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The relationship between Entrepreneurial Orientation, Market Orientation and Performance in University Spin-Offs

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Abstract The paper aims to examine the relationship between Entrepreneurial Orientation (EO), Market Orientation (MO) and performance in University Spin-Offs (USOs). Initially, the paper, assesses the existence of a moderating effect of MO in the relationship between EO and performance, next, it analyses the mediation role of MO between EO and performance. To strengthen paper results, we test our hypotheses on a cross-sectional sample of 162 Italian USOs using both perceived and objective performance. Findings suggest that there is no synergistic effect of MO and EO as mutually independent constructs. Instead, our evidences support the idea that EO and MO in USOs occur within the same learning process. Both EO and MO support USO performance, but MO cannot occur without EO as an antecedent condition. At the same time, a significant portion of the EO contribution to performance occurs through MO.

Keywords Entrepreneurial orientation · Market orientation · Performance · University spin-offs

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Introduction

In the last decades, university spin-off companies (USOs) have been increasingly recognized as one of the main drivers for the commercialization of scientific knowledge and research (Fontes, 2005; Kirwan et al. 2006), with the aim to generate positive consequences on regional and national competitiveness and economic growth (e.g. Goldstein 2010; Newbert et al. 2008; Rothaermel et al. 2007; Stephan 2014). An USO can be defined as "a new company that is formed by a faculty, staff member, or doctoral student who left the university or research organization to found the company or start the company while still affiliated with the university, and/or a core technology (or idea) that is transferred from the parent organization" (Clarysse et al. 2010,: 4; Steffensen et al. 1999).

Policies in support of the establishment of research-based ventures have been developed first in the United States (e.g. Mowery et al. 2004) and later in Europe and Asia (Wright et al. 2008; Grimaldi et al. 2011), fostering universities and researchers to engage in the "third mission" associated with the economic development, in addition to their traditional goals of research and higher education (Etzkowitz 2003). However, in Europe the societal and economic impact of technology transfer through the establishment of university-based start-ups has been significantly lower compared to the United States (e.g. Degroof and Roberts 2004; Iacobucci and Micozzi 2014; Mustar et al. 2008): only a small portion of USOs have become large high-technology companies, whereas a large proportion survives with low rates of employment and revenue growth (Hesse and Sternberg 2016). Empirical evidence shows, in general, that university-spin offs tend to underperform compared to similar firms, such as corporate spin-offs (Zahara et al., 2007; Wennberg et al. 2011), start-ups (Zhang et al. 2009) and other new technology-based firms (Ortìn-Ángel and Vendrell-Herrero, 2014; Ensley and Hmieleski 2005). Thus becomes important to identify and analyse the factors that might undermine the performance of USOs, in order to exploit their potential effect in terms of innovation and growth. One relevant contribution in this perspective might arise from the analysis of the strategic posture adopted in this particular type of companies, and specifically from a deeper understanding of the role of entrepreneurial orientation (EO) and market orientation (MO) in determining the strategic direction of the USO. The lack of an entrepreneurial mindset (e.g. Hayter 2015; Kassicieh 2011) and the insufficient commercial orientation (e.g. Rasmussen et al. 2014; Würmseher 2017) are widely acknowledged as factors impeding spin-off performance, both in early and later stages of the new venture's lifecycle.

However, so far, most of the existing literature dealing with the performance drivers of USOs at the entrepreneurial level has focused on the resource endowment of the company in terms of demographic characteristics, human capital, network position and communication capacity of individual founders and founder teams (e.g. Colombo and Piva 2012; Grandi and Grimaldi 2003; Knockaert et al. 2011, Scholten et al. 2015; Visintin and Pittino 2014), or on the motives and intentions of the scientists-entrepreneurs towards the venture establishment and subsequent growth (e.g. Cho and Sohn 2016; Clarysse and Moray 2004; Knockaert et al. 2015; Müller 2010; Neves and Franco 2016; Ramaciotti and Rizzo, 2015). Other contributions, mainly based on

case studies, examine entrepreneurial processes in the context of USOs, focusing on the early stages of new venture's life and exploring, for example, the steps in the formation of the entrepreneurial team (e.g. Clarysse and Moray 2004) or the acquisition and development of relevant competencies (e.g. De Cleyn et al. 2015; Rasmussen et al. 2011). Limited attention has been devoted to the impact that strategic posture in its key dimensions of EO and MO might have on the spin-off performance following the initial phases of venture creation (Walter et al. 2006).

This gap in the literature is relevant, as the strategic posture of USOs is likely to exhibit distinctive characteristics compared to other start-ups and from the generality of small companies. USOs are archetypical cases of organizations that need to effectively manage the intersection between basic and applied R&D and industry, in order to be successful. These companies are set up to market R&D outcomes from the university labs, finding appropriate applications or even building entire markets ex novo. This goal requires the implementation of a number of activities specifically aimed at the integration of technological knowledge and market knowledge: assessment of the technology impact on processes and/or products, market analysis, definition of a consistent business model, support by appropriate networks of stakeholders, adoption of efficient processes and routines (e.g. Linton and Walsh 2008; Walsh et al. 2002; Walsh and Linton 2011; Tolstoy and Agndal 2010; Cetindamar et al. 2009).

As anticipated above, we argue that the mentioned activities depend crucially on the combination of two strategic capacities, represented by the constructs of entrepreneurial orientation (EO) and market orientation (MO) (e.g. Boso et al. 2013; Morgan et al. 2015; Renko et al. 2009). In particular, in this study we examine the way the two dimensions interact to influence the performance of the USOs; in particular, we will assess the existence of: (1) a moderating effect and/or (2) a mediation role of MO in the relationship between EO and performance. We assess the mediation and moderation effects of MO primarily on a perceptual measure of performance. Then we show to what extent our results are robust across different objective measures of performance.

The assessment of the moderating versus mediating role of MO is relevant because it contributes to the emerging attempts to understand how the generation and dissemination of information on customers and competitors interact with USO's ability to successfully pursue technology-driven entrepreneurial opportunities (Abbate and Cesaroni 2017).

The analysis is carried out on a cross-sectional sample of 162 USOs from Italian universities.

We believe that our results are valuable as they shed light on a largely unexplored phenomenon, namely the distinctive features that should be present in the strategic posture of USOs to improve their competitiveness and profitability (e.g. Walter et al. 2006). The study also contributes significantly on the general knowledge about the relationship between EO, MO and performance in R&D intensive environments, by testing different possible patterns of interaction (Baker and Sinkula 2009; Kollmann and Stöckmann 2014; Morgan et al. 2015) and drawing conceptual implications from the observed relationships.

The remainder of the paper is structured as follows. In Section 2 we develop our research hypothesis. In Section 3 we describe our sample and define the variables used in the paper along with the empirical method and descriptive statistics. Section 4 details

the empirical findings of the study, Section 5 presents the discussions and Section 6 point out the managerial implications. The final Section concludes the paper.

Theory and Hypotheses

Entrepreneurial orientation and market orientation in USOs

EO is an organizational posture that emphasizes aggressive innovation (innovativeness), risky projects (risk-taking) and a proclivity to pioneer innovations (proactiveness) that pre-empt competition (Miller 1983). Research has shown that entrepreneurial orientation is a significant predictor of company performance in terms of profitability and growth (Covin et al. 2006; Delmar et al. 2003; Rauch et al. 2009). Although rather scarce, previous research provides arguments that highlight the crucial importance of an entrepreneurial orientation for USOs (e.g. Diánez-González et al. 2016; Dianez-Gonzalez and Camelo-Ordaz, 2016; Tietz, 2013; Walter et al. 2006). More specifically, the dimension of innovativeness is crucial as these new ventures are aimed at discovering and creating innovative products or new markets that target emergent or unexpressed needs that have not been addressed by competitors (Pérez and Sànchez, 2003; Walter et al. 2006) Risk propensity is also relevant, since in the pursuit of growth opportunities, USOs frequently commit a significant portion of their resources toward pioneering projects with high technological and market risks, uncertain returns and significant chances of costly failure (Diánez-González et al. 2016; Dianez-Gonzalez and Camelo-Ordaz, 2016). Finally, proactiveness in the USOs context is mainly related to innovativeness and is essential since the major chance to generate a competitive advantage for the USOs is to pre-empt competitors' actions, especially in the case of incumbents and large companies, establishing a first mover position. The first mover creates new product market and controls it before any competitive response, gaining the potential for technological leadership and privileged relationship with the customers and ultimately contributing to the protection of the innovation and the appropriation of the value generated by the technological advancement (Walter et al. 2006; Tietz 2013).

These arguments, mainly supported by previous literature lead us to the development of our first baseline hypothesis.

Hypothesis 1a: Entrepreneurial Orientation is positively related to performance in USO companies.

The success of the USO also depends on the capacity to effectively target the markets and the customer needs. These dimensions are captured by the market orientation (MO) construct. According to the definition by Slater and Narver (1999:1165) "market oriented business seek to understand customers' expressed and latent needs, and develop superior solutions to those needs".

The market orientation, as a corporate culture, characterizes an organization's orientation to deliver superior value to its customers continuously (Slater and Narver 1994). MO effectively and efficiently creates the necessary behaviours for the creation of superior value for customers. Kohli and Jaworski (1990) defined MO as the

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organization-wide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across department, and organization-wide responsiveness to it. Naver and Slater (1990) characterize MO through three behavioral components: customer orientation, competitor orientation and interfunctional coordination. Customer orientation refers to a continuous and proactive firm's disposition toward meeting customer expectations and needs. Competitor orientation focuses on competitors' identity, technology and distinctiveness (Slater and Narver, 1994). Interfunctional coordination refers to the capacity to integrate all the business areas in the response to customer needs, via information sharing and communication among functions (Zaltman et al. 1973).

Only few studies have so far highlighted the importance of MO and its components for USOs (e.g. Abbate and Cesaroni 2017), emphasizing the need to generate and disseminate customer-related information and knowledge to effectively target unfulfilled or even unexpressed needs with USOs novel technologies.

In particular, USOs, in connection with the EO components of proactiveness and innovativeness, may perform activities that imply the collection and use of information about customers' current and prospective needs to discover, interpret, and pursue market opportunities that are not recognized by competitors (Abbate and Cesaroni 2017). This finds support in an established literature in the area of R&D management and new product development, which emphasizes that the creation of innovative products imply the capacity to listen to customers and collaborate with them in the process of refinement of technology (e.g. Gupta et al. 2000). USOs customers also need to be involved in the product development processes, In the case of USOs, customers can provide essential inputs for the advancement of the technology and the improvement of its market potential (Meyer 2003); moreover, close partnerships with customers allow the USOs to have access to resources and complementary assets that are not available in-house (e.g. Renko 2006) and may crucially contribute to the commercialization and value appropriation process. Therefore, MO in USOs implies also the need to carefully examine the competencies and capabilities of the clients, seen as co-developers in the innovation process (Abbate and Cesaroni 2017).

This relevance in the gathering and diffusion of information on customers and markets for the USOs justifies our second baseline hypothesis:

Hypothesis 1b: Market Orientation is positively related to performance in USO companies.

The relationship between Entrepreneurial Orientation and Market Orientation in USO

Given the features of the USOs, both EO and MO might, therefore, contribute positively to the performance of the new venture. We could also argue that there is some kind of relationship between the two dimensions that drive their impact on the USO's performance.

Previous studies have represented entrepreneurial orientation as opposed to market orientation (Renko et al. 2009); traditionally, market orientation has been described as an adaptive behaviour by which firms respond to conditions in the environment thanks

to their market intelligence capabilities, whereas entrepreneurial orientation allows the firm to act according to their R&D capabilities and privileges the exploration of new solutions that are often distant from the customers' explicit needs (e.g. Atuahene-Gima and Ko 2001). As a result, the emphasis on both market orientation and entrepreneurial orientation reduces the firm's capacity to bring truly new products on the marketplace, since the "market-pull" rationale weakens the inputs deriving from the entrepreneurial orientation that is mainly "technology-push" (Morgan et al. 2015).

Other studies, mainly focused on high technology industries, suggest that the co-existence of MO and EO in a firm's strategic orientation has a positive effect on performance (e.g. Dhewanto and Sohal 2016; Renko et al. 2009; Boso et al. 2013; Mu and Di Benedetto, 2011). This occurs especially in highly innovative new ventures, since in these organizational settings the interpretation of market knowledge and the customer involvement are essential components of the entrepreneurial process. For example, Shane (2000) suggests that the process of entrepreneurial discovery in the high technology context benefits from: prior knowledge of markets, prior knowledge of ways to serve markets and prior knowledge of customer problems. Thus, there is no trade-off between the technology-push view of EO and market-pull view of MO since new information about a technology tends to be complementary to prior information about how markets and customers operate (e.g. Weisenfeld-Schenk 1994; Schweitzer et al., 2016).

This perspective applies rather properly to USOs. Although USOs might be established based on knowledge with different degrees of tacitness (Pirmay et al., 2003), the knowledge employed is, in any case, more tacit and embedded compared to other situations of technology transfer (e.g. licensing of patents). The general higher degree of tacitness of knowledge suggests that in the USOs the activities of knowledge exploration and knowledge exploitation cannot be easily separated. USOs indeed mostly focus all their development activities on one or some core project(s) and the organization roughly equals its new product (or service) development projects (e.g. Renko 2006). In this context, the project level of analysis corresponds to the firm level (Heirman and Clarisse, 2004), and this creates a strong integration between the new product development/exploration phase and the market-oriented activities (Kim and Wilemon 2002). In particular, both product/technology competence and more business oriented market and managerial competence have been found to be crucial for the success of the USOs (Jo and Lee 1996; Lundqvist 2014). In particular, since the entrepreneurial orientation in USOs is mainly technology or product-centred (Lundqvist 2014) and academic founders, due to their educational specialisation, often lack the understanding of the market necessary for the commercial development of their ideas (e.g. Druilhe and Garnsey 2004; Vohora et al. 2004), the likelihood of commercial success of the innovation can be improved through an enhanced market orientation, obtained, for example, through the integration of the team with commercial and business-related profiles (e.g. Müller 2006; Visintin and Pittino 2014, Vohora et al. 2004).

We can, therefore, propose the following:

Hypothesis 2a: MO positively moderates the effect of EO on USO performance.

According to the previous hypothesis, entrepreneurial potential driven by science and technology learning/opportunity refinement through the knowledge of the market

occur independently, and have different antecedents. An USO might thus exhibit a high entrepreneurial orientation linked to the excellence of the technology, which is not necessarily related to the definition and the understanding of its market potential. An alternative portrait of the strategic orientation of the USO views EO and MO as parts of the same learning process, such that the MO is the result of the development of a pronounced EO, and this reflects even better the close and complex interaction between technology push and market pull knowledge. USOs are indeed characterized by dynamic interactions between different actors throughout the start-up process (Clarysse and Moray 2004; Rasmussen 2011; Vanaelst et al. 2006). Business models are modified as the entrepreneurial team improves its knowledge of available opportunities and resources (Druilhe and Garnsey 2004); the entrepreneurial team itself of an academic spin-off evolves and changes in composition over time (Clarysse and Moray 2004; Vanaelst et al. 2006), and its resource configurations may need to be modified as the spin-off develops (Rasmussen et al. 2011; Vohora et al. 2004). This situation is captured by our:

Hypothesis 2b: Market orientation mediates the relationship between entrepreneurial orientation and performance in USO companies

The two proposed patterns of interaction between EO and MO in influencing USOs performance are summarized in the Fig. 1 and Fig. 2.

Empirical analysis

Sample and data

To test the research hypotheses, we surveyed a cross-section of 174 managers and academics from 162 Italian universities spin off. The mail survey has been used because existing empirical research has generally employed the field study approach to provide an in-depth analysis on only a limited number of spin-off. A survey approach aims to complement these studies by collecting information from a broader cross-section of USO.

The research has been carried out through a questionnaire using a web survey during 2010. The survey instrument was preceded by an introductory letter clarifying the purposes and objectives of the entire research project. The main purpose of the survey was to gather information from organizations in order to understand the dynamic by which entrepreneurial orientation and market orientation affected the performance. Based on the research purposes and objectives, we identified the survey population

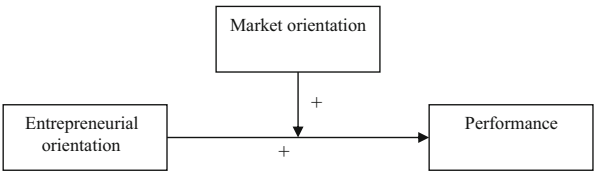

Fig. 1 EO and MO. Moderating effect

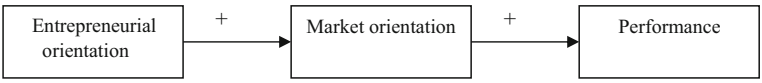

Fig. 2 EO and MO. Mediating effect

to ensure it adequately covered the target population (Van der Stede et al. 2007,: 461). We undertook an in-depth research through several Italian management books, specialized magazines, academic journals, working paper, internet website (i.e., netval.it), conference proceedings, and personal knowledge in order to discover Italian USOs. Next, we made telephone calls to check whether these were regularly working and to generate early interest in the research project. Overall, at this stage, 480 USO organizations were targeted. In order to develop the questionnaire used to collect the data, we first conducted a literature review of the areas of interest across USO. The questionnaire was divided into sections examining USO characteristics, entrepreneurial orientation, market orientation and performance. The questionnaire was reviewed with a sample of six among academics and USO directors. Respondents were mailed a copy of the survey and asked to review it for content, clarity and validity. Based on this feedback, some redundant or ambiguous items were modified or eliminated. No new items were added.

The revised questionnaire was sent out using a web survey to 480 university spin-off based in Italy. In total 174 valid questionnaires were returned (36% response rate). The characteristics of the final sample are reported in Table 1.

Non-respondent bias was also managed, as there is the possibility that the target respondents have self-selected, thus posing a threat to the theoretical generalizability of the survey results (Van der Stede et al. 2007,: 467). As suggested by Oppenheim (1966), two separate procedures were conducted to find evidence for possible bias from respondents. A first test based on time response was undertaken as suggested by Armstrong and Overton (1977). Also, an independent samples t-test was conducted, but failed to detect any significant difference between early and late respondents. Afterwards, a comparison was made based on two characteristics of surveyed respondents (USO department and size in terms of employees). Also, in this case, no significant differences were found ($p < 0.05$) between these groups. Hence, it appears that non-response bias is not a major concern in this sample.

Variables and estimation

The constructs employed in the study have been measured according to the items proposed in previous research and described in detail in Appendix 1. *Entrepreneurial Orientation* (EO) was assessed through the 6-item scale used in Walter et al. (2006) (Cronbach Alfa 0.831). *Market Orientation* (MO) was computed as the average value of the three constructs of *Customer Orientation* (CUSTOR) (Cronbach Alfa 0.903), *Competitor Orientation* (COMPOR) (Cronbach Alfa 0.883) and *Interfunctional Coordination*, (INTERCOOR) (Cronbach Alfa 0.923) drawn from Han et al. (1998). CUSTOR refers to a continuous and proactive firm's disposition toward meeting customers' needs (Deshpandé et al. 1993; Lawton and Parasuraman 1980). COMPOR revolves around three areas of knowledge (Day and Wensley 1988): 1) who are the competitors, 2) what technology do they offer, 3) do they represent an attractive

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t1.1 **Table 1** Descriptive characteristics of the final sample

		Spin off	Percentage
t1.3	**Industries**		
t1.4	Life Sciences	28	16,1%
t1.5	Medicine	25	14,4%
t1.6	IT	30	17,2%
t1.7	Energy and Environment	26	14,9%
t1.8	Electronic and manufacturing	27	15,5%
t1.9	Business Services	3	2,8%
t1.10	Others	33	19,0%
t1.11	*Total*	174	100,00%
t1.12	**Size**	Spin off	Percentage
t1.13	***Employees***		
t1.14	No employee	65	37,4%
t1.15	Between 1 and 2	52	29,9%
t1.16	Between 3 and 9	37	21,3%
t1.17	More than 10	20	11,5%
t1.18	*Total*	174	100.00%
t1.19	**Entrepreneurial team**	Spin off	Percentage
t1.20	2 members	28	16,1%
t1.21	3 to 5	92	53,9%
t1.22	More than 5	54	31,03%
t1.23	*Total*	174	100%
t1.24	**Age**	Spin off	Percentage
t1.25	From 1 to 4 years	54	31,03%
t1.26	From 5 to 10 years	106	60,91%
t1.27	More than 10 years	13	7,47%%
t1.28	*Total*	174	100,00%
t1.29	**Stage of life cycle**	Spin off	Percentage
t1.30	Start-up	63	36,2%
t1.31	Growth	85	48,9%
t1.32	Maturity	18	10,3%
t1.33	Decline	8	4,6%
t1.34	*Total*	174	100,00%

alternative from the perspective of the target customers (Slater and Narver, 1994). INTERCOOR implies the ability to coordinate all functions towards the achievement of customer value, through information sharing and the communication (Kohli and Jaworski 1990; Zaltman et al. 1973).

To measure *performance* (PFPER) we use a perceptual measure comprising four survey items adapted from Calantone et al. (2002) (Cronbach Alfa 0.940; see Appendix 1). As a robustness check, we also use objective measures of performance, by employing secondary financial data from Aida Bureau van Dijk, in terms of USO

profitability and growth. In particular: (1) *Return on Assets (ROA) and* (2) *Return on Investments (ROI)* over a three years period, plus (3) the natural logarithm of the absolute growth in sales, over a three years period.

According to previous studies on USO performance (e.g. Visintin and Pittino 2014; Walter et al. 2006; Zhang 2009) were also included control variables, in terms of *size* of the USO, measured by the number of employees, *size* of the entrepreneurial team, *age* of the company and *stage of the lifecycle* of the spin-off. The *industry* was also considered through the inclusion of dummy variables.

Both reliability and validity of the scales were then validated according to the following procedure: as a first step, exploratory factor analysis (principal components analysis, with promax rotation) was employed to purify the scales, with any items loading less than 0.40 and/or cross loadings greater than 0.40 identified. This process led to the exclusion of some items that loaded on more than one factor.

To overcome the concern of common method bias, we first included some reverse-scored items in the principal constructs to reduce acquiescence problems (Lindell and Whitney 2001). Then, common method variance was assessed after the data were collected using Harman's one-factor test (Podsakoff and Organ 1986). In this test, all the principal constructs are entered into a principal components factor analysis. Evidence for common method bias exists when a single factor emerges from the analysis or when one general factor accounts for the majority of the covariance in the interdependent and dependent variables. For the fact that each of the principal constructs explains roughly equal variance, the data do not indicate substantial common method bias.

Table 2 reports means, standard deviations and correlations between the variables of the study.

Hypotheses 1 and 2 were tested through OLS hierarchical regression models, were we first entered the control variables and subsequently the EO and MO constructs. Hypothesis 2a was tested including in the hierarchical regression the interaction term EO * MO.

t2.1 **Table 2** Descriptive statistics and correlations

		Mean	S.D.	1	2	3	4	5	6	7	8	9	10
t2.3	1. Performance (self assessed)	3.51	1.61	1.00									
t2.4	2. ROA	7.87	23	0.33	1.00								
t2.5	3. ROI	10.68	12.55	0.28	0.29	1.00							
t2.6	4. Sales Growth	8.18	6.02	0.39	0.27	0.31	1.00						
t2.7	5. MO	4.92	1.23	0.47	0.24	0.05	0.21	1.00					
t2.8	6. EO	5.12	1.13	0.42	0.53	0.24	0.26	0.64	1.00				
t2.9	7. Team size	3.31	2.22	−0.03	0.03	0.01	0.28	0.01	0.04	1.00			
t2.10	8. Size	3.99	7.46	0.33	0.32	0.21	0.32	0.21	0.24	0.05	1.00		
t2.11	9. Lifecycle	1.83	0.79	−0.01	0.21	0.23	0.14	−0.22	−0.27	−0.03	0.19	1.00	
t2.12	10. Age (year)	2006	2.61	−0.17	−0.03	0.19	0.19	−0.10	−0.05	0.08	−0.53	−0.36	1.00

Note: correlations higher than 0.20 and lower than −0.20 are significant at $p < 0.05$

Hypothesis 2b was estimated through a structural equation model, using the maximum likelihood method to estimate direct, indirect and total effects of the variables EO and MO on the USO performance. Before their inclusion in the model, the constructs have been validated through CFA. The results of the measurement model are reported in Appendix Table 5, and reveal satisfactory values of the standardized loadings.

Empirical Results

The tests of the direct effects of EO and MO on USO performance are presented in Table 3. The inclusion of the term EO in the second step of the model produces a significant increase in the model R-squared. The coefficient accounting for the EO effect is also positive and significant ($\beta = 0.55$; $p < 0.001$). MO also exhibits a positive effect ($\beta = 0.46$; $p < 0.001$), with a further increase in the explanatory power of the model. Among the control variables, only company size is significantly related to USO performance. These results support our Hypotheses 1 and 2. We found no evidence regarding the interaction effect between EO and MO. The coefficient of the interaction is negative but insignificant, and the inclusion of the interaction term does not produce any change in the variance explained by the model. Therefore, hypothesis 2a is not supported.

In Table 4, we present the results of the testing of Hypothesis 2b. The structural model employed to assess the mediation effect of MO in the relationship between EO and performance indicates that EO affects market orientation ($\beta = 0.64$; $p < 0.001$). In turn, market orientation has a significant and positive effect on USO performance ($\beta = 0.46$; $p < 0.001$).

Further, the model indicates that MO partially mediates the relationship between EO and performance, as the total effect of EO on performance is decomposed in a direct effect ($\beta = 0.25$; $p < 0.001$) and in an indirect effect ($\beta = 0.29$; $p < 0.001$). The resulting mediation path is depicted in Fig. 3.

Our results are robust across various specifications of firm performance. The partial mediation of MO on ROA performance leads to the decomposition of the EO effect in the direct effect $\beta = 0.36$; $p < 0.001$ and in the indirect effect $\beta = 0.38$; $p < 0.10$. The partial mediation of MO on ROI performance leads to the decomposition of the EO effect in the direct effect $\beta = 0.19$; $p < 0.05$ and in the indirect effect $\beta = 0.20$; $p < 0.01$. Finally, the partial mediation of MO on growth in sales leads to the decomposition of the EO effect in the direct effect $\beta = 0.20$, which is not significant, and in the indirect effect $\beta = 0.20$; $p < 0.001$.

Discussion

Analyzing the strategic posture of USOs can be particularly relevant to understand their chances of success better. USOs usually face ambiguous, hostile, uncertain, technologically sophisticated environments, in which the adoption of a proactive and entrepreneurial attitude has been recognized as crucial for venture's development (Covin and Slevin 1998; Dianez-Gonzalez and Camelo-Ordaz 2016; Pérez and Sànchez, 2003; Walter et al. 2006).

Table 3 OLS estimation of the direct and interaction effects of EO and MO on different measures of USO performance

		(1) Control variables				(2) Entrepreneurial orientation				(3) Market orientation				(4) Interaction effect			
		Self-assessment	ROA	ROI	Sales growth	Self-assessment	ROA	ROI	Sales growth	Self assessment	ROA	ROI	Sales growth	Self assessment	ROA	ROI	Sales growth
t3.4	Firm Size	0.07*** (0.02)	0.04** (0.03)	0.06*** (0.02)	0.07*** (0.02)	0.05*** (0.02)	0.04* (0.03)	0.06*** (0.02)	0.07*** (0.02)	0.05*** (0.02)	0.04* (0.03)	0.06*** (0.02)	0.07*** (0.02)	0.05*** (0.02)	0.04* (0.03)	0.06*** (0.02)	0.07*** (0.02)
t3.5	Firm Age	−0.01 (0.07)	−0.00 (0.04)	−0.01 (0.07)	−0.01 (0.07)	−0.00 (0.07)	−0.00 (0.04)	−0.01 (0.07)	−0.01 (0.07)	−0.01 (0.05)	−0.00 (0.04)	−0.01 (0.07)	−0.01 (0.07)	−0.01 (0.05)	−0.01 (0.04)	−0.02 (0.07)	−0.01 (0.05)
t3.6	Team size	−0.02 (0.03)	0.01 (0.03)	−0.04† (0.03)	−0.02 (0.03)	−0.02 (0.03)	0.01 (0.03)	−0.04† (0.03)	−0.02 (0.03)	−0.02 (0.03)	0.01 (0.03)	−0.04† (0.03)	−0.02 (0.03)	−0.02 (0.03)	0.01 (0.03)	−0.04† (0.03)	−0.02 (0.05)
t3.7	Stage in lifecycle	−0.16 (0.16)	−0.21 (0.14)	−0.16 (0.16)	−0.16 (0.16)	0.09 (0.16)	−0.22* (0.14)	−0.16 (0.16)	−0.16 (0.16)	0.16 (0.15)	−0.21* (0.14)	−0.16 (0.16)	−0.16 (0.16)	0.16 (0.15)	−0.21* (0.14)	−0.16 (0.16)	−0.18 (0.16)
t3.8	EO				0.38†	0.55*** (0.10)	0.65*** (0.12)	0.40* (0.29)	0.38† (0.30)	0.25** (0.12)	0.65*** (0.12)	0.40* (0.29)	0.20*** (0.11)	0.50** (0.30)	0.65*** (0.12)	0.40* (0.29)	0.20*** (0.11)
t3.9	MO									0.46*** (0.11)	0.38** (0.20)	0.21** (0.11)	0.41*** (0.21)	0.70*** (0.29)	0.38** (0.20)	0.21** (0.11)	0.41*** (0.21)
t3.10	EO*MO													−0.05 (0.05)	−0.08 (0.07)	−0.01 (0.02)	−0.05 (0.04)
t3.11	Constant	18.24 (113.47)	14.24 (103.47)	16.43 (111.34)	14.24 (103.47)	7.83 (55.90)	6.31 (101.11)	8.22 (102.21)	7.12 (109.22)	−24.12 (101.52)	−31.23 (111.23)	−26.43 (96.23)	−18.75 (111.33)	−33.38 (102.37)	−28.33 (114.22)	−35.28 (135.22)	−17.36 124.58)
t3.12	N	174	174	174	174	174	174	174	174	174	174	174	174	174			
t3.13	F-value	5.62***	5.52***	6.01***	5.52***	10.32***	11.21***	9.22***	10.10***	12.00***	10.38***	9.12***	11.54***	10.39***	10.11***	11.38***	10.28***
t3.14	R-sq	0.11	0.10	0.09	0.10	0.23	0.21	0.19	0.18	0.30	0.29	0.33	0.34	0.30	0.32	033	0.30
t3.15	F for R-sq. change					7.62***	5.66***	5.34***	6.66***	6.69***	7.88***	7.02***	8.29***	0.611	0.627	0.662	0.689

Note. Standard errors in parentheses; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$. Industry dummies included but not reported

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t4.1 **Table 4** Test of the mediation effect of MO in the relationship between EO and performance

		Self Assessment (Survey data)				ROA				ROI				Sales Growth			
		(1) EO effect on Market Orientation	(2) EO total effect on perf.	(3) EO and MO direct effects	(4) Indirect effect of EO	(1) EO effect on Market Orientation	(2) EO total effect on perf.	(3) EO and MO direct effects	(4) Indirect effect of EO	(1) EO effect on Market Orientation	(2) EO total effect on perf.	(3) EO and MO direct effects	(4) Indirect effect of EO	(1) EO effect on Market Orientation	(2) EO total effect on perf.	(3) EO and MO direct effects	(4) Indirect effect of EO
t4.4	Firm Size	0.00 (0.00)	0.05*** (0.02)	0.05*** (0.02)	0.05*** (0.02)	0.00 (0.00)	0.04* (0.03)	0.04* (0.03)	0.07*** (0.02)	0.00 (0.00)	0.06*** (0.02)	0.06*** (0.02)	0.07*** (0.02)	0.00 (0.00)	0.07*** (0.02)	0.07*** (0.02)	0.07*** (0.02)
t4.5	Firm Age	−0.03 (0.02)	−0.00 (0.07)	−0.01 (0.05)	−0.01 (0.05)	−0.03 (0.02)	−0.00 (0.04)	−0.00 (0.04)	−0.01 (0.07)	−0.03 (0.02)	−0.01 (0.07)	−0.01 (0.07)	−0.01 (0.07)	−0.03 (0.02)	−0.01 (0.07)	−0.01 (0.07)	−0.01 (0.05)
t4.6	Team size	−0.00 (0.01)	−0.02 (0.03)	−0.02 (0.03)	−0.00 (0.03)	−0.00 (0.01)	0.01 (0.03)	0.01 (0.03)	−0.02 (0.03)	−0.00 (0.01)	−0.04† (0.03)	−0.04† (0.03)	−0.02 (0.03)	−0.00 (0.01)	−0.02 (0.03)	−0.02 (0.03)	−0.02 (0.05)
t4.7	Stage in lifecycle	−0.14 (0.110)	0.09 (0.16)	0.16 (0.15)	0.16 (0.15)	−0.14 (0.110)	−0.22* (0.14)	−0.21* (0.14)	−0.16 (0.16)	−0.14 (0.110)	−0.16 (0.16)	−0.16 (0.16)	−0.16 (0.16)	−0.14 (0.110)	−0.16 (0.16)	−0.16 (0.16)	−0.18 (0.16)
t4.8	EO	0.64*** (0.07)	0.55*** (0.10)	0.25** (0.12)	0.29*** (0.30)	0.64*** (0.07)	0.65*** (0.12)	0.36** (0.12)	0.38† (0.30)	0.64*** (0.07)	0.40* (0.29)	0.19* (0.29)	0.20*** (0.11)	0.64*** (0.07)	0.38† (0.30)	0.18 (0.11)	0.20*** (0.11)
t4.9	MO			0.46*** (0.11)	–			0.38** (0.20)				0.21** (0.11)	0.41*** (0.21)			0.41*** (0.21)	
t4.10	Overall Model Fit				58.36				46.27				36.27				46.27
t4.11	Chi-sq				0.98				0.98				0.88				0.98
t4.12	CFI				0.99				0.99				0.98				0.99
t4.13	RMSEA				0.48				0.48				0.46				0.48
t4.14	Overall R-sq				58.36				46.99				32.16				45.11

Note. Standard errors in parentheses; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$. Industry dummies included

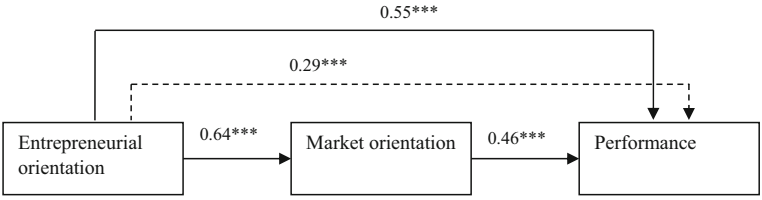

Fig. 3 EO, MO and performance. Estimated Mediation path. Coefficients and significance reported. Coefficients are from the model with Self-assessed performance as dependent variable

At the same time, the entrepreneurial posture should be combined with superior market intelligence capabilities, since USOs are expected to build their own markets, as a consequence of the high levels of novelty of their products and services, and of the need to challenge existing market and technology standards (Walter et al. 2006).

Our results, supporting our hypotheses 1 and 2 suggest that, similarly to other start-up companies, USOs benefit both from the adoption of an entrepreneurial posture and from high levels of market knowledge. Therefore, high degrees of entrepreneurial learning based on technological opportunities (EO) and high degrees of market learning targeting the technology adopters (MO) are beneficial for the success of the research-based venture. However, our distinctive finding concerns the way EO and MO interact as drivers of USO performance. The analyses suggest that there is no synergistic effect of MO and EO as mutually independent constructs. In other words, we found no evidence that high levels of sensitivity towards the market enhance the performance returns of an entrepreneurial posture. Instead, our results support the idea that EO and MO in USOs occur, at least partially, within the same learning process. Both EO and MO support USO performance, but MO cannot occur without EO as an antecedent condition. At the same time, a significant portion of the EO contribution to performance occurs "through" MO. This path reflects the close and complex interaction between technology push and market pull knowledge occurring in USO throughout the start-up process (Fig. 3) (Clarysse and Moray 2004; Rasmussen 2011; Vanaelst et al. 2006). Moreover, EO maintains also a direct effect which is not mediated by MO.

We believe that our results make several contributions to the literature on technology-based entrepreneurship. We primarily add to the studies on the determinants of USOs performance, by shifting the focus from the demographic variables, that so far have been mainly targeted by the emergent research on the topic (e.g. Colombo and Piva 2012; Grandi and Grimaldi 2003; Knockaert et al. 2011, Scholten et al. 2015; Visintin and Pittino 2014), to the behavioural constructs accounting for the strategic posture of these companies. Recent works have considered the performance effects of technology and IP strategy (e.g. Woolley 2016), the degree of innovativeness in the product/market strategy (e.g. Siepel et al. 2017) and organizational capabilities (e.g. Löfsten and Löfsten 2016). Our results integrate this line of research, by considering the EO and MO components of strategic posture as key antecedents of USOs performance. Also, our results ideally complement previous work on the team-level antecedents of EO in USOs (e.g. Dianez-Gonzalez and Camelo-Ordaz 2016).

Furthermore, our study deepens the understanding of some determinants of the USOs performance, analyzing the relationships between these rather than analyze them separately. Specifically, our results expand the knowledge of what factors increase the effect of EO on the USOs performance. Furthermore, we offer a comprehensive and

rather robust assessment of USOs performance, by evaluating both qualitative/self-assessed measures and objective measures. This analysis adds to the research accounting for the multidimensional assessment of performance in academic ventures (e.g. Woolley, 2017; Siepel et al. 2017).

Moreover, this study contributes to research on MO in entrepreneurship going beyond the analysis of a general MO effect on firm performance. Specifically, as some works suggest (Atuahene-Gima and Ko, 2001; Baker and Sinkula 1999, Grinstein 2008; Matsuno et al., 2002), our study contributes to understanding whether and how other strategic orientations (in this case EO) influence the effectiveness of a firm's market-oriented behaviour. This study confirms that firm's performance and survival depend on the good balance between MO and other strategic orientations.

We also shed further light on the relationship between EO, MO and performance in R&D intensive entrepreneurial setting (Kim and Wilemon 2002; Mu and Di Benedetto 2011; Choi and Williams 2016). In reference to previous literature, this allows us to conclude that when new product development process is highly uncertain and ambiguous, and the markets and target users are not able to codify their needs, there is no trade-off between EO and MO, contrarily to the findings of part of the literature (Baker and Sinkula 2009; Kollmann and Stöckmann 2014; Morgan et al. 2015).

These results about EO and MO highlight that the USOs must be able to match the knowledge produced by the research organization and the needs expressed by the market; so being able to take the necessary and suitable process for the commercialization of scientific knowledge and research.

Thus, EO and MO, in their joint action, may be seen as key factors in the transformation of knowledge into economic value. In this perspective, the results of our analysis expand the recent findings about the role of MO in university-based new ventures (Abbate and Cesaroni 2017). The validation of our mediation model suggests that EO and MO are part of the same learning process whereby market orientation may be seen as a further development of the innovativeness, risk-taking and proactiveness components of EO. For example, MO enables the innovative capacity to design solutions that meet customers' needs and the proactive orientation to anticipate the actions of the competitors.

Managerial implications

The results of this study have useful managerial implications. It was found that the relationship between EO and MO is important for USOs performance and then for the transformation of their knowledge into economic value. Specifically, our results suggest that managers need to consider that decisions on EO and MO are strategic and then they should set performance goals considering an appropriate combination of these two firm orientations. Moreover, managers need to be interested in understanding the different impact on performance in implementing each strategic orientation or simultaneously more than one. This approach can help the manager to understand better how each orientation may serve the firm's performance goals.

In this regard, the managers also need to note that these decisions require greater management competence and that the focus on both orientations could generate higher costs compared to the exclusion of one of them or other strategic behaviour. Consequently, managers should be cautious in evaluating the effects produced by the emphasis on both EO and MO, even if this may be attractive for firm performance. This study is an initial step in providing guidance for managers in this respect and about the need to examine the extent to which EO and MO are able to affect the USO performance. Moreover, considering that a portion of EO contribution to performance translates through MO, the task for managers is how to support such orientation. Managers should choose and generate an appropriate process to facilitate market knowledge creation and its development within the entrepreneurial team. In partial contrast with previous insights and prescriptions from the extant literature (e.g. Visintin and Pittino 2014), which recommends the inclusion of specialist commercial/management profiles to integrate a team of scientists/technicians, our results indicate that the entrepreneurial teams in USOs should exhibit high levels of knowledge integration among members, instead of having differentiated profiles and clearly defined functional tasks.

Instead, the creation of a common knowledge base whereby technical and commercial expertise are diffused at the team level seems to be the most appropriate way to develop a proper understanding of the market and commercial priorities as a direct outcome of the technology-based entrepreneurial effort. Through this process it is easier to achieve a fit between the technology of the USO with the demands of the market.

Conclusions, limitations and implications for future research

This study examines the way Entrepreneurial Orientation (EO) and Market Orientation (MO) interact to influence the performance of University-Based Spin-Off companies (USOs); In particular, we assessed the existence of: (1) a moderating effect and/or (2) a mediation role of MO in the relationship between EO and performance. The analysis is carried out on a cross-sectional sample of 162 USOs from Italian universities. Results reveal that, other than through direct effects, EO and MO impact on USOs performance through a partial mediation effect, whereby EO translates into performance through the emergence of MO.

Our analysis has, of course, a number of limitations, which can indicate directions for future research. First of all, we have only limited information on further characteristics that both at the contextual level and also at the organizational and team level might influence the relationship between strategic posture and performance.

Further studies could adopt a multilevel perspective taking into consideration the environmental factors surrounding the USO, both at the institutional level (e.g. characteristics of the parent university) and at the industry level. In particular, the moderating role of industry should be carefully considered in further investigations on larger

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samples. Having more observations would lead to properly assess the contingent effect of industry-related knowledge and competitive dynamics on the interplay between MO and EO.

Appendix 1

Items and constructs from the survey

Entrepreneurial Orientation – Adapted from Walter et al. (2006).
(Likert scale 1 strongly disagree – 7 strongly agree)
In this organization:
ENTEROR 1 Entrepreneurial behaviour is a central principle.
ENTEROR 2 People are very dynamic.
ENTEROR 3 Innovation is emphasized above all.
ENTEROR 4 People are willing to take risks.
ENTEROR 5 Willingness to continuous progress in the joint foundation.
ENTEROR 6 People are eager at being always first to market.
Customer Orientation (CUSTOR) - Adapted from Han et al. (1998).
(Likert scale 1 strongly disagree – 7 strongly agree)
In this organization:
CUSTOR 1 Customer commitment.
CUSTOR 2 Create customer value.
CUSTOR 3 Understand customer needs.
CUSTOR 4 Customer satisfaction objectives.
CUSTOR 5 Measure customer satisfaction.
CUSTOR 6 After-sales service.
Competitor Orientation (COMPOR) - Adapted from Han et al. (1998).
In this organization:
COMPOR 1 Salespeople share competitor information.
COMPOR 2 Respond rapidly to competitors' action.
COMPOR 3 Top managers discuss competitors' strategies.
COMPOR 4 Target opportunities for competitive advantage.
Interfunctional Coordination (INTERCOOR) - Adapted from Han et al. (1998).
In this organization:
INTERCOOR 1 Interfunctional customer calls.
INTERCOOR 2 Information shared among functions.
INTERCOOR 3 Functional integration in strategy.
INTERCOOR 4 All functions contribute to customer value.
INTERCOOR 5 Share resources with other business units.
Perceived Financial Performance (PFPER) - Adapted from Calantone et al. (2002).
(Likert scale 1 very low – 7 very high)
Please rate the performance of your organization against initial expectation on each of the following dimensions.
for the past 12 months:
PFPER 1 Sales volume.
PFPER 2 ROI.

PFPER 3 ROA.
PFPER 4 Overall profitability

Archival Data from AIDA (Italian Digital Database of Companies) branch of the Bureau van Dijk group.

Return on Assets -ROA- (Three year average).
Return on Investments-ROI- (Three year average).
Growth in sales over three years.

Appendix 2

t5.1 **Table 5** Measurement model for the mediation analysis. Standardized loadings

	MO ($\alpha = 0.903$)	EO ($\alpha = 0.831$)	PERF ($\alpha = 0.940$)
t5.3 CUSTOR	0.83		
t5.4 INTERCOOR	0.85		
t5.5 COMPETOR	0.71		
t5.6 ENTEROR 1		0.59	
t5.7 ENTEROR 2		0.71	
t5.8 ENTEROR 3		0.68	
t5.9 ENTEROR 4		0.60	
t5.10 ENTEROR 5		0.86	
t5.11 ENTEROR 6		0.76	
t5.12 PERF 1			0.83
t5.13 PERF 2			0.90
t5.14 PERF 3			0.87
t5.15 PERF 4			0.92

LR test of model vs. saturated: $chi^2(63) = 206.77$, Prob > $chi^2 = 0.0000$.

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