D-Exp. (BS)	
SMEs' collaborative innovative ecosystem	INNO-SME.CO	Innovative SMEs collaborating with others	Filippetti et al. (2009) & Nasierowski (2019)
	PP-Co-P	Public-private co-publications-PP-	
SMEs' Innovativeness	SME-Prod/Proc. INNO	SMEs with product or process innovations	Nasierowski (2019) & Zygiaris (2010)
	SME-MKT/ORG INNO	SMEs with marketing or organisational innovations	
INNO_Output	EMPKIA	Employment in knowledge-intensive activities (% of total employment	Anderson & Stejskal (2019) & Nasierowski & Arcelus (2012)
	PCT-PAT	PCT patent applications per billion GDP (in PPS)	

Source: author's own.

SMEs' innovation activities were measured according to SMEs with product or process innovations and marketing or organizational innovations. SMEs' innovation performance was measured based on sales of new-to-market and new-to-firm innovations. In all, thirteen variables (for details see Table 1) were selected within the EIS structural methodology as the latent variables for the empirical analysis. Many researchers (e.g. Refs. [44–46], have used this data source.

3.2. Methods

Innovation effect is mostly realized with at least a one-year time lag; hence, the analysis provided the reflective public policy and SMEs' innovation activities in a seven-year period, where 2012 policy indicators and SMEs' innovation activities as the input year with expected effect in 2019. Such an approach is in line with prior studies (e.g. Refs. [28,47]). This assumption was possible as the composite data from the EIS provides this possibility.

PLS-SEM was used for the empirical analysis [48,49]. PLS-SEM relies on a multi-regression analysis to provide scores, or the latent variable measured by one or more indicators. It can provide estimates with small sample size issues while measuring very complex models with many latent and manifest variables. PLS-SEM is given by equation (1) [50].

$$zk = \beta 0^{(k)} + \sum \beta i^{(k)} z_i + v_k \tag{1}$$

zk depicts the explained variable in this study, innovation performance, $\beta 0^{(k)}$ denotes the constant term, $\sum \beta i^{(k)}$ represents the regression coefficient, v_k connotes residual term.

PLS-SEM employs two supplementary approaches that seek to measure linkages between latent variables and associated indicators. These approaches include the covariance-based SEM used to assess model path co-efficiency by exploiting the covariance matrix difference. Through parametric assumptions, the significance levels of a hypothesized relationship of factors are ascertained [49]. The variance-based approach, the second type of PLS-SEM, uses parametric analysis in estimating the latent variable scores through a weighted aggregation of indicators. Rather, it focuses on the use of numerous methods, constituting a regression analysis based on sum scores, principal component analysis, and partial least squares path modelling. This method's broad system and development have led to worldwide acceptance and usage.

The analytical approach used in this research includes first testing for data reliability using PLS-SEM inferential statistics. This test is estimated through a confirmatory composite analysis to identify data incongruities as well as offer data reliability through the goodness-of-fit analysis. This analysis checks the correctness of the data by employing the goodness-of-fit estimation with unweighted least squares (dULS), geodesic discrepancy (dG), and many other factors (see Table 3). Second, multicollinearity of the manifest variables was checked using a variance inflation factor analysis. All data showed a value below the acceptable threshold of <5 [51].

4. Experimental results

4.1. Model evaluation

To ensure the internal consistency of variables operationalized to measure constructs used in the model, an analysis of construct reliability and validity was carried out in order to test the trustworthiness of the results obtained from the model. The research used Cronbach's alpha, rho alpha, composite reliability analysis, and AVE. The generally acceptable value for consistency analyses is 0.7 [52], thus our model was consistent and reliable since all the values for the constructs exceed the threshold.

Following the test for construct reliability and validity (Table 2), the goodness-of-fit test was conducted to measure overall model fitness [53]. This analysis provided a better estimation to ascertain whether the model fit with the data used, which goes a long way in affecting the conclusions drawn from the results, as shown in Table 2. The test indicates acceptable fit of the model because the significant levels of the bootstrapped data are above ($p > 0.05$).

Table 2
Construct reliability and validity (CRV) and model fit.

CRV	R^2	Cronbach's Alpha	Rho_ Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Financial Support		0.876	0.877	0.942	0.880
Non-financial support		0.889	0.896	0.925	0.756
INNO_Output	0.506	0.707	0.711	0.872	0.773
SMEs' collaboration activities	0.819	0.737	0.748	0.883	0.791
SMEs' innovation activities	0.510	0.912	0.926	0.958	0.919
Model Fit	**Saturated Model**			**Estimated Model**	
SRMR		0.115		0.166	
d_ULS		1.028		2.159	
d_G		1.424		1.656	
Chi-Square		1378.400		1520.370	
NFI		0.576		0.532	

Source: author's own

Table 3
PLS-SEM path coefficient- direct and indirect effects.

Constructs	Original Sample	Sample Mean	T-Statistics	P-Values
Financial Support - > SMEs' collaboration	0.427	0.425	8.289	0.000***
Financial Support - > SMEs' innovation activities	−0.002	−0.000	0.026	0.979
Non-financial support - > SMEs' collaboration	0.535	0.538	10.620	0.000***
Non-financial support - > SMEs' innovation activities	0.248	0.242	2.311	0.021**
SMEs' collaboration - > SMEs' innovation activities	0.492	0.496	4.338	0.000***
SMEs' innovation activities - > INNO_Output	0.712	0.711	20.290	0.000***
Indirect Effect of Non-financial effect on Innovation output				
Non-financial support - > SMEs' innovation activities- > INNO_Output	0.176	0.172	2.303	0.022**
Non-financial support - > SMEs' collaboration- > SMEs' innovation activities	0.263	0.267	3.914	0.000***
Non-financial support - > SMEs' collaboration- > SMEs' innovation activities- > INNO_Output	0.187	0.190	3.682	0.000***

Source: author's own; Note: *** significant at; 0.01; ** significant at 0.05

4.2. Results of the PLS-SEM analysis

Based on the PLS-SEM analysis, both non-financial support and SMEs' collaboration proved to have a direct and positive significant effect on SMEs' Innovation Activities. These results suggest that public non-financial support for SMEs' collaborative innovative ecosystem helps to translate the benefits created from the collaborative activities into innovation performance; thus, SMEs' collaboration showed significant effect with a strong Cohen's effect size, as illustrated by Fig. 2.

The analysis proved that, within the -year time lag (2013–2020), the EU non-financial support has had a significant effect on creating SMEs' collaborative innovative ecosystem. Hence, there was a direct significant effect observed for the SMEs' innovation activities on their innovative output.

The results in Table 3 indicate that, a positive relationship exists between SMEs' collaborations with others and collaboration for research and scientific contribution with both the private and public sectors, which significantly affect their innovation activities.

The path analysis showed a high significance improvement with respect to SMEs' innovation activities over time when public non-financial support systems were provided. The positive significant effect suggest that non-financial support of the public sector directly influence innovation activities of the SMEs, which effectively leads to the confirmation of hypothesis $\mathbf{H_1}$.

On the other hand, the analysis showed that non-financial support contributed highly to SMEs' collaboration. Training the population to attain higher levels of education and a scientific contribution mix with an opportunity-driven entrepreneurship economy induce collaboration among SMEs contributing to science with both private and public partners, thereby creating an innovation ecosystem [54,26]. Based on this finding, hypothesis $\mathbf{H_2}$ was supported. Additionally, the results proved that SMEs' innovation activities have very significant effect on the sales of SMEs' innovation output measured by employment in knowledge-intensive activities and patent application, thereby confirming hypothesis $\mathbf{H_3}$ due to the successful translation of SMEs' innovation activities to innovation output.

Lastly, the analysis tested for indirect effect of the non-financial support on SMEs' innovation activities and their innovation output. Based on the findings, we observed a moderate indirect effect of public financial effect on both SMEs' innovation activities and output, which duly confirms the hypothesis $\mathbf{H_4}$. The overview of results is provided by Table 4.

5. Discussion of results and implication

The aim of the research is to explore the role non-financial support systems play in triggering SMEs' collaborations and

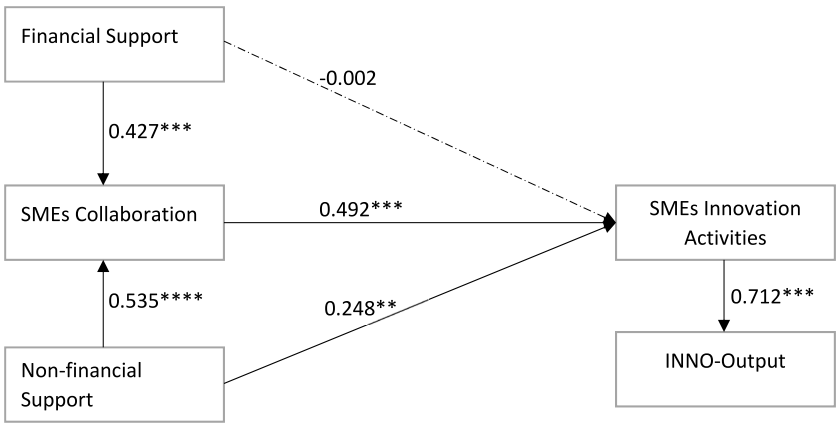

Fig. 2. PLS-SEM result.

Table 4
Summary of research hypotheses.

Hypotheses	Decision
H_1: Non-financial support from the public sector has significant effect on SMEs' innovativeness	Accepted
H_2: Non-financial support of the public sector has positive and significant effect on SMEs' collaborative innovative	Accepted
H_3: SMEs' innovation activities have positive and significant effect on their innovation output.	Accepted
H_4: Non-financial support of the public sector has indirect and significant effect on SMEs' innovative activities and innovation output	Accepted

Source: author's own

innovativeness in Europe [15,27]. The non-financial support of training for the population to attain skills in information technology and scientific contribution, together with an opportunity-driven entrepreneurship economy, influences the creation of SMEs' collaboration and innovation activities. Our finding proved the long-term effect of the public sector's non-financial support systems on SMEs' collaboration activities inadvertently contributing to the factors that enable the creation of innovation ecosystem by showing that the support of education and scientific contributions with an opportunity-driven entrepreneurship and networking enhance the collaborative innovative behavior of SMEs in the EU [26,55].

Thus, within the EU, non-financial support facilitates SMEs' collaboration for public–private co-publications and private co-funding of public R&D expenditures, with positive and significant effects. This finding is consistent with Caloffi et al.'s [56] and Kim et al.'s [57] assertions that public support activities tenaciously and effectively stimulate networking behavior among firms that receive such support. Additionally, the research indicates government takes promoter role in prompting SMEs' collaboration. In fact, Hottenrott and Lopes-Bento's [58] probit analysis showed collaboration significantly induces SMEs' innovation activities, which supports our finding.

We recognize the importance of financial support of public sector to mitigate SMEs' financial struggles, interestingly, our financial support control construct proved significant only for SMEs' collaboration, which means that SMEs' financial support triggers collaboration activities for innovation, which confirms the findings of Kim et al. [57]. This suggest that high degree in financial support of the government induce SMEs' collaborating together which suggest the input additionality of public support for innovation. The social benefit of SMEs' collaboration is critical for the innovation ecosystem due to possible spillover of knowledge and technology for innovation.

More so, a non-significant negative effect was observed for the direct effect of financial support on SMEs' innovation activities. This suggest that excessive financial support from the public sector may push away (crowd out) the SMEs' internal resource use as well as public fund may be misappropriated. Our results also showed a rather high positive effect of innovation activities on the innovation output of SMEs. This finding proves the case for value-added innovation outputs within the remit of the EU according to EIS (2021) data and information from the EU Commission. A significant amount of support is warranted to firms that collaborate.

The above findings of the research raise important concerns, which need to be addressed by policy makers and management of SMEs. It is an unescapable responsibility of EU policy makers to ensure that policies and systems to support SMEs incorporate the creation of conducive environment based on the structural support of education, training, and quality institutions. This will create fertile conditions for SMEs to thrive through collaborative innovation activities [59,60]. The goal of every innovation policy seeks to benefit economic growth and productivity by increasing SMEs' innovation output, our finding confirms the effective conversion of SMEs' innovation activities into actual performance. Hence, we recommend right balance of both non-financial and financial public supports to stimulate a synergistic atmosphere among innovative SMEs.

Collaborative support not only to innovative SMEs, but also start-ups and new firms with the potential to grow; there should not be discrimination in terms of innovation credentials. Therefore, EU policy makers should institute proper monitoring support systems to coordinate and enhance the use of non-financial support programs for SMEs' innovation activities. The specific public support could seek to identify the individual actors of collaborative innovative support to ensure the alignment of collaborators' goals. Suffice to say the result rather showed a highly significant indirect effect of public non-financial support and collaboration on the innovation output of the SMEs through innovation activities.

Collaboration-induced policies should be implemented along with the necessary support systems, such as science parks, SMEs' incubators, and cluster initiatives with firm coordination and supervision to strengthen SMEs' innovation performance. Member states should focus on the country-specific conditions necessary to improve the innovative ecosystem through the specific support for lagging conditions, as proposed by Prokop et al. [61,62], Stejskal et al. [63] or Halaskova et al. [64–66].

6. Conclusions and limitation of the research

The current research has contributed to the ongoing debate on the effects of non-financial support for cooperation and innovation activities of European SMEs. This study to the best of our knowledge is the first research discussing the government non-financial support on SMEs' innovation activities and collaboration in the EU context. The research has also showed the relevance of the structural and institutional support of SMEs from the government, highlighting several implications for the policy makers and SMEs. Theoretically, the study has shown the connection between SMEs' open innovation initiatives and government backing in cultivating a culture of collaboration among employees. By emphasizing the influence of non-financial government support on the education and training of SMEs' employees to foster innovation and competitive advantage, the study clearly extends the tenets of the RBV and human capital theory.

However, several challenges and opportunities remain for future research. The current research used specific and limited non-financial support variables in the PLS-SEM analysis. We acknowledge that several non-financial support policies from structural and institutional point of views exist, which could have impact on the SMEs' innovation and collaboration which are not presently available in the EIS data, therefore, it is necessary to consider the quality of institutions and regulations as well as demand-side support from the government, like technology procurement support variables to assess the effect on innovation from different data sources. Nevertheless, the current research proves to be among the few research, which has attempted to empirically prove the importance/role of the public non-financial support on SMEs' collaboration and innovation in the EU employing the EIS data.

The current analysis lumped all EU member states into a panel data for the analysis. However, an analysis of the various EU countries based on their innovation rankings would better explain and offer specific context of diverse member states. Different innovation systems deploy specific framework conditions to encourage innovation ecosystems. In addition, the EU-level framework conditions are not applicable in a blanket fashion as they induce different effects based on the specific national contextual conditions and level of development of the national innovative ecosystems. Thus, comparing the institutional and regulatory fabric of the various EU states is necessary, such as an analysis of the Central and Eastern Europe (CEE) and their Western counterparts.

The research conclude that non-financial support significantly facilitates cooperation among innovative SMEs. Non-financial support induces SMEs to collaborate with others and engage in public–private co-publication, which showed a high statistically significant effect at the 99 % confidence interval. The model further showed that the framework condition (non-financial support) has a direct effect on SME's innovation activities and enhances synergies among SMEs. Furthermore, the results showed that SMEs' innovation activities had a strong direct influence on their innovation output. The framework condition seems to be on the right path, but policy makers should steer it to include a balanced financial and non-financial support instrument. This study has proven that more focus should be given to the non-financial support since it has been shown to be effective for SMEs' growth and competitiveness. With government support in lifelong learning of employees, SMEs can ensure absorptive capacity and continuous improvement to be tech-ready when any new technology will be available to use. Redundancy in the input resources requires reshaping and the matching audit to identify the needs in the short to medium term followed by the long-term efficient deployment of these resources for economic development.

Data availability statement

For our research we used the publicly available data of the European Innovation Scoreboard (EIS), which is available at European innovation scoreboard (europa.eu).

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Note: In the model, financial support construct was used as control for the analysis of the effect of the non-financial support since financial support has found to have positive influence on the SMEs' innovation activities.

CRediT authorship contribution statement

Solomon Gyamfi: Writing - review & editing, Writing - original draft, Methodology, Investigation, Conceptualization. **Wolfgang Gerstlberger:** Writing - review & editing, Funding acquisition. **Viktor Prokop:** Writing - review & editing, Writing - original draft, Supervision, Methodology, Conceptualization. **Jan Stejskal:** Writing - review & editing, Writing - original draft, Supervision, Formal analysis.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

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