Strategic orientation and new product development performance of academic spin-offs: The importance of team cohesion and team heterogeneity

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***Abstract*— Prior studies have highlighted the importance of team heterogeneity and team cohesion in supporting academic spin-offs during their commercialisation activities. However, there has been little insight into the role of strategic orientation, namely speed to market and product performance, in moderating the relationship between team characteristics and market performance in the new product development (NPD) process. From the analysis of 105 academic spin-offs, this study suggests that team heterogeneity is more likely to support a strategic orientation focusing on product performance, while team cohesion supports both speed-to-market and product performance. This study provides both theoretical and practical recommendations for managing academic spin-offs for the development of new products, especially highlighting the importance of building a heterogeneous team whilst at the same time maintaining cohesion amongst team members.**

***Index Terms*—academic spin-offs, commercialization, cohesion, heterogeneity, team, new product development**

I. INTRODUCTION

ACADEMIC SPIN-OFFS Academic spin-offs are important for innovation and economic growth since they account for a high proportion of high-tech start-up firms [31] [50] [51]. Such spin-offs often bring together individuals with diverse skills, networks and competences to successfully commercialise novel and innovative business ideas that emerge from academic research [42]. The accumulation of knowledge and learning from working in a team can be a valuable asset [6] [59] [71]. It has been argued that heterogenous teams with diverse educational backgrounds and experience help academic spin-offs to overcome resource deficiency and challenges during the new product development (NPD) process [41]. At the same time, the literature on group dynamics points to the importance of team cohesion, where cohesion is defined as a strong sense of belonging and a united approach in the pursuit of its instrumental objectives [7] [14].

There are, however, conflicting and incongruent findings within the literature. For example, some studies have suggested positive effects of team heterogeneity on performance [36] [39] while other studies have pointed to negative effects [49] [70]. Similarly, there remains inconclusive findings from the literature on team cohesion and its effect on performance 32] [65]. Moreover, although previous studies have explored the link between team characteristics and performance, there has been much less focus on the mechanisms that underpin how team heterogeneity and cohesion impact on the performance of the NPD process.

This study addresses these problems by focusing on two important areas. The first is to reconcile the conflicting findings of previous research by arguing that academic spin-offs need to develop both team heterogeneity and team cohesion for greater chances of NPD success. The premise underlying this argument is that to commercialise research with limited resource, academic spin-offs need to rely on the resources of a heterogeneous team at the same time as ensuring there is a unified objective and group cohesion amongst group members to avoid conflict and communication barriers [1] [7] [27]. This study therefore argues that cohesion, and a sense of belonging, is critical for academic spin-offs to harmoniously manage the process of NPD.

The second, is that this study also addresses the lack of empirical research that simultaneously examines team characteristics and strategy during NPD [15] [42] [68]. This research addresses this gap by modelling strategic orientations – namely: (1) speed to market, a strategy to increase the timeliness of the firm's market entry; and (2) product performance, a strategy aiming to strengthen the quality of the product to meet customer's needs – as mediators of the team characteristics–market performance relationship. This is important as for many academic spin-offs, there is pressure to introduce new products into the market as soon as possible. Yet access to incubators, research facilities and funding can often

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be limited, and the longer the time spent on NPD, the higher the cost and the higher the risk of failure [3]. However, faster is not always better [11]. Bringing a new product, albeit an innovative one, to market without carefully investigating the market's needs and the product quality exposes academic spin-offs to market failure [2]. This study thus also works to reconcile conflicting arguments regarding the trade-off between focusing on speed to market and product performance and how team characteristics can help academic spin-offs facilitate the implementation of both strategies.

Using data from academic spin-offs in the UK, this study makes three contributions. First, this study examines the impact of academic spin-offs' team characteristics on performance. The finding shows how academic spin-offs can leverage team heterogeneity and cohesion to overcome their liability of newness and smallness [42]. Second, simultaneous consideration of both strategic orientations enhances insight into academic spin-offs' NPD process. In this context, this study contributes to limited empirical insights into the strategic orientation of academic spin-offs during research commercialisation [42] [68] especially in relation to the trade-off between speed to market and product performance [72]. This study provides evidence that strategic orientations focusing on speed to market and product performance jointly mediate the relationship between team characteristics and market performance. Lastly, this study contributes to the development of support policy for academic entrepreneurship. While most of the studies on academic spin-offs have been dominated by incubation-type support, this study provides further nuance to understanding team dynamics and its effect on new product development process [51]. As a result, this study provides managerial and practical recommendations which are especially important for the construction and development of entrepreneurial teams.

In the next section, we discuss the conceptual background and the construction of the hypotheses on team characteristics, strategic orientations and market performance during NPD. This is followed by a brief description of our methodological approach. We then introduce the findings and discuss the implication for academic spin-offs. Finally, we outline the study's contribution, limitations, and future research directions.

II. Team characteristics, strategic orientations, and market performance

Figure 1 represents the hypothetical model that strategic orientation mediates the relationship between team characteristics and market performance. Also illustrated are the way in which both strategic orientations focusing on speed to market and product performance are supported by team heterogeneity and cohesion. The model offers an explanation not only for the process of NPD in the context of academic spin-offs but also how strategic orientation and team characteristics are aligned in order to produce positive performance.

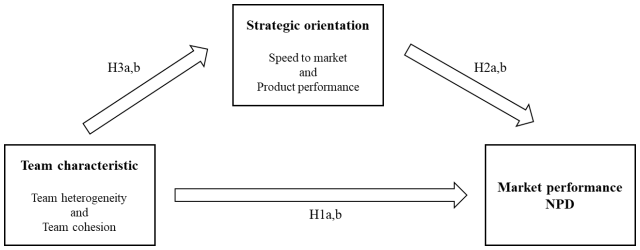

Fig. 1. The hypothetical model of this study

A. Team characteristics - market performance relationship

There is a growing body of work that has explored how team characteristics impact on the success of academic spin-offs [51]. The overarching conclusion is that team heterogeneity is crucial for success, especially diversity of educational background and business-related experience of team members [36] [39]. Heterogeneous teams enable better decision making and more creative thinking [53]. Variety in the perspectives of team members has also been found to broaden the scope of new product creations whilst also stimulating more effective solutions to key industry challenges [64]. However, there have been studies that exposes the dark side of heterogeneity in terms of communication strain and conflict [62]. Heterogeneous teams might also be less predictable which requires additional managerial oversight [58].

In studies of group dynamics, team cohesion has also been found to facilitate faster agreement and consensus in decision-making, resulting in greater participation in delivering the task and solving problems [22]. Cohesion positively influences group process such as coordination, mutual support and participation [25]. The literature therefore suggests that cohesion will help new organisations, such as academic spin-offs, to be more effective in executing their strategy as unanimous commitment to key decisions and strategies is crucial. Yet at the same time, studies have also found that cohesion can also lead to a lack of openness to new information and thus create strong attachment to non-novel ideas which may not be conducive for new product development [58] [61]. There thus seems to be a double-edge sword in the relationship between team heterogeneity and team cohesion, as cohesiveness can lead to a lack of ideas and innovation, whilst team heterogeneity can help overcome these problems, but create additional challenges in achieving team cohesiveness.

While previous studies have debated the impact of heterogeneity and cohesion, there is an argument that both heterogeneity and cohesion are both needed for entrepreneurial activities such as developing a new product [41]. Academic spin-offs often operate in ambiguous, resource-constrained and cross-functional environments with a lack of established routines for NPD, within such environments team heterogeneity is essential, but prior studies would suggest that this may not be effective without team cohesiveness [38]. Indeed, such studies point to how the many obstacles experienced during NPD can be mitigated if teams develop strong unity and work as a group [7]. The overarching challenge is thus: heterogeneity without cohesion can result in interpersonal conflict within teams while cohesion without heterogeneity will limit discovery process and new knowledge exploration [1] [22] [27]. Yet previous studies

often investigate heterogeneity and cohesion separately, despite sufficient evidence to suggest that cohesion will help teams to overcome the limitations of heterogeneity and vice versa [8] [22]. For that reason, there is a strong case for suggesting that both team heterogeneity and team cohesion positively influence market performance measured by the contribution of new products to sales and profit growth.

Hypothesis 1a: Team heterogeneity positively influences market performance of new product development
Hypothesis 1b: Team cohesion positively influences market performance of new product development

B. Strategic orientation – market performance relationship

In the context of new product development, speed and quality are frequently discussed and regarded as key success strategies [28] [72]. While extant research finds that both speed and quality define superior performance, few studies have investigated how both strategic orientations together impact market performance [72]. The literature has suggested for some time that introducing a new product faster than competitors has a positive effect on performance [18] [48]. By doing so, firms might enjoy substantial advantages, such as the ability to serve customers who are willing to pay a high price, and the ability to establish industry standards and technological leadership. These advantages are also essential in achieving competitive advantage in technology-based markets where academic spin-offs operate [23].

At the same time, a strategic focus on product performance has also been highlighted as important during NPD. Studies have demonstrated how legitimacy in front of customers and competitors increases as firms deliver a quality product [11]. In a competitive market environment, launching a new product, albeit an innovative one, requires attention to users' needs and a strong value proposition. Firms need to make sure that their product meets market requirements such as features, functions, safety, reliability, durability.

The literature, however, points to how meeting both these objectives is fraught with difficulty, as these two strategies are often juxtaposed and efforts towards one can contradict the other. For example, focusing on speed to market may sacrifice the quality of product which may result in a poor market performance, or focusing on adding more features, performing more market research, and bringing more people to the project will add further costs and delay market introduction [45]. For academic spin-offs with limited resources, focusing on a strategy of speed to market makes sense as any delay in launching the product will increase the cost [31]. However, they cannot sacrifice the performance of the product. In trying to commercialise innovative new products, academic spin-offs need to work diligently with their potential users. This process can be time consuming and costly, but studies would suggest that it leads to greater product performance. As a result, academic spin-offs need to find a balance in meeting both strategic orientations during NPD. This leads to our second set of hypotheses:

Hypothesis 2a: Implementing a strategic orientation focusing on speed to market is positively related to market performance of a new product
Hypothesis 2b: Implementing a strategic orientation focusing on product performance is positively related to market performance of a new product

C. Team heterogeneity - strategic orientation relationship

There is strong evidence that suggests team heterogeneity enables academic spin-offs to more effectively pursue both speed to market and product performance strategies [30] [38] [57]. As a consequence, academic spin-offs are often encouraged to build entrepreneurial teams with a diverse range of educational backgrounds and experiences. Having a heterogeneous team provides access to diverse resources, skills and experiences [10], which is especially important within environments characterized by greater competition, shorter product life cycles, and rapid changes in dominant technology [37].

Previous studies have shown that as the diversity of backgrounds and experiences of an academic spin-off's team increases, the availability of critical resources and skills during the new product development process also increases leading to an ability to reach the market more quickly than would otherwise be possible [10] [57]. At the same time, heterogeneous teams allow a more rapid approach to solving unstructured problems [57] [67], equally contributing to a faster development process. Moreover, having a team with a diverse range of experiences, knowledge and skills leads to the generation of more ideas for fulfilling customer needs, and develops team members' existing capabilities, which in turn leads to high-performance or high-quality products and a greater ability to bring products to market faster than other competitors [10] [38]. This leads to our third set of hypotheses:

Hypothesis 3a: Team heterogeneity helps academic spin-offs to implement strategic orientation of speed to market.
Hypothesis 3b: Team heterogeneity helps academic spin-offs to implement strategic orientation of product performance.

D. Team cohesion - strategic orientation relationship

Team cohesion describes the extent to which team members feel confident as a team and desire to remain in the team [19] [46]. Cohesion is both an affective state and a social relationship, based on a sense of belonging and morality among team members [24] [46]. Strong cohesion leads to commitment to the task and the presence of a team spirit [44]. For academic spin-offs, cohesion is critical as it allows teams to work more effectively, increase work satisfaction and self-esteem and decrease anxiety due to team differences.

Team cohesion enables academic spin-offs to increase the speed of bringing new product to market. Previous research suggests that cohesive teams are able to make faster decisions [38]. In the dynamic environment in which academic spin-offs usually compete, having cohesive teams has also been found to be more effective [63]. For example, studies have suggested a positive and significant relationship between group cohesion and the effectiveness and efficiency of new product

development [25]. Moreover, in highly cohesive teams a significant proportion of time and effort is devoted to planning and problem solving, without losing time in unproductive social conflicts [24]. Cohesion thus enables members to more effectively collaborate with each other to achieve a collective goal quickly, focus on important issues, and use their resources, energy and time in productive activities [38].

The importance of team cohesion that enables firms to react faster, be more flexible, effective and efficient [9] [61] is most critical during NPD when there is a lot of uncertainty and rapid changes in the market. Cohesive teams are able to share tacit understandings and values, generate synergies to improve performance, and more effectively incorporate feedback from customers [9]. Such advantages help them improve and refine routines quickly which results in strengthening product performance and quality [40] [61]. There is therefore much evidence to suggest that team cohesion supports both strategic orientations focusing on speed to market and product performance, leading to our final set of hypotheses:

Hypothesis 4a: Team cohesion helps academic spin-offs to implement strategic orientation of speed to market.
Hypothesis 4b: Team cohesion helps academic spin-offs to implement strategic orientation of product performance.

III. Research method

The study is based on academic spin-offs from different universities in the north of England, United Kingdom, including Lancaster University, the University of Manchester, University of Liverpool, University of Leeds, University of Central Lancashire, and University of Salford. Although the most common sampling design that permits reliable generalization is random sampling, this was not possible as the total population was unknown. This is a recognised challenge for studies focusing on academic spin-offs, spin-offs as they are often created without formal institutional connections and supports from their universities. .For this reason, we employed a purposive sampling design where we selected a sample that was able to yield the most comprehensive understanding of the object of study. A sample of candidate spin-offs and a population/database was carefully developed from several sources. An initial list of spin-offs was collected from the managers of university business incubators, university technology transfer officers and professors. In addition, a snowball technique was used during interactions with founder(s) of university spin-offs, enabling us to identify further spin-off cases. To test the clarity and relevance of our survey questions, we conducted informal interviews with several academic and non-academic founders of academic spin-offs before administrating the final version, asking them to point out unclear and unfamiliar terms [54].

The sample of this study consisted of more than 320 academic spin-offs. All academic spin-offs were developing a new product based on their research or knowledge from universities. Academic spin-offs with service-based business were excluded to ensure our sample focused only on product development. The study was conducted in two stages to capture the causal relationship between the configuration of the founding team and the impact on the new product's performance. The first data collection started in 2017 with a survey focusing on the characteristics of the founding team, NPD performance and their commercialization activities. A second set of data was collected in late 2019 and although similar questions were asked, the survey also measured the performance of their newly developed products in the market. Only firms that had had products for at least two years in the market were included. The final sample included 105 academic spin-offs, all with more than one founder.

For each academic spin-off, all team members were invited to complete the survey. The final variable for each academic spin-off was the average value from the team's responses. To minimize bias in the responses due to social desirability, we guaranteed participants' confidentiality. In addition, to control nonresponse bias, we tested any significant differences between the early and late respondents for all variables of the survey. Moreover, as data were collected twice, we could check the consistency and any anomaly that might exist in our sample.

A. Variables and measurement

The dependent variable of this study was measured as a formative construct of two performance indicators: (1) the product's sales growth (the percentage of cumulative growth experienced by the firm during the past 2 years) and (2) the product's net profit growth (the percentage of cumulative growth experienced by the firm during the past 2 years). Both indicators were selected to ensure the robustness of the performance measurement.

We used team heterogeneity and team cohesion as independent variables in the model. Regarding team heterogeneity, we employed Simpson's diversity index for educational background and experience. The index was measured using the formula: ($D=1-((\Sigma n(n-1))/(N(N-1))$; n: the number of team members in a particular category; N: the total number of teams) was calculated where 0 represents low heterogeneity level and 1 represents high heterogeneity level. Both variables consisted of several categories. For educational background, we listed the following categories: Science, Engineering, Business and Management, Arts, Law, Medical, Social Science. The categories for experience variable, managerial experience, start-up experience, and no experience were considered.

To measure team cohesion, we used the five-point Likert-scale instruments created by [5]. The variable measures a team's sense of belonging and morale [5] [66]. Regarding the sense of belonging, we asked participants to respond to the following items: I feel a sense of belonging to the team; I see myself as a part of the team; I feel that I am a member of the team. With respect to the team sense of morale, the scale consisted of the following statements: I am enthusiastic about the business; I am happy to be in the business; The team is the best team that I have. The variable of cohesion was measured as an average of those items.

As mediator variables, the variable of speed to market and product performance were used. To measure the speed to market, we based the variables on [13] [60]. We asked for an indication of the degree of the development speed of the new product using a five-point Likert-scale for: the product was developed much faster than other comparable products in the industry (Speed1); the product commercialization took place

faster than expected (Speed2). This study based the measurement of product performance on the instruments built by [45]. We asked for an indication of the degree of the quality of the new product using a five-point Likert-scale and the following statements: The usefulness of the product relative to the objective (Quality1); The technical performance of the product relative to the objective (Quality2). Again, the final variable was measured as an average of the items.

The study used age of firm, patents, and technology and market turbulence as control variables. Patent is a dichotomous variable that takes the value 1 when the company has patents and 0 otherwise. Regarding turbulence technology, we used a five-point Likert-scale and the following statements: The technology in this product area is changing rapidly (Technologyturbulence1); Technological changes provide big opportunities in this product area (Technologyturbulence1); It is very difficult to forecast where the technology in this product area will be in the next five years (Technologyturbulence1) [29] [48] With respect to market turbulence, we used a five-point Likert-scale and the following statements: In our kind of business, customers' product preferences change quite a bit over time (Marketturbulence1); Our customers tend to look for new products all the time (Marketturbulence2); New customers tend to have product-related needs that are different from those of our existing customers (Marketturbulence3) [29] [48].

B. Analysis

A structural equation modelling with partial least squares (PLS) was employed to test our hypotheses. PLS is selected for several reasons. First, PLS is useful for complex models that include different latent variables and to consider mediation relationships between them [20]. PLS allows multiple hypotheses to be tested simultaneously as well as enabling single- and multi-item measurement and the use of formative scales [56]. Like other structural equation modelling techniques, PLS combines principal component analysis, path analysis, and regressions to generate estimates of standardized coefficients (beta values) for the model's paths and factor loadings for the measurement item. This feature is relevant for our analysis as it simplifies the process. Another advantage is that PLS does not make assumptions about (a) the data distribution to estimate model parameters, (b) the independence of observations, and (c) variable metrics. Due to a relatively small number sample in our study, PLS is selected as it shows robustness in dealing with complex models. This technique is considered valid in early development research which does not yet have sufficient empirical support [16] [55]. Prior research in the extant NPD literature has employed PLS as the data analysis procedure [26] [45].

Following [54], we employed both procedural and statistical methods to control for potential common method bias. First, we ensured the confidentiality and anonymity of the respondents of the questionnaire. Second, a Harman one-factor test was conducted. The test consists of performing an exploratory factor analysis of principal components using all the items in the questionnaire. Results of the unrotated factor solution indicated that several factors were obtained. In addition, the first extracted factor explained 38,4% of the overall variance. Therefore, these results demonstrated that common-method bias is not a major concern in our study [54]. Third, based on [34] and [35], we develop a full collinearity test based on variance inflation factors (VIFs) by PLS-SEM. This analysis indicates that when a VIF have a value greater than 3.3, the data might have a problem of common method bias. Regarding outer VIF values, we obtained values between 1.000 and 1.968. With respect to inner VIF values, as our model include mediator variables, we develop this test for both mediator and dependent variables. As shown in the appendix, all these VIFs are equal to or lower than 3.3, so the model can be considered free of common method bias.

IV. FINDINGS

The sample of this study consists of spin-offs with diverse backgrounds, the majority of which were manufacturing, and engineering (45.71%) followed by ICT (31.43%) and science-based technology and healthcare (14.29%). 23.81% of the total sample have patents for their product with more than 29% of the sample investing more than 20% of their turnover on research and development. With regards to team size, 34.29% of the sample have two founders, 44.76% of the sample consist of three or four founders and 20.95% of the sample have more than four founders. 6.67% have female founders and around 75% of the sample are less than five years old. Table 1 shows the characteristics of the sample in the study.

TABLE I
THE SAMPLE OF THE STUDY

Type of industrial sector	ICT (31.43%), Manufacturing and engineering (45.71%), Science-based technology and Healthcare (14.29%), Construction and Transportation (6.67%), Agriculture and mining technology (1.90%)
Degree of innovativeness	Patent or license (23.81%) Research & Development investment: >20% (29.52%); 11-20% (57.14%); 0-10% (13.33%)
Founding team	Female founder (6.67%) Size: 2 (34.29%); 3-4 (44.76%); >4: (20.95%)
Age of firm (first data collection)	2-3 years: 40.95%, 4-5 years: 34.29%, 5-6 years: 20.95%, > 6 years: 3.81%

Table 2 presents the descriptive statistics of the variables used in our study. Overall, the results allowed us to state that there is no multicollinearity among the dimensions of the study.

TABLE II
THE DESCRIPTIVE STATISTICS

	Mean	**SD**	**Min**	**Max**
Market performance	28.11	18.30	0.00	75.00
SO: Product performance	3.16	0.91	1.00	5.00
SO: Speed to market	3.00	0.71	2.00	5.00

TC: Team cohesion	3.33	0.72	2.00	5.00
TC: Team heterogeneity	0.38	0.39	0.00	1.00
CV: Firm's age	4.72	2.79	1.00	10.00
CV: Patents	0.40	0.49	0.00	1.00
CV: Technology turbulence	3.61	0.60	3.00	5.00
CV: Market turbulence	3.73	0.68	2.00	5.00

Note: SO: Strategic orientation; TC: Team characteristic CV: Control variable.

A. Academic spin-offs' strategic orientations and new product development process

Welch's t-test was performed to examine the mean differences between speed to market and product performance. A significant difference will show that academic spin-offs focus more on one strategic orientation over the other. Overall, the analysis found that the majority of the sample show no significant differences indicating that academic spin-offs perform both strategic orientations focusing on speed to market and marker performance. In more detailed analysis, we found that ICT spin-offs focus more on speed to market than product performance. Strong competition and the speed of technological development force academic spin-offs in this sector to choose this strategy. They also rely heavily on human capital and a short NPD process which make applying this strategy more feasible. Moreover, academic spin-offs with patents put more emphasis on employing product performance strategy than speed to market strategy. Apparently, developing commercialising patented products require more resources and time. Before launching the product, academic spin-offs need to ensure that the new product meets requirements such as standard, quality and safety.

TABLE III
THE MEANS OF STRATEGIC ORIENTATIONS PERFORMED BY SUBGROUP

	Speed to market (mean)	Product performance (mean)	T-test result
Total sample	4.12 (0.69)	3.89 (0.93)	2.34
Industrial sector			
ICT	4.56 (0.94)	3.05 (0.34)	4.02*
Manufacturing and engineering	3.54 (0.87)	3.78 (0.94)	-1.21
Science-based technology and health care	3.60 (0.54)	3.98 (0.70)	-1.90
Construction and Transportation	3.09 (0.77)	3.40 (0.90)	-2.18
Agriculture and mining technology	3.54 (0.50)	3.45 (0.34)	1.84
Degree of innovativeness			
Patent	2.90 (1.02)	4.09 (0.98)	-4.30*
No patent	3.21 (0.44)	3.40 (0.32)	-2.64

* $p < 0.05$; ** $p < 0.01$ *** $p < 0.001$

B. The role of strategic orientation in mediating team characteristics – market performance relationship

This section presents the mediation analysis using PLS. With respect to the assessment of the global model, we analyzed the standardized root mean square residual (SRMR), that measures the difference between the observed correlation matrix and the correlation matrix [21]. The SRMR should be less than 0.08. In our study, the value is 0.065, indicating a good overall fit. Regarding the measurement model, we considered technology turbulence and market turbulence to be reflective indicators as the dimensions of each construct were correlated, and changes in the underlying construct might have caused changes in their indicators. In addition, team heterogeneity and market performance were considered as a formative construct. With respect to the assessment of team cohesion, we created a second-order latent variable using the reflective constructs related to the sense of belonging and sense of morale. Before that, we evaluated model measurement including both variables. Firstly, all loadings of the sense of belonging (loading BEL1= 0.852; loading BEL2=0.913; loading BEL3=0.899) and morale (loading MOR1= 0.867; loading MOR2=0.818; loading MOR3=0.894) were higher than 0.707 [20]. Secondly, the construct reliability (CR) evaluation assessed the extent to which a variable is consistent in what it measures. Each item had a higher value than 0.8 [52]. Both the sense of belonging (CR=0.918) and morale (CR=0.895) exceeded this condition. Thirdly, we evaluated the AVE that quantifies the variance that a construct has from its indicators relative to the amount due to measurement error and should be higher than 0.50 [16]. The results indicate that both sense of belonging (AVE=0.789) and morale (AVE=0.740) exceeded this condition. Considering these results, we used both latent variables to create the variable team cohesion as a formative construct.

The second step is to evaluate the measurement of all variables considering team cohesion as a second-order construct. Regarding formative construct, we analyze the weights and the significant of team cohesion, team heterogeneity and performance of academic spin-offs. Table 4 shows the weights and that they are significant for each item of these variables.

TABLE IV
FORMATIVE CONSTRUCTS

	Weight	**T-student**
Team cohesion		
Sense of belonging	0.427	6.604
Sense of morale	0.702	11.419
Team heterogeneity		
Educational background	0.665	6.483
Expertise	0.658	6.576
Market performance		
Profit growth	0.375	2.568
Sale growth	0.663	4.357

With respect reflective indicators and regarding item reliability, all loadings were higher than 0.707. With respect to CR evaluation, each latent variable had a greater value than the value of 0.7 52). With respect to convergent validity, our results indicate that the AVE of all our reflective indicators was higher than 0.5 (Table 5).

TABLE V
LOADINGS, CR AND AVE

	Loadings	CR	AVE
Product performance		0.92	0.85
Quality1	0.91		
Quality2	0.93		
Speed to market		0.85	0.75
Speed1	0.84		
Speed2	0.89		
Technology turbulence		0.79	0.56
Technologyturbulence1	0.77		
Technologyturbulence2	0.74		
Technologyturbulence3	0.83		
Market turbulence		0.81	0.59
Marketturbulence1	0.79		
Marketturbulence2	0.74		
Marketturbulence3	0.72		

Finally, we analysed the discriminant validity, which examines the extent to which the constructs vary from other constructs. We assessed the correlations among the constructs and compared them to the square root of the AVE. Overall, the results show that each construct was related strongly to its own measures than to the others [20] (Table 6).

TABLE VI
DISCRIMINANT VALIDITY

	Age	Market turbulence	Patent	Product Quality	Speed	**Technology turbulence**
Age	**1.000**					
Market turbulence	-0.020	**0.771**				
Patent	-0.101	0.274	**1.000**			
Product performance	-0.101	-0.609	-0.112	**0.922**		
Speed to market	0.018	0.505	0.207	-0.656	**0.864**	
Technology turbulence	-0.039	0.438	0.180	-0.433	0.436	**0.750**

Note: Diagonal elements (bold) are the square root of variance shared between the constructs and their measures (AVE). Off-diagonal elements are the correlations among constructs. For discriminant validity, the diagonal should be larger than off-diagonal elements.

To test our mediation hypotheses, we followed the common approach in mediator analysis [12]. In this approach, the indirect effects are specified and contrasted with the mediators (speed to market and product quality). Following [16] and [17], we chose the bootstrapping procedure to test the indirect effects in PLS. The results are shown in table 7.

TABLE VII
DIRECT AND INDIRECT EFFECTS ON ENDOGENOUS VARIABLES

Effects on endogenous variables	Model	
	Coefficients	t-value (bootstrap)
Market performance (R^2= 0.900)		
Age	0.015	0.397
Patent	0.023	0.620
Market turbulence	-0.112**	3.052
Technology turbulence	-0.075*	1.831
Team heterogeneity (c')	0.065	1.621
Team cohesion (d')	0.508***	7.408
Speed to market (b1)	-0.134**	2.393
Product performance (b2)	0.214***	3.820
Speed to market (R^2= 0.477)		
Team heterogeneity (c1)	-0.173*	1.711
Team cohesion (d1)	-0.565***	6.738
Product performance (R^2= 0.557)		
Team heterogeneity (c2)	0.179*	1.884
Team cohesion (d2)	0.616***	6.689

* p < 0.05; ** p < 0.01 *** p < 0.001 t(0.05, 4999) = 1.645158499, t(0.01. 4999) = 2.327094067, t(0.001, 4999) = 3.091863446.

Overall, the findings from table 7 support hypothesis 1b. Team cohesion has a positive influence of market performance while the result for team heterogeneity was insignificant. Moreover, both strategic objectives have a positive impact on performance. Thus, hypothesis 2a and 2b are confirmed. Moreover, we calculated the product of the direct paths that form the indirect path under assessment. We used both team heterogeneity and team cohesion to measure the mediation role of strategic objective. For testing the relationships mediated by product quality, we multiplied both variables of team characteristics, heterogeneity and cohesion, with the variable of speed to market. As a result, the following product were calculated: c1 (team heterogeneity) *b1 (speed to market) and d1 (team cohesion) * b1 (speed to market). Similarly, we calculated the following products: c2 (team heterogeneity) * b2 (product quality) and d2 (team cohesion) * b2 (product quality) for testing the relationship mediated by product quality. In analysing the mediation role of both product quality and speed to market, we estimated the significance using the percentile bootstrap of all the effects calculated previously: speed to

market and product quality (table 8). This generated a 95% confidence interval for mediators.

With regard to speed to market, the finding shows that the mediator variable was only significant in mediating the relationship between team cohesion and market performance (d1*b1). The results show that the relationship between team heterogeneity and market performance are mediated by product performance (c2*b2). Product performance also mediated the relationship between team cohesion and market performance (d2*b2).

TABLE VIII
MEDIATING EFFECTS TEST

Direct effects of team heterogeneity and team cohesion on market performance			
Variable	Coefficient	T value	
Team heterogeneity	0.065$^{n.s.}$	1.621	
Team Cohesion	0.508***	7.408	
Indirect effect of team heterogeneity and team cohesion on market performance			
Variable	Point estimate	Confidence Intervals Bias Corrected	
		Lower (2.5%)	Upper (97.5%)
	Mediator: Speed to market		
Team heterogeneity	c1*b1	0.023$^{n.s.}$	-0.008	0.071
Team Cohesion	d1*b1	0.075*	0.016	0.153
	Mediator: Product performance		
Team heterogeneity	c2*b2	0.038*	0.008	0.086
Team Cohesion	d2*b2	0.132**	0.062	0.233

* $p < 0.05$; ** $p < 0.01$ *** $p < 0.001$; n.s.

V. Discussion

This study has explored the relationship between team characteristics and market performance, and how this relationship is mediated through strategic orientation. The findings point to three key contributions. First, both speed to market and product performance are important strategic orientations for academic spin-offs. This finding is important as prior literature has suggested that product performance and speed to market are juxtaposed strategic orientations [45]. Yet for academic spin-offs both are important as they try to commercialise new technologies or innovations with limited resource. Second, the findings show that the direct effect of team heterogeneity on market performance is insignificant, yet the impact of team heterogeneity is fully mediated through a strategic orientation on product performance. This finding might explain why previous studies have found mixed and contradictory results in the relation between team heterogeneity and market performance [38] [49] [33]. Third, the findings show partially mediated roles between team cohesion and market performance, with both strategic orientations of speed of market and product performance as mediators, alongside evidence of a direct effect of team cohesion on market performance. This is an important finding as it points to how strategic orientation as well as other factors contribute to the success of cohesive academic spin-off teams, and combined with our second contribution above, this would suggest that both team cohesiveness and team heterogeneity are important for academic spin-offs. We discuss each of these contributions in turn below.

Our study's confirmation that both strategic orientations have positive impacts on market performance provides important insight into key factors that lead to more successful academic spin-offs. The trade-off between speed to market and product performance strategy is often explained as a juxtaposition [13] [45]. Speed to market focuses on the most efficient and low-cost solution, or minimum viable product, with the purpose of penetrating the market quickly. A strategy focusing on product performance, on the other hand, involves investment in R&D activities, and where the focus turns to knowledge development and investment in patents and intellectual property. Our study suggests that for academic spin-offs, these two strategic orientations cannot be separated. As academic spin-offs are often resource constrained, focusing on speed to market makes sense. Yet focusing on speed to market without considering the performance and quality of the product will result in a poor market performance. This finding is important as employing a strategic focus on speed to market and market performance is often seen as key choice faced by firms during NPD, yet for academic spin-offs our study suggests that there might be additional complexity in balancing both of these strategic orientations.

Building upon the finding above, our study also points to the important role of a product performance strategic orientation in mediating the relationship between team heterogeneity and market performance. This result is in line with previous research that indicates a non-significant direct influence of heterogeneity on market performance [4] [33] and that this relationship might be positively related to the quality of new product innovations. This result seems to indicate that because academics' spin-offs may have limited access to resources, heterogeneity in the team's experience and background provides a diverse supply of knowledge, capabilities, and expertise upon which it can draw when pursuing the goal of product performance or quality. This heterogeneity might promote the generation of new ideas, which may enable a diverse range of solutions to any problems and more effective ideas that lead to an improvement to product quality. An additional finding was that team heterogeneity fails to contribute to performance when the variable of speed to market was used as a moderator. This finding shows that increasing heterogeneity may at the same time cost academic spin-offs in terms of time and effort to bring their product into market.

Finally, and perhaps most interesting in terms of the overall picture about the mediating role of strategic orientation on the relationship between team characteristics and market performance, is that the results show that team cohesion plays an important role in facilitating both strategic orientations. As our empirical finding shows that achieving both strategic orientations will produce positive market performance, developing team cohesion is critical for academic spin-offs. Performing speed to market strategy will become easier as the

entrepreneurial teams are effective and efficient [25]. Additionally, team cohesion might allow for simultaneous development activities in different fields, such as engineering, marketing, and manufacturing (Dayan & Di Benedetto, 2009; Edmondson & Nembhard, 2009). Moreover, team cohesion enables more efficient sharing of tacit knowledge and values, thus uncovering greater opportunities for knowledge synergies that improve and refine current products, leading to the increase in the quality, performance and market acceptance of new products and innovations.

The overarching conclusion of our findings is that both team heterogeneity and team cohesion play key roles in the pursuit of speed to market and product performance, which lead to greater market performance overall. However, the mechanism through which team heterogeneity and team cohesion influence market performance is different. Team heterogeneity is fully mediated by product performance, with no direct effect on market performance, while team cohesion is partially mediated by both speed to market and product performance, as there is also evidence of a direct effect of team cohesion on market performance. The advantage of having diverse skills and experience for the success of academic spin-offs might not necessarily apply in all cases of strategic orientations. In fact, our study suggests that it is important to build cohesive teams as a harmonious and unified working environment together with a strong sense of belonging are more effective in pursuing both strategic orientations. Figure 2 summarises the result of the hypothesis testing.

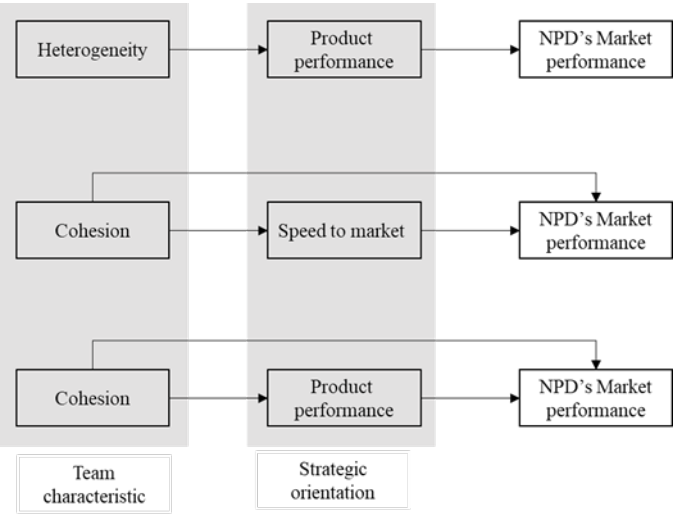

Fig 2. Outcomes of the hypothesis testing

VI. Conclusion

This study builds upon the relatively underexposed topic in the literature of academic spin-offs and its founding team. In particular, the study examines the relationship between team characteristics and strategic orientations and how this relationship influences the performance of NPD. With the majority of study focusing on each theme separately and mostly in the context of general entrepreneurship, this study contributes to the development of knowledge on academic spin-offs in several ways. First, it adds to the few studies focusing on the role of team in the context of academic spin-offs. In this stream of research, we have noticed that despite the recent development, very few studies have touched on the role of the team during new product development. Our finding indicates the importance of having both team heterogeneity and cohesion. However, cohesiveness is the key for managing heterogeneous team. As many entrepreneurships' literature has been argued the importance of brining various skills and experience into the team, building a heterogeneous team is not without any drawback. Thus, academic spin-offs need to consider heterogeneity and cohesion as two sides of the same coin. The benefit of having founders with various skills, educational background and experience can only be gained if academic spin-offs develop a cohesiveness among team members.

The second contribution deals with impact of team characteristics on speed to market and product performance strategy. While heterogeneity is proven to help academic spin-offs in performing product performance strategy, the finding shows that cohesion play a significant role to meet both objectives. This is consistent with our assumption that the potential benefits of heterogeneity can only be gained by developing a cohesive team.

The third contribution resides in the focus on NPD. By examining speed to market and market performance strategy, this study brings a more nuanced understanding of the growth strategy of academic spin-offs. As the finding shows that they perform both strategies, the challenge is not about selecting one strategy over the other. In fact, the discussion should be directed toward finding a suitable condition such as team characteristics that allows academic spin-offs to meet their objectives.

Moreover, this study has practical implications for academic entrepreneurship. With respect to the characteristics of team, to achieve better performance, academic spin-offs must focus their efforts on the development of team cohesion by promoting a supportive team atmosphere and mutual trust between the members. In addition, since our results show that team heterogeneity has a positive impact on performance through product performance strategy, academic entrepreneurs should consider the inclusion of members with different backgrounds and expertise in the entrepreneurial team of their academic spin-offs.

For universities, these institutions should be aware of the importance of the inclusion of members with different experiences and education in spin-offs' teams but at the same time, encourage academic spin-offs to develop a cohesive team. Universities, through transfer technology offices, university incubators and entrepreneurship education, should promote more interaction among nascent entrepreneurs from various educational subjects and experience. In addition, they should facilitate more connection with non-academic professionals that may help academic spin-offs during NPD process but at the same time, they should equip academic spin-offs with knowledge on team building and team management.

Like many empirical studies, this study has various limitations. A first significant limitation is related to how we measured heterogeneity or cohesion. Further studies would broaden the scope of measuring heterogeneity or cohesiveness. Examining other demographic characteristics, such as gender, duration of experience and sector, will improve the

understanding of the effect of different configurations of the founding team and their impact on performance. Secondly, this study investigated the role of strategy during NPD process by looking at two strategic orientations, speed to market and product performance. Those two strategies have a bias toward the development of product. Start-ups in service industry may consider different objectives and develop a different strategy during their NPD process. Future empirical enquiries could consider this context to unveil the interaction between NPD's strategic orientation and team characteristics. Moreover, we encourage future scholars in academic entrepreneurship literature to reflect more deeply on the dynamic during NPD. Lastly, as we use measures of financial or market performance, future studies might replicate our analyses incorporating measures of innovative performance in order to determine if team heterogeneity and cohesion might improve the innovativeness of academic spin-offs through variables related to new product development. Including nuances in this relationship may contribute to developing further understanding of the impact of team and strategy on the survival and growth of academic spin-offs.

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Appendix 1. Full collinearity test for inner VIF value

	Inner VIF Values
Dependent variable: Market performance	
Age	1.049
Patent	1.179
Market turbulence	2.022
Technology turbulence	1.397
Team heterogeneity	1.934
Team cohesion	2.983
Speed to market	2.139
Product quality	2.732
Mediator variable: Product performance	
Team heterogeneity	1.759
Team cohesion	1.759
Mediator variable: Speed to market	
Team heterogeneity	1.759
Team cohesion	1.759

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