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Integration and Selectivity in Open Innovation: An Empirical Analysis in SMEs

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***Abstract*—**The company's ability to draw on a range of external sources to meet their needs for innovation, has been termed 'open innovation' (OI). Very few empirical analyses have been conducted on Small and Medium Enterprises (SMEs) to the extent that they describe and understand the characteristics and implications of this new paradigm.

The study's objective is to identify and characterize different modes of OI, (considering innovation process phases and the variety and breadth of the collaboration), determinants, barriers and motivations in SMEs. Therefore a survey was carried out among Italian manufacturing firms and a database of 105 companies was obtained. With regard to data elaboration, a factorial and cluster analysis has been conducted and three different OI modes have emerged: selective low open, unselective open upstream, and mid-partners integrated open. The different behaviours of the three clusters in terms of determinants factors, performance, firm's technology intensity, barriers and motivations have been analyzed and discussed.

***Keywords*—**Open innovation, R&D management, SMEs.

I. Introduction

THE idea that the enterprise can sustain processes of innovation development in collaboration with other subjects and therefore must be open to the flow of knowledge and competences deriving from the world "outside itself", is refuted by the analyses on the best performances attained by open enterprises. Studies demonstrate that enterprises adopting an open innovation strategy attain best performances in terms of capacity to innovate [1], innovative level of products/services [2], [3], [4], improvement of basic competences [5], reduction of development costs and time-to-market of new products/processes [6], and increase of sales volumes and market acceptance of new products [4], [7], [8] though there are conflicting opinions [9].

The OI phenomenon has many facets and different typologies of representation: openness towards the external environment can be emphasized to a greater or lesser extent (depth, breadth, integration and variety), expressed during different phases of the innovative process (exploration or exploitation), with different organizational forms (outsourcing, alliances, licensing, etc), and by using various combinations of actors, roles and strength of connections [10].Enterprises' modes of conduct in the development of OI strategy are different depending on whether the enterprises are large or small and medium sized [10]. For example, while large firms focus collaboration efforts with sources outside the R&D function, small firms principally focus open innovation practices in the commercialization phase of the technology, precisely because they lack the marketing channels and manufacturing facilities [11]. Small firms differ from large firms also with regards to organizational forms and selected actors, preferring networks with public research institutes and universities at first and then relations with large suppliers in the second part of the innovative process.

Lastly, the factors that influence (including the motivations) or hinder (barriers) open innovation strategy will be different. Such factors have been studied for large firms [12]; [5] and some have also been tested on SMEs [13] while studies on other factors are still pending.

The literature on open innovation in SMEs is relatively recent [13], [10] and one of the questions still open is the extent to which open innovation is embedded in SMEs [10] and what the differences are within the same SMEs, regarding the level and types of openness adopted and the factors influencing their open strategy [13].

This study's objective is to identify and characterize different profiles of openness towards the external environment, and it has been conducted on Italian manufacturing firms, i.e. a context which is highly characterized by SMEs. The choices in terms of OI will be investigated in terms of the contextual factors and firm-specific characteristics influencing open innovation.

A web-based online questionnaire survey was carried out and a database of 105 manufacturing companies was obtained. With regard to data elaboration, after the descriptive statistics and factorial analysis, a K-means cluster analysis and a univariate analysis of variance (ANOVA) have been conducted to identify different modes of open innovation and verify the significance levels of differences between clusters.

II. Literature Review on Open Innovation

As [14] claimed the OI strategy "is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively".

In OI processes organizational boundaries are more porous and firms interact strongly with external actors [7]. Firms may open up their innovation processes at two different moments:

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in the phase of acquiring knowledge and technology for the development of innovation (outside-in or technology exploration), and the phase of marketing the innovation itself (inside-out or technology exploitation).

According to [15] and [16] there are different definitions and classifications of openness in the literature; in this paper we consider the collaborations between organizations both inside-out and outside-in to study the phenomenon of OI, and in particular we will consider the number and type of partner and the phases opened, [17], [18], [8], [19], [20], [21], [22], [23], [3], [24], [2], [25], [26], [5], [14].

The strategy of open innovation depends on a number of factors that can be divided according to whether they are exogenous to the firm, i.e. contextual, or endogenous and therefore inside the firm itself. Table I reveals that, industry sector and technological turbulence, patent protection, corporate competence, firm size, corporate venture, geographical area and aggressive technology strategy are still debated; on the other hand, Ict adoption, globalization trend, organization structure and support mechanisms, corporate culture, R&D intensity, product characteristics and development of radical innovation result to positively influence the adoption of OI in previous literature; the other hypothetical determinants have not yet been properly studied.

TABLE I
LITERATURE REVIEW OF FACTORS AFFECTING OPEN INNOVATION

exogenous factors			
CATEGORY	DETERMINANTS	POSITIVE INFLUENCING	NOT or NEGATIVE INFLUENCING
INDUSTRY	Type of Sector and Technological Turbulence	[14], [7], [19] , [27], [28], [29], [30]	[12], [25], [31], [26], [4], [12],[25], [26]
	Industry Speed [90]	[5], [32]	
	Globalization trend	[33], [34], [35], [15]	
	Patent Protection	[36], [37], [38], [34], [39], [14], [31], [15], [19]	[7], [37], [40], [41], [42]
	Diffusion of New Technology (i.e. ICT)	[34], [14], [40], [45], [46], [47], [48], [49], [50], [51], [52]	
endogenous factors			
FIRM PECULIARITIES	Firm Size	[45], [38], [12], [4], [53],[54], [31], [37], [55], [56], [57], [34]	[5], [13], [58], [38], [45], [40], [59], [8]
	Age		[26], [32]
	Organisational structural and support mechanisms	[43], [40], [44], [45], [13], [60]	
	Core competence and cognitive distance	[51], [2], [61], [62], [63], [64]	[32], [40], [65], [64]
	Corporate culture	[34], [5], [66], [31], [67], [3], [45], [44]	
	Corporate venture	[4], [5], [68], [69], [45]	[70]
	The role of a champion	[12]	
	Intensity of R&D	[38], [26], [12], [4], [25], [71], [42], [3], [72], [16]	
	Geographical area	[38], [44]	[26]
PRODUCT STRATEGY	Product Characteristics	[5], [27] [40], [28] [38], [26] [31], [5], [73], [66], [74]	
	Technological Aggressiveness	[75], [76], [12], [37], [77], [8], [45], [40]	[78], [79]
	Development of radical innovation	[80], [81],[2], [51], [45], [77], [82], [4],	
	Technological and product diversification and internationalization	[83], [70], [4]	
OBJECTIVES		[5], [45], [40]	
IMPEDIMENTS		[26], [84], [85]	

III. OBJECTIVES AND METHODOLOGY

A. Research questions

The analysis of the literature has highlighted the following gaps: the extent to which open innovation is embedded in SMEs [10] and what differences there are within the same SMEs regarding the level of openness adopted and the factors influencing their open strategy [13].

This study focuses on the following dimensions of open innovation: breadth (measured by the number of partners), integration along the innovation process, and the diversification of sources. Since 95% of firms in Italy are SMEs and in this country the open innovation phenomenon has not yet been properly studied, the study's objective is to identify and characterize different modes of OI, determinants, barriers and motivations in Italian manufacturing firms.

In particular, the research questions were:

1. Do different modes of openness exist considering the innovation process phases and the variety and breadth of the collaboration?
2. How are the different OI modes (if identified) characterized with regards to determinants of Open Innovation and context variables?
3. What are the barriers and motivations of the diverse OI profiles (if identified)?

B. Data collection and sample profile

A survey has been carried out using a web questionnaire organized into the following sections: degree of open innovation, structural-organizational characteristics of the firm, product-technology strategy, knowledge-competence-learning, external context characteristics, performance. Almost all the items have been measured with seven-point Likert-type scales (1 = strongly disagree; 7 = strongly agree).

From the AIDA Bureau van Dijk database of Italian firms, 2500 manufacturing firms have been randomly extracted and invited to participate in the research by emails addressed to the director of R&D or to the CEO/entrepreneur; follow-up phone

calls were made to participants to increase the response rate. During the data collection period (January 2010-March 2011) a database of 105 companies was obtained; the final respondent rate is 4.2%.

The companies in the sample used for this analysis are mostly located in Northern Italy and most of them are manufacturers of machinery and equipment (27%), producers of fabricated metal products (except for machinery and equipment) (19%), followed by the food and beverage (8%), rubber and plastics (7%), electrical equipment (7%), computer, electronic and optical products (5%) and textile, leather and clothes (5%) sectors. Other sectors were represented to a lower degree.

91% of the companies in the sample are SMEs (68% are micro and small) and many of them do not invest huge amounts in R&D.

A Chi-Square test was carried out in order to verify whether the sample was representative of the universe of studied firms; for this analysis the industrial sector was considered since the frequency distributions of the reference universe (AIDA database) are well known for this variable. The test confirms that there are no significant differences between the sample obtained and the overall reference universe of firms (α=0.001).

C. Variables and data elaboration

The survey data have been analyzed using SPSS 17.0 statistical application software.

Principal components factor analysis (PCFA) by varimax rotation has been implemented in order to reduce the number of variables obtained from the questionnaires (see Table II):

- We obtained three factors to measure the level of open innovation: upstream innovation process phases, downstream innovation process phases and another factor (partners) which considers breath, measured by the number of partners, and variety. The latter represents the number of different partners and is measured by counting the number of affirmative answers (score 2) obtained from 6 questions about collaboration over the last 5 years with each of the 6 types of partner: universities and research centres, service companies supporting innovation, government bodies and agencies, clients, suppliers, competitors, enterprises operating in other sectors). These factors explain 76.1% of the total variance, and the KMO test result is 0.71.
- Six factors were extracted from the PCFA in order to create the determinant variables, explaining 70.2% of the total variance, and a KMO test result of 0.77. They are: internal OI practices, employees' innovation capability and attitude, employee development, aggressive technology strategy, inimitability of the firm's capability, ICT adoption.
- From a third PCFA we created the factor "firm performance", explaining 89.3% of the total variance, and a KMO test result of 0.745. This factor was extracted separately since it does not constitute a determinant of open innovation, but rather a control variable.

TABLE II
VARIABLES AND FACTORS: VALIDITY TEST OF MEASURE (PAIRWISE OPTION)

FACTORS	ITEMS	Variance explained	KMO	αCronbach (listwise)
Upstream innovation process phases	-In the last 5 years you have collaborated on the Ideas Generation phase -In the last 5 years you have collaborated on the Experimentation phase -In the last 5 years you have collaborated on the Design phase	76.1 %	0.709	0.798
Downstream innovation process phases	-In the last 5 years you have collaborated on the Commercialization phase -In the last 5 years you have collaborated on the Production phase			
Partners	-With regard to your innovation process, in the last 5 years you have collaborated with many partners -Partner variety			
Internal OI practices	- You formally assess and manage the progress of the collaboration and any problems, -You formally assess the success of collaborations, -You formally analyze the reasons for the success/failure of the collaboration, -You formally analyze and select potential partners, -You formally analyze and assess different types of organization for the collaboration, -You formally assess the objectives and risks of a potential collaboration, -You use project management to manage your collaborations	70.2%	0.771	0.925
Employees' innovation capability and attitude	-Your employees exchange their ideas with a very high number of colleagues, -Employees habitually interact with many people in other areas of the firm about their own specific area of competence, -Your employees habitually exchange information on their specific area of competence, -Your employees easily adapt to new situations, -Your staff knowledge is varied and versatile, -Your staff is creative and brilliant			
Employee development	You give your employees time and resources to generate new ideas, -You assign employees creative and challenging objectives, -You allocate resources to the continuous development and training of employees, -You have explicit mechanisms for the recognition of contributions to innovation made by your employees			
Aggressive technology strategy	- You invest to become technological leaders, -You try to aggressively acquire new areas of activities through innovation, -You try to influence sector structure and rules through the characteristics of your products, -Emphasis is placed on radical rather than incremental innovation			
Inimitability of firm's capability	-Past experience is a resource that cannot be reproduced by your competitors, -Your intellectual capital gives you know-how that your competitors cannot ever have, -The knowledge underlying the technology is difficult for your competitors to imitate, -Your employees have extremely specialist competences in their own fields of work			
ICT adoption	-You use internet based systems to facilitate communication between partners in the collaboration, -You use internet based systems to facilitate the research for possible partners to collaborate with, -You use virtual simulation or prototype techniques to facilitate the development of new products in collaboration			
Firm performance	-Have improved the profitability of the capital invested, -Have improved the profitability of sales, -Have increased the firm's overall profitability	89.12%	0.746	0.941

The items in each factor have high factor loadings (i.e. more than 0.5), thus reflecting high construct validity, while the off-factor loadings for the other variables comprising each factor are low (i.e.<0.392), reflecting discriminant validity and the unidimensionality of the variables. The factor analysis was conducted using the pairwise option so as to work on a broader sample of firms (N=105). Later this analysis was verified by

also using the listwise option and the same factors were obtained. Then a K-means cluster analysis was carried out in order to group firms into homogeneous categories with regards to the ten factors previously obtained and two control variables, and with the intent of identifying different modes of OI. The K-means analysis was conducted using squared Euclidean distance and SPSS17.0 software. The control variables that have been considered are: firm size, classified according to the number of employees as micro, small, medium and large [86], and the technological intensity of the sector the firm belongs to, classified as high, medium-high, medium-low and low [87].

The adequacy of the resulting clusters was also evaluated using a univariate analysis of variance (ANOVA) to verify the significance levels of differences among the groups, also with regard to the control variables.

In order to determine the final number of clusters, we took three criteria into account: (a) the statistical properties in terms of the relationship between within-cluster and between-cluster variance, (b) the plausibility of the clusters identified ("can the clusters convincingly be interpreted as different OI modes referring to innovation process phases and partners?"), and (c) the cluster's size. Based on these criteria, we arrived at a three-cluster solution which is satisfactory in statistical terms and can be interpreted as will be explained in the results section.

Finally, a descriptive analysis of the barriers, motivations and OI clusters has been performed in order to answer to the third research question.

IV. Results Of The Empirical Analysis

A. Open innovation modes of the Italian manufacturing companies

The firms in the sample studied do not appear to have collaborated with many partners or on many phases of the innovation process, since they show near average values for all the variables considered, and openness on the downstream innovation process phases results as below average (Table III).

Nevertheless, all the firms have opened their innovation process to at least one partner, and almost all to at least two partners (96%), firstly favouring suppliers (partners for 94% of firms) and clients (88%), but also firms operating in other sectors (51%), research centres and companies supporting innovation (49%), universities (47%), competitors (26%), government bodies and agencies (24%). On average these firms collaborate with almost 4 different types of partner, using chiefly informal alliances as the form of collaboration.

TABLE III
Main Characteristics Of Oi In The Sample Analyzed

(Likert scale from 1=strongly disagree, to 7= strongly agree)			N	Mean	Std. Dev.
OPEN INNOVATION	PARTNERS	In the last 5 years have you collaborated with many partners in the innovation process	105	3.8	1.7
		partner variety (no. of different type of partner from 0 to 7)	96	3.7	1.4
	UPSTREAM PHASES	In the last 5 years you have collaborated on the Experimentation phase	95	3.3	1.6
		In the last 5 years you have collaborated on the Design phase	90	3.0	1.6
		In the last 5 years you have collaborated on the Ideas Generation phase	94	3.0	1.7
	DOWNSTREAM PHASES	In the last 5 years you have collaborated on the Production phase	85	2.9	1.8
		In the last 5 years you have collaborated on the Commercialization phase	84	2.5	1.7

These first descriptive results reveal that the OI phenomenon is very diffuse but with medium intensity.

Three groups emerged from the cluster analysis and for each grouping of variables, the average values are reported in Table IV, together with the univariate analysis of variance (ANOVA). The three clusters are well differentiated ($\alpha<0.1$) with regard to the OI factors, with very high significance levels ($\alpha<0.001$) in two out of the three factors. Significant differences ($\alpha<0.05$) between the three groups emerged also in 4 out of 6 determinants analyzed and in firm performance and technological intensity, while little significant difference can be seen for firm size ($\alpha=0.154$). The most discriminating variables (highlighted in dark grey in Table IV, with $\alpha<0.001$) are: OI on the upstream of the innovation process and numbers and different types of partner, internal open innovation practices, employees' innovation capability and attitude, ICT adoption, firm performance and technological intensity. Less significant variables, but still important in differentiating the two clusters (highlighted in light grey in Table III with $\alpha<0.059$), are: the upstream of the innovation process and aggressive technology strategy

TABLE IV
DESCRIPTIVE STATISTICS OF THE CLUSTERS OBTAINED AND ANALYSIS OF VARIANCE

Grouping Variables	Mean				F	Sig.
	Cl. 1 (std dev)	Cl. 2	Cl. 3	Tot.		
UPSTREAM PHASES	-0.747 (0.604)	-0.019 (0.840)	0.454 (1.020)	-0.139 (0.942)	11.7	.000
DOWNSTREAM PHASES	-0.206 (0.784)	-0.182 (0.831)	0.397 (1.138)	-0.035 (0.933)	2.9	.059
PARTNERS	-0.612 (0.789)	0.736 (0.666)	0.060 (0.996)	0.099 (0.984)	18.1	.000
INTERNAL OI PRACTICES	-0.575 (1.069)	0.718 (0.670)	-0.509 (0.773)	0.115 (1.031)	18.1	.000
EMPLOYEES' INNOVATION CAPABILITY AND ATTITUDE	0.523 (0.932)	0.209 (0.536)	-1.352 (1.042)	0.020 (1.008)	22.2	.000
AGGRESSIVE TECHNOLOGY STRATEGY	-0.399 (1.012)	0.337 (0.937)	-0.172 (0.687)	0.028 (0.967)	4.0	.024
EMPLOYEE DEVELOPMENT	-0.241 (1.107)	0.230 (0.822)	-0.162 (1.183)	0.020 (0.990)	1.6	.218
INIMITABILITY OF FIRM'S CAPABILITY	0.128 (1.198)	0.014 (0.844)	0.063 (0.821)	0.056 (0.943)	0.1	.922
ICT ADOPTION	-0.869 (0.613)	0.315 (0.935)	0.239 (1.113)	-0.048 (1.026)	10.9	.000
FIRM PERFORMANCE	-0.406 (0.918)	0.719 (0.514)	-1.030 (0.779)	0.007 (1.010)	40.0	.000
TECHNOLOGICAL INTENSITY	-0.343 (0.879)	-0.240 (0.915)	0.687 (0.915)	0.000 (1.00)	11.2	.000
FIRM SIZE	-0.236 (0.066)	-0.004 (0.625)	0.257 (1.699)	0.000 (1.00)	1.9	.154
NO. OF CASES	32	43	30	105		

In order to more deeply understand the OI modes resulting from the cluster analysis, they have been examined by considering the mean values of each OI factors, mentioned above (Fig.1).

As expected there are no high open clusters, but at low and medium level of openness the following pattern can be recognised:

- cluster 1, composed of 32 cases, has low openness values on both upstream and downstream phases, and for numbers and types of partners, so it will be called "selective low open" (SLO);
- cluster 2, composed of 43 cases, has medium openness level on the upstream phases and low open value on the others, whereas it has value which is above average for number and types of partners. It will be called "unselective, open upstream (UOU)";
- cluster 3, composed of 30 cases, has medium openness values on both upstream and downstream phases, and almost average value for partners. It will be called "mid-partners, integrated open" (MIO).

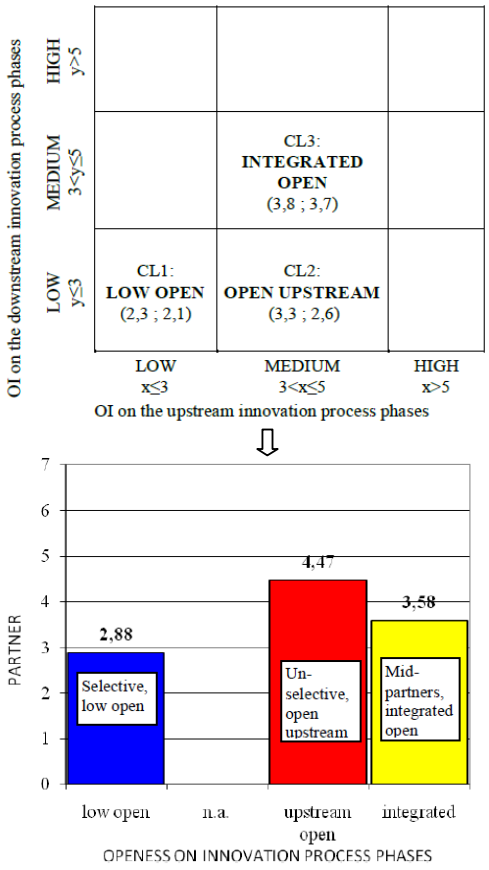

Fig. 1 Description of the three OI modes

B. Profiles of open innovation clusters: determinants, firms' performances, size and technology intensity

By using the mean of the values obtained in the variables that comprise each factor, it is possible to obtain the profile of the three clusters illustrated in Fig. 2. Technology intensity and firm size are not considered in this analysis as they have a different scale of measure, and they are discussed separately.

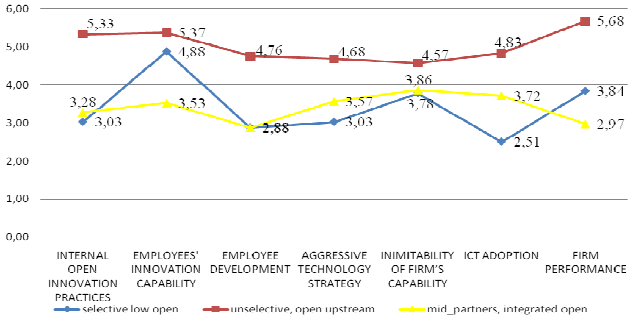

Fig. 2 Profiles of the clusters obtained

Since the considered variables measure the degree of agreement on a Likert scale (1 = strongly disagree, 7 = strongly agree), it is revealed that the "unselective open upstream" cluster has medium or high values for each

determinant considered and high performance as well. The "selective low open" cluster has a medium level of performance, and denotes the presence of personnel with high aptitudes towards innovation and inimitability of the firm's capability, it reveals medium aggressive technology strategy, but does not use practices that support open innovation, nor those for the development of personnel and ICT instruments. The third cluster, "mid-partner integrated open", has lower performance, even though it has an average levels of aggressive technology, inimitability of the firm's capability, and adoption of ICT instruments, but it shows a low use of internal OI practices, and lower employees' innovation capability.Moreover it is interesting to underline that employees' innovation capability and inimitability of firm's capability are medium or high in all three clusters, while the other determinants are not so widely used.In Table V, the three clusters are described using the control variables technology intensity of the sector and firm's size. As can be observed companies belonging to low tech and medium-low tech industries are distributed between cluster 1 and cluster 2, while the others belonging to more high tech industries are in clusters which are more open (cl.2 and cl.3). Therefore the degree of technology intensity of the industry seems to positively influence open innovation. Conversely, ANOVA (Table IV) shows that firm size is not significantly different between the clusters, and this is evident also in Table V, but here we also notice that while micro and small companies are well distributed between the three clusters, half the medium sized firms belong to the "unselective, open upstream" cluster and large companies belong only to more open clusters.

TABLE V
TECHNOLOGY INTENSITY AND SIZE OF CLUSTERS

TECHNOLOGY INTENSITY		SLO	UOU	MIO	Tot. 100%
low tech	Textiles, leather and clothes, food and beverage, wood and furniture, others	46%	46%	8%	24
m-low tech	Plastics and rubber, manufacturers of basic metals and fabricated metal products (no machinery and equipment)	42%	38%	19%	26
m-high tech	Manufacturers of machinery and equipment, electrical equipment, motor vehicles, chemicals and chemical products	26%	34%	40%	35
high tech	Manufacture of computer, electronic and optical products, drugs	0%	0%	100%	6
N/A		1	10	3	14
SIZE					
micro	employees < 10	33%	25%	42%	24
small	10 =< employees < 50	38%	43%	19%	47
medium	50 =< employees < 250	24%	48%	28%	25
large	employees >= 250	0%	56%	44%	9
N/A		0	0	0	0

At the end of our research we considered the barriers and the motivations of OI in order to extend the description of the clusters obtained (see Table VI).

TABLE VI
BARRIERS AND MOTIVATIONS OF OPEN INNOVATION

BARRIERS TO OPEN INNOVATION	MEANS				DEV STD				N
	SLO	UOU	MIO	tot	SLO	UOU	MIO	tot	
Economic/financial questions	4.5	4.9	4.5	4.6	1.9	1.7	2.0	1.8	87
Actual times longer than planned times	3.9	5.1	4.6	4.6	2.2	1.8	1.9	2.0	86
Lack of adequate competences for the management of collaborative relationships	4.1	4.5	4.5	4.4	2.1	1.7	1.9	1.9	84
Actual costs greater than planned costs	4.0	4.9	4.1	4.4	2.1	2.0	2.0	2.0	86
Quality of partners	3.6	4.6	3.2	4.0	1.9	1.7	1.4	1.8	85
Managerial complexities	3.6	4.1	3.5	3.9	2.1	1.9	1.5	1.9	85
Opportunistic behaviour of partners	2.9	4.0	4.2	3.7	1.6	2.2	2.1	2.1	81
Cultural resistance inside the firm	3.7	4.3	3.2	3.8	2.1	2.2	2.2	2.2	83
At lower degree: problems linked to imitation of the innovation, cultural differences between partners, difficulty in meeting client requirements, difficulty in evaluating the technologies available on the market, difficulty in knowing about the technologies available on the market, sensation that the technologies acquired from outside the firm can add to the perceived risk of the project, firm's difficulty in understanding and accepting something which has not been developed internally, fear that the success obtained thanks to external technologies will be detrimental to the internal R&D staff, fear that the success obtained thanks to external technologies will be detrimental to the financing of internal research are excluded as they not so relevant.									
MOTIVATIONS FOR OPEN INNOVATION ADOPTION	MEANS				DEV STD				N
	SLO	UOU	MIO	tot	SLO	UOU	MIO	tot	
Broaden the firm's competence base	4.0	5.3	5.3	4.9	1.9	1.6	1.7	1.8	104
Stimulate creativity and the capacity to generate new ideas	4.3	5.4	4.7	4.9	2.1	1.6	1.8	1.9	102
Maximize the possibilities to commercially exploit proprietary technologies	4.0	5.1	4.4	4.6	2.1	1.9	2.0	2.0	99
Increase the flexibility of the internal organization for innovation	3.9	5.1	4.5	4.6	1.8	1.8	2.0	1.9	100
Avoid the risk that own technologies become obsolete before being translated into consistent cash flows for the firm	3.5	5.4	4.3	4.6	2.1	1.7	2.0	2.1	102
Integrate competences of heterogeneous areas and disciplines	3.6	5.1	4.6	4.5	1.6	1.3	1.8	1.7	100
Contain the "time-to-market"	2.9	4.7	5.3	4.3	2.0	1.6	1.7	2.0	97
Reduce or share the costs of the innovation process	3.6	4.7	4.1	4.2	2.2	1.7	1.7	1.9	103
Access sources of public funding (national or international)	3.4	4.6	4.5	4.2	1.9	2.2	1.7	2.0	101
Reduce or share the risks associated with innovative activities	3.2	4.2	4.2	3.9	1.9	1.7	1.8	1.8	102

The mid-partners integrated open firms have the largest number of barriers to OI, whilst low open firms are hampered by economic and financial questions as are all the firms we analyzed. Mid-partners integrated open firms show not only the economic and financial issues as barriers, but also actual times longer than planned times and lack of competence to manage collaborations and we can claim that this group of firms corresponds to the average trend because of medium values for all the barriers. Referring to the motivations, unselective open upstream firms are strongly motivated to adopt the OI approach. The most open clusters show a broader firm's competence base as the motivation and mid-partners integrated open firms tend to use OI strategy in order to contain time-to-market (TTM), as they integrate their innovation process also in the downstream phases.

V. Discussion And Conclusion

The analysis conducted contributes to the study of the open innovation phenomenon in SMEs and in the Italian territory, where SMEs are so well represented; these are the elements of peculiarity of the sample analyzed, which has, until now, been little investigated.

At overall level this study highlights that SMEs are also widely interested in the open innovation phenomenon, but with medium intensity, in terms of numbers of phases and partners involved. In more detail, by answering the research questions we found three clusters differing in their integration of openness along the innovation process, and the degree of selectiveness of partners: the selective low open, the unselective open upstream and mid-partner integrated open, the main characteristics of which are summarized in Table VII. So, as asserted by [16], the OI phenomenon is much less a dichotomy (open than closed), than a continuum with varying degrees of openness.

From the analyses carried out we can infer that when firms open their innovative process they appear to open upstream first and then, if necessary, downstream; in fact no cluster has opened just in the downstream phases. Furthermore, generally large firms and high-tech firms belong to the two most open clusters, while smaller companies are spread across all the clusters, and those with lower technology intensity rarely open their innovative process in an integrated way.

The most numerous cluster is the "unselective, open upstream" cluster (45% of the total), which has a high level of firm performances (significantly higher than the other clusters); the firms in the cluster, which are different sizes and levels of technological intensity from low to mid-high, appear to have used all the determinants that have emerged from the literature at medium-high levels. The principal motivations for OI are consistent with the opening of the first phases of the innovation process, while with regard to the barriers, besides the economic and financial barriers common to all the sample, others include managerial issues and partners' quality.

TABLE VII
Main Characteristics Of Open Innovation Profiles

	TYPE OF OI	DETERMINANTS	PERFORMANCE	FIRMS' SIZE and TECH-INTENSITY	MOTIVATIONS	BARRIERS
SLO	low open upstream and downstream and few partners	High employees' innovation capability, average inimitability of firms' capability, low the others	average	Micro, small and medium firms; mostly low or medium-low tech	They are not motivated to adopt OI model	Economic-financial issues
UOU	open innovation on upstream phases and many partners	Medium or high values in all	high	all types of size, Low, medium-low and medium-high tech	broader and integrate competences, stimulate creativity and idea generation and exploit them, increase the flexibility, avoid the risk of obsolescence	Economic-financial and managerial issues and partners' quality
MIO	open innovation in all phases and average partners	average aggressive strategy, ICT adoption, and inimitability of firms' capability, but lower employees' innovation capability and low the others	Low	all types of size. Medium-high and high tech	broader firm's competence base and to contain the time to market	Economic-financial and managerial issues

The "selective low open" cluster contains 33% of firms, not large in size and characterised by low or medium low-tech intensity. Such firms make little use of OI practices, ICT instruments and other determinants, but indicate high capacity and aptitude to innovation. They are not particularly motivated towards adopting OI, and they highlight barriers which are generally economic/financial; therefore they emerge as developers of innovation mainly within the firm, and secondarily through collaborations outside the firm.

The remaining 32% of firms belong to the "mid-partners integrated open" cluster, which is characterised by having opened the whole innovative process in an integrated manner, but with a limited number of partners. In this case the determinants have medium or low values and, in particular, it must be underlined that the value of aptitude and innovative capacity compared to the other clusters is considerably lower, despite an averagely aggressive strategy. It appears that we can conclude from this analysis that it is better to develop a good internal innovative capacity, and open the innovation funnel a little, as in the closed cluster with has average performances, rather than opening the whole innovative process in an integrated way, but with lower innovative capacities, with particular reference to the absorptive capability. With regard to the motivations, also in this case we find that the firm's competence base is broader, in addition to containing the time to market, while the principal barriers are economic, financial and managerial issues.

To conclude it must be observed that in accordance with previous studies OI strategy is not always associated with an improvement in performances, since it depends on how the opening takes place and in what context [25], [2], [88], [34],[89], [3]). The principal determinants for an effective opening are the adoption of aggressive technology strategy, OI

practices and ICT instruments and the capability and attitude of employees toward innovation; if used they are associated with high performances, as emerged in the "unselective open upstream" cluster. If however these determinants are not adequately considered, as in the "mid-partners integrated open" cluster, so it seems more worthwhile to concentrate on the development of innovation within the firm, in order to obtain better performances, as in the "selective low open" cluster.

This work identifies different modes of integration and selectiveness of OI and describes which factors characterize and distinguish the different models. However, the level of influence of the group of factors examined (determinants, technology intensity and firm's size) on the adoption of OI, and the influence of OI modes on performance remain to be studied, by using a regression analysis for example. Furthermore, the sample could be extended to allow a sector analysis, as well as a geographical extension which would allow different countries to be compared, and finally to deeply understand if other OI modes can be identified enlarging the sample of analysis.

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