

Inbound open innovation in SMEs: towards a new conceptualization to explore openness behaviour and motivations in the Tunisian manufacturing sector

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Abstract— The objective of this paper is threefold by studying the degree of openness of SMEs under the aegis of the inbound dimension of Open Innovation model. In particular, it is intended to clarify the concept of the degree of openness, explore the behaviour of SMEs when approaching inbound practices and also explain the degree of openness of the innovation process through the effect of motivations. Then, in the light of a new conceptualization of the degree of openness and by referring to the dimensions of breadth and depth, it was possible to propose a configuration of 141 Tunisian manufacturing SMEs involved in innovative activities on the basis of classification analysis. The results categorize SMEs into four homogeneous groups that differ according to their degree of openness: *Closed, Supervisors, Engaged and Open*. In addition, findings show that the degree of adoption of inbound practices is stimulated by a range of internal incentives that can be linked either to the benefits of openness as such or to obstacles to innovation. The results of this paper have practical implications for both managers and political organisations involved in sustaining innovation.

Keywords— Inbound open innovation, degree of openness, openness behaviour, openness motivations, SMEs

I. INTRODUCTION

Innovation has long been regarded as the key element of business growth, development and survival. It is seen as a driver for strengthening their competitive position in the market and improving their competitiveness and performance. However, the question today is not to know the merits of innovation, nor to identify the related risks, but rather to explain the conditions for its success and the necessary mechanisms to stimulate it, particularly in the new economy based on knowledge. Regarding the way in which companies are organized to develop innovations, the debate is still ongoing and various approaches are trying to clarify this phenomenon. For years, innovation has remained an internal business process with a vision of protecting and hiding new ideas internally to ensure power and business advantage over competitors. Thus, innovation is traditionally considered as taking place mainly within a single company. This way of innovating reflects a limited interaction of companies with their environment. However, with the increasing availability and mobility of knowledge workers and the increasing importance of external sources and actors ([14]), more and more companies have redesigned their ways of innovating.

Recently, academics and professionals have agreed on an emerging trend towards new practices based on interaction, information sharing and collaboration to advance innovation ([43]-[44]). It is in this logic of openness that Professor Henri Chesbrough has introduced a new theoretical trend in innovation management, based on the Open innovation model.

Referring to [11], the Open Innovation model is defined as “*a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firm look to advance their technology.*” Indeed, the open innovation model has redefined the new boundaries of companies, making them more porous so that knowledge flows more freely between the company and its external environment [6]. Three dimensions were then proposed in the literature to reflect these movements of ideas and knowledge: the inbound dimension which aims at an innovation process from the outside to the inside to innovate, the outbound dimension which reflects a process from the inside to the outside to open new markets and the coupled dimension which corresponds to the combination of the first two dimensions ([4], [15]-[19])

Through the literature review, we have observed that the corpus of knowledge on open innovation in the context of SMEs is very recent and still poorly developed, which requires more investigation by researchers([21], [22], [33]-[43]). In this sense, this paper aims to take part in this research effort by studying open innovation in the specific context of SMEs. Moreover, there is a fairly broad consensus in the literature that these companies are more inclined to adopt the new innovation model through its inbound dimension because it does not require significant investment compared to other perspectives ([17], [30], [42]-[45]). This last observation led us to focus in this research on the analysis of the inbound dimension related to the open innovation paradigm in the specific context of SMEs.

To analyze this dimension, literature has introduced the concept of openness ([15], [26]-[27]) to designate a set of avenues that the company should pursue to remain innovative, moving from a closed innovation model to a more open model. Indeed, the authors pointed out that the adoption of the open innovation model is not a closed versus open dichotomous form, but rather is located on a continuum

ranging from a less open degree to a more open degree and with different degrees of openness ([14], [15], [16], [26], [27]). However, this idea of the degree of openness remains insufficiently studied in the literature. In fact, the openness of firms to open innovation practices has been widely associated in the literature with the practice of searching for external sources of information ([26]-[27]). Considered from this perspective, the conceptualization of openness seems very limited.

All these considerations lead us to focus, in this research, on studying the degree of openness of innovative SMEs under the aegis of the inbound dimension of the open innovation model. In order to achieve this general objective, three specific objectives will be pursued to address the identified gaps in the literature. First, our research attempts to contribute to the clarification of the concept of the degree of openness, which is considered very little explored in the literature on the open innovation model. This gap is all the more pronounced in the context of SMEs. Second, our research aims to explore the behaviour of SMEs in adopting open innovation practices. This means identifying innovative SME configurations that differ according to their degree of openness. Finally, and to go further in analyzing the degree of openness of SMEs and understanding their behaviour when adopting inbound practices, we propose in this article to answer in part the question: *why do some SMEs succeed in opening their innovation process more than others?* More specifically, we choose to explain the behavioral difference of SMEs in terms of their degree of openness through a motive-based approach. To achieve all these objectives, we opted for a quantitative approach and conducted an empirical study among Tunisian SMEs operating in the manufacturing sector.

The remainder of the paper is structured in four main parts. In Part II, we will conduct a literature review, focusing in particular on inbound open innovation and the degree of openness, in order to set out a roadmap for a new conceptualization of the degree of openness. Next, we will present, in Part III, the conceptual framework for studying the behaviour and determinants of the degree of openness. Then, we will present the empirical study in Part IV, detailing respectively the research methodology, the measurement of variables and the results of the various empirical analyses. At the end of this document and through Part V, we will discuss the results obtained and present through the conclusion a reminder of the strengths of this work, also highlighting the limitations of this study, as well as recommendations for the orientation of future research in our field of research.

II. LITERATURE REVIEW

A. Inbound Open Innovation in SMEs

Since this paper focuses on open inbound innovation in the specific context of SMEs, we specify the inbound opening practices in the first instance, and the advantages of integrating SMEs to an inbound open innovation approach in the second instance.

1) *Inbound Open Innovation Practices:* The inbound dimension of the open innovation model consists of the acquisition, assimilation and internal incorporation of new ideas, knowledge and technologies developed in the company's external environment. In this way, inbound open innovation is a way for companies to renovate and enrich their internal knowledge base through opportunities to access new, complementary and unique resources ([19]) in order to stimulate innovation processes.

To innovate through this approach of resource internalization, the literature predicts that companies embrace several practices. References [26] and [27] linked the inbound dimension to the strategy of searching for external information sources. Indeed, the authors suggest that companies should rely on the knowledge and expertise of a wide range of external actors and information sources ([26]-[27]). This research practice is carried out through various external sources of information used by companies to support their innovative activities: customers, suppliers, research laboratories, etc. reference [42], for their part, use the terminology "exploration" to refer to the inbound dimension. The authors present five practices related to this dimension: customer involvement, external networking, external participation, the acquisition of technical and scientific services from other organizations (R&D outsourcing) and the acquisition or use of intellectual property rights held by other organizations (inward licensing of IP).

In the continuity of research exploring inbound practices adopted by SMEs, [15] introduced a theoretical model to present the forms of openness according to which the inbound or outbound process is related. The authors linked the inbound dimension to two major practices: Sourcing and acquiring. This implies that the inbound dimension is associated with the exploration and integration of external resources to develop the knowledge base and internal resources that are available in the external environment ([15], [26], [27], [32]-[42]).

The review of the current state of the literature on the open innovation paradigm in the context of SMEs has enabled us to propose a categorization of forms of openness according to inbound logic. Thus, we can classify inbound activities into three main practices of internalizing external resources. These are practices of internalization through the use of external information sources, collaboration and acquisition. Table I illustrates some empirical work on the adoption of the innovation model through inbound practices. It should be noted that the analysis focused more specifically on the SMEs context.

By examining the empirical literature relating to the inbound dimension, we can see that this way of approaching the open innovation model has attracted the attention of researchers who have reported the positive impact of this dimension on innovation in the context of SMEs. Reference [41] has already carried out a systematic literature review to structure the field of open innovation in SMEs. The authors note an emerging trend towards a practical application of open innovation by SMEs. In order to better understand the

adequacy of the open innovation paradigm with the specific context of SMEs, it is necessary to present the advantages of integrating into an open innovation approach.

TABLE I
 INBOUND OPEN INNOVATION PRACTICES IN SMEs

Inbound Open Innovation Practices	Activities related to Inbound practices	Some Empirical studies
Internalization practices by external search of information	Suppliers of materials and equipment, customers, competitors, research laboratories; public and private research centers; professional conferences and congresses; fairs; professional networks, etc.	[16], [23], [26], [27], [30], [32], [36], [39]
Internalization practices by collaboration	Client involvement; External participation; Vertical collaboration; Horizontal collaboration; Collaboration with end-user; Scientific collaboration; Domestic collaboration; International collaboration	[16], [26], [30], [32], [34], [40], [42]
Internalization practices by acquiring	Acquisition of technical and scientific services from other organizations; Acquisition of intellectual property rights owned by other organizations; Acquisition of equipment and other preparations.	[4], [16], [30], [32], [34], [42]

2) *Benefits of adopting an inbound open innovation approach by SMEs:* The literature explicitly relates the interactive nature of the innovation process in the context of SMEs. Several authors affirm the importance of the conjunction of the firm's internal resources with external resources to ensure the successful development of innovations in SMEs, given their specific characteristics in terms of insufficient resources ([7], [21], [25]-[41]). Previously, [9] and [39] demonstrated that due to scarcity of resources and capacity, SMEs profit from open innovation activities and use these practices more intensively than large companies. By cooperating with other companies, SMEs can have access to inter-firm resources with low costs that help to overcome technological, financial or human capital obstacles [17].

Collaboration with customer firms is an essential practice to compensate for the lack of internal resources and then transform ideas and inventions into commercially viable innovative products ([17]-[32]). Partnering up with third parties can help SMEs to complement limited qualitative and quantitative resources and share risks associated with the development and commercialization of new products or services ([41]). Therefore, establishment of partnerships promotes the development of new products, marketing in new

markets, as well as economies of scale and cost advantages ([46]).

Compared to large companies, being generally more flexible, less bureaucratic and faster in decision-making and in responding to market changes, open innovation is a feasible innovation strategy for SMEs ([1]-[17]). It is due to these specific characteristics that they could benefit even better from the concept than large companies ([7]; [9], [38]). Moreover, the speed at which new ideas are transformed into marketable products is crucial to differentiate from competitors and remain competitive in the global marketplace. On this basis, the integration of open innovation practices by establishing cooperation with universities and other companies helps SMEs to meet this challenge and create innovative products in an open way ([46]). Reference [37] adds that in a highly competitive and rapidly changing environment making innovation today more difficult, costly and risky, SMEs should adopt the new open innovation approach to overcome these challenges and reduce the cost and risk of innovation.

As we can see from the most recent systematic literature reviews (SLR) on open innovation in SMEs ([21]; [25]-[41]), the majority of the articles are in favor of open innovation for SMEs. A growing number of studies on such companies demonstrate the relevance of an open innovation approach to improving overall innovation performance ([21]). The proximity of SMEs to the external resource landscape is therefore a key factor in the success of an effective and efficient innovation strategy, not only to overcome the obstacles inherent in the process but also to be inspired for new ideas from external actors. Therefore, it could be seen that SMEs were certainly taking advantage of the opportunities offered by the new open innovation model.

B. Efforts to Conceptualize the Degree of Openness

1) *The Degree of Openness in the Literature:* The literature on open innovation considers the notion of openness in many ways and it has been established in recent years that open innovation should be considered not from a dichotomous perspective between open and closed processes, but rather along a continuum with varying degrees of adoption of the foundations of open innovation ([14]; [15]-[28]). This observation will generate a particular enthusiasm on the part of researchers who have tried to explore the modalities of opening up companies.

Two previous studies are particularly relevant to improve our understanding of the concept of openness: these are the works of [26], [27] and [15]. It should be noted that these studies are widely cited in research papers on open innovation.

Based on the work of Katila and Ahuja, [26] and [27] present the concept of openness while emphasizing two dimensions, which are external search breadth and external search depth. From this perspective, openness is carried out from various channels and sources of information, such as customers, suppliers, competitors and research institutions, with certain intensity.

Referring to [27], external search breadth refers to the degree to which the company explores new information and knowledge. This reflects the number of external sources or search channels that firms rely upon in their innovation process. External search depth is defined in terms of the extent to which company draw deeply from the different external sources or search channels. This way of conceptualizing the degree of openness through the breadth and depth in the use of external information sources is proposed by the authors as a new theoretical contribution. Moreover, [27] argued that firms who are more open to external sources are more likely to have a higher level of innovation performance.

Even if the conceptualization of openness has been very well defined by [27], their operationalization is still considered very specific to the inbound process of open innovation ([42]). On the other hand, and despite the debate that this conceptualization has generated among some authors ([42]; [15]; [22]), it remains widely used in studies referring to the new open innovation paradigm and most recommended in studies conducted in the context of SMEs ([30]).

On the other hand, [15] propose, in their seminal article "How Open is Innovation?" different forms of openness. Presented as a theoretical model, their proposal seems to be most relevant in the literature on open innovation because it is the first to include the question of forms of openness in the particular context of SMEs. Through an extensive literature search, the authors categorized the papers in the database by distinguishing inbound and outbound innovation as a starting point. Then, they divide inbound and outbound innovation to pecuniary versus non-pecuniary transactions. In doing so, the authors distinguish four forms of openness. Acquiring and Sourcing are practices related to the inbound dimension. Sourcing refers to how firms can use external sources of innovation with non-pecuniary transaction. Companies can therefore analyze the external environment to explore ideas and technologies available externally and integrate them into internal innovation processes ([15]).

Acquiring is the inbound practice with a pecuniary transaction. This type of openness refers to the acquisition of inputs available on the market to strengthen the innovation process. Following this reasoning, openness can be understood as how firms license-in and acquire external expertise or technology to stimulate the internal innovation process ([15]).

Reference [15] distinguishes in addition between two outbound practices: the first refers to selling by referring to how firms commercialize their inventions and technologies through selling or licensing-out of internally developed resources; and the second refers to revealing, which refers to how internal resources are revealed to the external environment without immediate financial rewards, in search of indirect benefits. Finally, the authors suggested that the different dimensions of the open innovation model could be considered in a continuum covering various degrees of openness.

2) *Towards a new conceptualization of the degree of openness*: The literature presents the concept of openness in reference to the open innovation model to focus on a set of open practices that organizations could adopt to stimulate the innovation process. However, this question of opening up companies has been relatively unexplored. Very few studies have focused on the detailed analysis of SME openness. Moreover, we have found in the literature that when the authors referred to openness, it was difficult to appreciate in what form and to what degree. Studies on openness include either an identification of the forms of openness or an operationalization of the degree of openness with reference to a single form. To the best of our knowledge, we never find a study that considers openness in reference to both form and degree.

With regard first of all to forms of openness, Dahlander and Gann's (2010) pioneering study is undoubtedly instructive. An examination of their model shows that although the four forms of openness are well defined in the study, their degree of application remains ambiguous. Consequently, the contributions developed by Dahlander and Gann (2010) remain, in our view, incomplete since they do not shed enough light on the degree to which companies are approaching the different forms provided in their study.

Turning then to the degree of openness in the literature on open innovation, we make two main findings from the conceptualization point of view. First, the degree of openness has been amply linked in the literature to the strategy of searching and using a wide range of external information sources with reference to the pioneering work of Laursen and Salter (2004; 2006). Second, we find that empirical research on the open innovation model focuses largely on the conceptual effort of Laursen and Salter (2004; 2006) to study the degree of openness of organizations. As a result, the notion of the degree of openness was not satisfactorily defined in the literature as it is commonly represented by reference to the use of a wide range of external information sources. Indeed, considered from this angle, the openness of companies seems very limited because it is only applied to the practice of external search of information.

In this paper, we wish to enrich the concept of the degree of openness. In fact, this notion merited further attention in order to provide a better explanation of the adoption of openness practices by the particular class of SMEs. As a result, we will build on the work on conceptualizing openness provided by Laursen and Salter (2004; 2006) and adopt an integrated approach to include the majority of forms of openness related to the inbound process. In fact, our theoretical reflection is based on both the forms of internalization of external resources and their degree of adoption. In this research work, we then choose to combine two research postures, i. e. the forms, referring to [15] and the degree of openness, referring to [27].

By extending to the work of [27], we believe that understanding the degree of openness of organizations also requires the integration of other practices for internalizing external resources. As a result, we extend the same

conceptualization of the degree of openness predicted by [27] through the dimensions of breadth and depth to include the majority of the forms of openness predicted in the literature. Therefore, our conceptualization is founded on three inbound open innovation practices. This involves the internalization of resources available outside organizational boundaries through search activities and the use of external information sources, collaborative relationships with other external actors and the acquisition of technologies and knowledge to fortify the internal expertise base. These practices that served our proposition of conceptualizing the degree of openness have a well-founded recognition in the literature on open innovation.

For this reason, we have chosen to include our proposal in a globalizing vision by presenting the degree of openness as a combined set of these three main inbound practices that the firm could adopt when managing its innovation process.

In order to identify this theoretical contribution, we present Fig.1 to visualize our approach considering the degree of openness of SMEs to the inbound practices of the new open innovation model. Therefore, we assume that the more the company uses all these practices, the more open its innovation strategy will be.

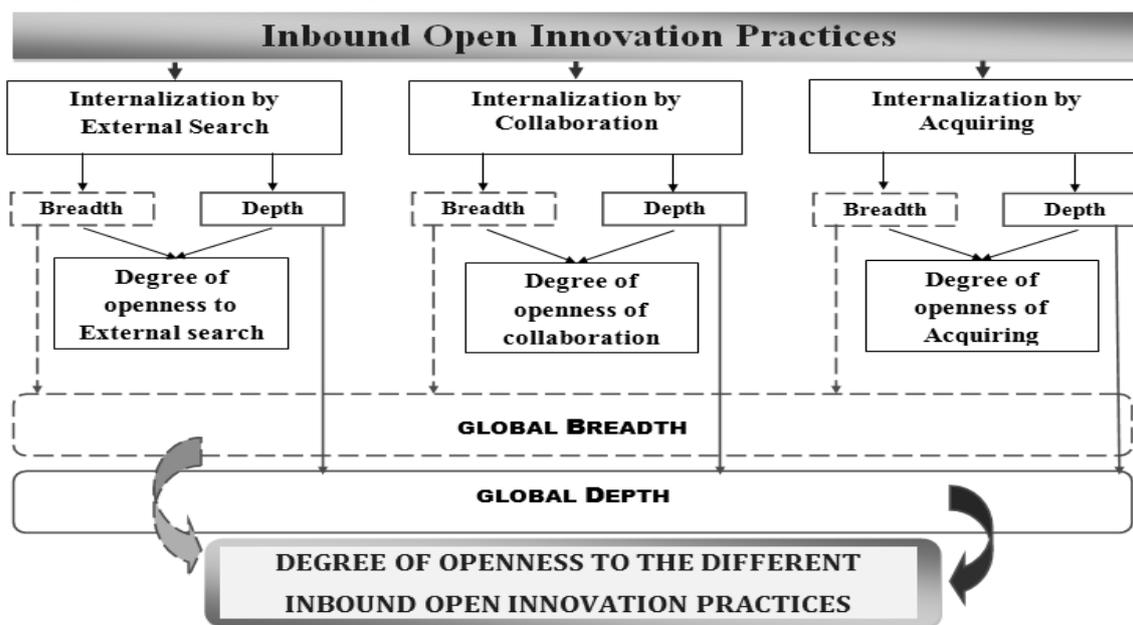


Fig. 1 The conceptualization of the degree of openness to inbound open innovation practices

Fig. 1 illustrates how to consider the degree of openness in this research. This new conceptualization is our first conceptual contribution to the literature on open innovation. We thus propose to define the degree of openness as a multidimensional approach driven by organizations that try to inject dynamism into their innovation process and whose purpose is to adopt various innovative organizational modalities that are situated on a continuum, thus breaking the close versus open cleavage.

Now that we have clarified our way of conceptualizing the notion of the degree of openness by adopting a globalizing approach, we now present our conceptual framework for the analysis of the degree of openness in the specific context of SMEs.

III. CONCEPTUAL FRAMEWORK FOR THE ANALYSIS OF OPENNESS: BEHAVIOUR AND DETERMINANTS

A. Behaviour of SMEs

Based on the above developments, we agree with the idea that openness behaviour should be placed in a continuum from a less open degree to a more open degree ([14]; [15],

[22]). Empirically, this way of considering the degree of openness has been examined in the literature on inbound practices by a pioneering study carried out by [23].

The authors proposed a classification of company profiles based on the dimensions of breadth and depth related to the degree of openness, but without differentiating between large companies and SMEs. In addition, the authors have approached the concept of openness by referring only to the practice of searching for external sources of information. In this study, an approach similar to that recommended in the classification analysis by [23] is adopted to show that SMEs are also a class of companies that can have different degrees of openness as large companies. Indeed, we will use the same openness criteria (breadth and depth) to categorize SMEs according to their degree of openness, but by applying them to the three inbound practices serving our conceptualization of openness.

This means splitting the openness of SMEs, as defined in this research, into four classes, according to the overall degree of breadth and depth. On theoretical level, Figure 2 shows the configuration to be empirically validated in this study.

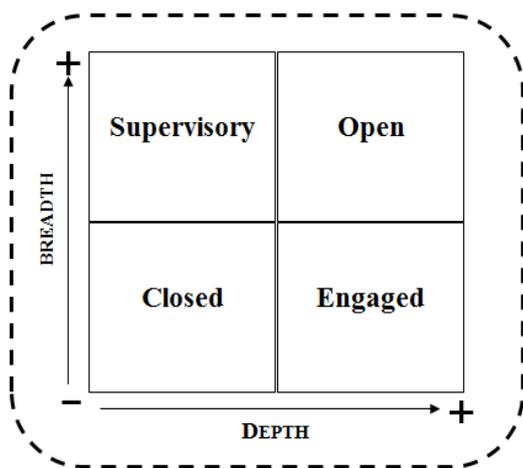


Fig 2. Theoretical classes of SMEs by degree of openness

B. Motivations of Degree of Openness

To go further in analyzing the degree of openness of SMEs and to understand their behaviour when adopting practices linked to the open innovation model by its inbound dimension, we propose in this paper another question to be explored, namely: Why do some SMEs succeed in opening up their innovation processes more than others? This amounts to joining a little-explored field of research that aims to study the determinants of open innovation in order to succeed in this approach ([24], [34], [36]). In this paper, we propose to study the factors that stimulate the degree of openness of SMEs. In this context, we have identified some work that attempts to identify incentives for the adoption of an open innovation strategy. These incentives can be linked either to the benefits of openness as such or to obstacles to innovation.

Reference [13] identifies that the main motivations for the use of external technologies are the quest for growth in terms of new product development and revenue and also the reduction of time-to-market. Despite the proliferation of the benefits of open innovation that could motivate companies to open their organizational boundaries, little empirical work has been done to analyze these sources of motivation. In this context, [42] explored the adoption of the open innovation model in the context of SMEs through the examination of motivations. The authors suggest that market considerations and knowledge creation are key motivations for fostering more open practices in the conduct of innovation activities. Other motivations in terms of expected revenues are also noted in the literature on innovation collaborations and open innovation. Thus, acquiring missing knowledge and complementary resources, sharing risks, expanding social networks, reducing costs and generating revenue are key incentives for companies to adopt open practices [42]. We therefore strongly believe that the presence of serious motivations in the company to strengthen and advance its internal innovation process can be the basis for its proactive behaviour when managing innovation activities. Thus, we can formulate the following research hypothesis.

Hypothesis 1: The different sources of motivation influence the behaviour of SMEs in terms of the degree of openness.

On the other hand, in the innovation literature, several studies have focused on the effects of different barriers on the innovation process of firms. The literature distinguishes between internal and external barriers. Internal barriers include financial resources, technical resources, human resources and factors related to the culture and structure of the company ([10]). External barriers are those related to market forces, supply, demand and the government environment. Research on innovation management has addressed the negative impact of these different obstacles on the innovation process of companies. Nevertheless, in the literature on the open innovation model, the vision is reversed such that obstacles to innovation are considered as factors that stimulate the openness of innovation processes, particularly in the specific context of SMEs. The argument for this consideration is motivated by the fact that SMEs had specific characteristics in terms of resource endowment and the adoption of the open innovation model is seen by them as a strategy to palliate deficiencies in internal resources and skills. Thus, inbound practices often serve to mitigate existing barriers by allowing firms to approach a much broader range of resources than can be obtained internally ([38]). This could therefore accelerate the innovation process by reducing the related costs and risks. Moreover, some empirical studies ([23], [30]-[47]). have been conducted around this question and all show that companies facing these obstacles to innovation could open their innovation processes in order to circumvent the effect of these obstacles. Reference [23] studied the impact of internal barriers on the adoption of the open innovation model by firms. In particular, the authors showed that barriers related to the lack of knowledge and information and barriers related to the overvaluation of innovation risks have led companies to opt for strategies to open up their innovation processes in order to face and overcome these obstacles inhibiting the development of innovations. The study conducted by [30] contains a series of the most notable barriers to innovation in the SME context that have encouraged companies to adopt inbound openness practices. The authors presented four categories of barriers: Labour shortages, lack of information (technological information, market information), lack of infrastructure and lack of financial resources (financing difficulties due to a high risk of technological uncertainty or due to marketing and innovation costs). In a related vein, [47] demonstrated in an empirical study the positive effect of internal barriers to innovation on the opening of SMEs' organizational boundaries by focusing on the categorization of innovation barriers presented by [30].

The opening of innovation activities can then be considered as the result of a deliberate search for an alternative solution to the internal presence of all the resources essential to innovation ([38]). All these findings allow us to suggest that the existence of such internal barriers to innovation can act as motivating factors for SMEs to open

up their innovation activities according to the open innovation model. Therefore, we aim to test the following research hypothesis:

Hypothesis 2: The presence of internal barriers to innovation influences the behaviour of SMEs in terms of the degree of openness.

IV. EMPIRICAL STUDY

A. Methodology and Variable Measurement

To study the openness behaviour of SMEs and identify its determinants, we used a quantitative analysis and focused on the questionnaire as a measurement instrument. For this, we conducted a field survey of 141 manufacturing companies distributed across the different industrial sectors in Tunisia (see Table II).

TABLE II
 THE SAMPLE BY ACTIVITY SECTOR

Activity sector	Numbers	Proportion
Food	24	17,0
Mechanical and Metallurgical	11	7,8
Construction Materials, Ceramics and Glass Industries	6	4,3
Electrical and Electronics Industries	7	5,0
Leather and Footwear Industries	13	9,2
Textile and Clothing Industries	46	32,6
Chemical Industries	7	5,0
Various industries	27	19,1
Total	141	100,0

For the operationalization of the dependent variable "degree of openness", we have been inspired by the measurement of [27] which consists in presenting the degree of openness through the dimensions of the breadth and depth of external information sources. We have generalized this same operationalization method for the other two inbound practices (collaboration and the practice of acquiring external resources). To do this, we have chosen 20 items from the literature review, distributed among the three inbound practices already identified.

External sources of information and knowledge was measured through twelve items referring to search from suppliers of materials and equipment, customers, competitors, consultants, research laboratories; universities and educational institutes; public research centers; private research institutes, professional conferences and congresses and meetings; fairs and exhibitions; professional networks; Internet. Collaboration was measured through five items referring to collaborate with five partners: Customers; Supplier of equipment, materials, components, or software; Competitors or other companies in the same sector of activity; End users and user community; Academic world (laboratories and research organizations, universities, etc.). With regard to acquiring practice, it was measured using the following three items: Recruiting employees who had qualifications that did not previously exist in your company,

Acquiring existing knowledge or patents from other companies and acquiring of sophisticated equipment essential to the innovation process. In the questionnaire, companies were asked to characterize their degree of use (Breadth) and importance (depth) of the various sources of openness in the conduct of their innovation process. Each source (item) is measured using a 5-point Likert ordinal scale.

Concerning independent variables, motivations were measured based on the study of [42]. Therefore, motivations are expressed first of all in terms of innovation processes (improving product development, integrating new technologies), in terms of knowledge (creating knowledge; bringing expertise to the organization), in terms of costs (sharing costs, profitability, etc.), in terms of capacities (offsetting lack of capacity) and in terms of markets (monitoring market development, responding to customer demands, new markets, increasing growth, etc.). In addition, factors related to the company's external environment can be considered as sources of motivation that can encourage an SME to establish a collaborative relationship during their innovation process. The items concern the evolution of the sector of activity, market instability, intensive competition, government incentives and the geographical proximity of the partners. SMEs are then asked about their level of appreciation of the various sources of motivation for adopting inbound opening practices, using a 5 point Likert scale ranging from (1) "Not at all important" to (5) "Very important".

With regard to the operationalization of innovation barriers and based on the work on open innovation ([23], [30], [47]), we have selected a group of eight barriers referring respectively to the lack of internal capacity and skills, difficulty in recruiting qualified people, difficulty in training workers on time required, high costs and funding difficulty, lack of diffusion of market and technology information; insufficient opportunities for cooperation with other companies and insufficient opportunities for cooperation with universities, public research centers and training institutions. Thus, SMEs were asked about obstacles that have slowed down or caused difficulties in improving and/or developing new products or processes. Each obstacle attribute is measured using a 5-point ordinal scale ranging from (1) "no delay" to (5) "was made impossible".

We also introduce two control variables, commonly used in empirical work ([26], [27], [23], [5]-[17]). This refers to the size and age of the SME. The size of the SME was measured by the number of employees of the company; the age was measured by the number of years of activity during the year in which the survey was conducted.

B. Results

For all variables, we first performed principal component analyses with "Varimax" rotation on the measurement scales using the Kaiser-Meyer-Olkin criterion (KMO) and the Bartlett Sphericity Test. Then, we performed a reliability analysis based on the Cronbach alpha study (α). In summary, we present the results obtained in Table III. Examination of

this table demonstrates that for all variables, the results of the factor analyses are all acceptable with regard to the significance of the KMO and *Bartlett sphericity* indices and also the importance of the variances explained. The reliability of the measurement scales has also been validated through the *Cronbach alpha* indices which range from 0.775 to 0.984.

1) *Classification analysis: State on SMEs' openness degree*: Hierarchical classification analysis supported by non-hierarchical classification (K-means) validates the coexistence of four business configurations based on the criteria of the breadth and depth of inbound opening practices. The results of the classification are presented in Table IV. Based on the means of the dimensions of the degree of openness, we considered the following four profiles respectively: *closed* SMEs, *Supervisory* SMEs, *Engaged* SMEs and *Open* SMEs. To provide more robustness to the results obtained, we conducted the Kruskal-Wallis test to assess the significance of the differences between the variables used in the classification analysis. The test result is summarized in Table V. By observing the table above, we can affirm the significance of the difference between both breadth and depth variables. Thus, the class with the highest degree of openness in terms of its two dimensions is the class with the highest average rank. We can then confirm that the open SME class has the highest average rankings on both

dimensions of openness, which corresponds to the class with the highest degree of openness. The class of closed SMEs, by contrast, has the lowest average ranking on both dimensions, which shows that it is the one with the lowest degree of openness.

The different groups of companies obtained from the classification analysis are as follows: The first configuration of openness is associated with companies that are qualified as "closed". This profile represents 31.9% of the survey sample. SMEs in this class have a very low degree of both dimensions of global openness, which shows that this group is characterized by a great reluctance to adopt inbound practices while defending the principles of closed innovation.

The second configuration is associated with the profile of the "supervisors". They represent 15.6% of the total sample. This class of companies differs from the "closed" in particular in terms of the breadth of the practices of internalizing the resources needed to advance their innovation process. In fact, "supervisors" are characterized by a high degree of breadth and a low to medium degree of depth. Thus, they are seeking to engage in a well-planned way to avoid surprises dedicated to the complexity of managing the open innovation model. That is why they opt for an improvement of their network by scanning their environment to capture and choose the best partners before being engaged in deep relationships.

TABLE III
 FACTORIAL ANALYSIS AND RELIABILITY ANALYSIS

Variables Analyzed	Extracted factors	KMO Indices	Total Var. Exp.	Cronbach's Alpha
Openness to different sources of information (A)	[OPESI]	0,500 (0,000)*	83,094	0,775
Breadth of external information sources	[BREIS]	0,682 (0,000)*	80,860	0,967
Depth of external information sources	[DEEIS]	0,684 (0,000)*	63,715	0,973
Openness to the collaboration practice (B)	[OPCOLL]	0,500 (0,000)*	86,569	0,853
Breadth of collaboration	[BRCOLL]	0,875 (0,000)*	90,672	0,978
Depth of collaboration	[DECOLL]	0,862 (0,000)*	84,047	0,952
Openness to Acquisition Practice (C)	[OPACQ]	0,500 (0,000)*	87,946	0,788
Breadth of acquisition	[BRACQ]	0,736 (0,000)*	78,816	0,844
Depth of acquisition	[DEACQ]	0,715 (0,000)*	81,868	0,875
Global Breadth	[GBR]	0,767 (0,000)*	94,011	0,976
Global Depth	[GDE]	0,784 (0,000)*	90,546	0,977
Global openness (A+B+C)	[OPEN]	0,780 (0,000)*	93,727	0,984
Motivations of inbound open innovation	-	0,826 (0,000)*	90,173	-
Internal Motivations	INMTV	-	49,041	0,942
External Motivations	EXMTV	-	41,131	0,814
Obstacles to innovation	-	0,854 (0,000)*	94,455	-
Internal Obstacles	INOBS	-	57,951	0,942
External Obstacles	EXOBS	-	36,503	0,911

* *Test de sphéricité de Bartlett (Sig)*

TABLE IV
 CLASSIFICATION RESULT BY DEGREE OF OPENNESS

	Class 1	Class 2	Class 3	Class 4
Number of SMEs	45 (31,9 %)	22 (15,6%)	53 (37,6%)	21 (14,9%)
Mean of Global Breadth	-1,158	1,257	-0,085	1,382
Mean of Global Depth	-1,213	-0,211	0,493	1,576
Denomination of classes	Closed SMEs	Supervisory SMEs	Engaged SMEs	Open SMEs

TABLE V
 INCIDENCE OF DEGREE OF OPENNESS DIMENSIONS IN SMES CLASSES

Degree of Openness Dimensions	Class 1 Closed	Class 2 Supervisors	Class 3 Engaged	Class 4 Open	Kruskal Wallis Test χ^2 (ddl=3)
Breadth	23,00	115,00	72,00	125,24	124,728 (0,000)
Depth	23,00	58,73	93,08	131,00	124,916 (0,000)

The third configuration is represented by the profile of the "Engaged". This category, which represents 37.6% of total companies, has a medium to high degree of depth and a medium degree of breadth. In this group, companies are involved in an acceptable way in the adoption of the open innovation model by opting for a strategy based on strengthening business relationships with a limited number of partners.

The fourth configuration of openness includes companies with the "open" profile and represents 14.9% of the survey sample. It is the most involved in the adoption of the open innovation model. This class has higher averages than the other groups with a high degree of breadth and depth. These companies perceive the open innovation model as very interesting for innovation management.

2) *Motivations as Determinants of the Degree of Openness*: To verify our hypotheses regarding the influence of motivations on companies' degree of openness, we rely on a multiple regression analysis. The regression model is as follows:

$$OPEN_i = \alpha_0 + \alpha_1 INMTV_i + \alpha_2 EXMTV_i + \alpha_3 INOBS_i + \alpha_4 EXOBS_i + \alpha_5 SIZE_i + \alpha_6 AGE_i + \epsilon_i$$

The results on the impacts of independent variables on the degree of openness of SMEs are presented in Table VI, which shows the linear regression coefficients corresponding to the direct effects between the variables.

TABLE VI
 RESULT OF REGRESSION ANALYSIS EXPLAINING DEGREE OF OPENNESS (N=141)

Regression model of the degree of openness			
	Coefficient $s\beta$	t of Student	Sig
Constant	- 0,399***	- 2,824	0,005
INMTV	0,685***	12,114	0,000
EXMTV	0,094 ^(NS)	1,963	0,052
INOBS	0,294***	6,458	0,000
EXOBS	- 0,091 ^(NS)	-1,941	0,054
AGE	0,078 ^(NS)	1,589	0,114
SIZE	0,126**	2,578	0,011
R²	0,739		
F	63,230 0,000		

*** : significant at the 1% level; ** : significant at the 5% level; (NS) : not significant

The results shown in table VI attest to the overall significance of the model explaining the degree of openness, with an F statistic of (63,230) and a significance of less than

1% (p = 0.000). The analysis also demonstrates the importance of the model which explains about 74% of the variation in the degree of openness in SMEs (R² = 0,739).

In sum, the explicative power R² is important, the F statistic and its signification are also important. Thus, we can conclude that our model is statistically significant and explains the degree of openness in the SME context. We now proceed to test the research hypotheses associated with this model.

The results show a positive and statistically significant relationship between internal sources of motivation and the degree of openness of the innovation process. Thus, we find that the coefficient that associates the variable "INMTV" with the variable to be explained "OPEN" is positive ($\beta = 0,685$) and statistically significant at the 5% level (t = 12,114; p = 0.000 < 5%). In contrast, the table shows that external motivations have no significant effect on the degree of openness being the low values of student t and the significance of this (t = 1,963; p = 0.052 > 5%). As a result, the first hypothesis is partially validated. This implies that the motivations for adopting open innovation positively influence the degree of openness of the innovation process only when they are related to internal incentives. This result confirms the work of [42], which examined the adoption of an open innovation approach in SMEs by presenting a set of internal incentives for the implementation of open practices, such as the creation of new knowledge, access to additional resources and cost sharing.

Turning now to the impact of internal barriers to innovation on the degree of openness of firms, the results shown in table VI demonstrate a positive link between the variable "INOBS" and the degree of openness of the innovation process with a coefficient β in the order of (0,294). The t-statistics, which allows the significance of the coefficients to be tested, reveals that this relationship is significant at the 5% threshold (t = 6,458; p = 0,000). As a result, the internal obstacles encountered by the company positively affect their degree of openness to the external environment. This last result corroborates the conclusions of previous empirical studies such as those conducted by [23], [30] and [47], which showed that certain barriers to innovation encourage companies to opt for strategies to open their organizational borders in order to face and overcome these obstacles inhibiting the development of innovations. On the other hand, the empirical results of the regression model show a statistically insignificant relationship between external barriers to innovation and the degree of openness of the innovation process (t = -1,941; p = 0,054 > 5%). Therefore, our statistical results confirm the positive relationship between internal barriers to innovation and the degree of

openness to inbound practices and invalidate the relationship with external barriers, confirming also partially our second hypothesis.

In addition, the firm's particularities were taken into account in the formulation of our empirical model explaining the degree of openness of SMEs, particularly the size and age of the company. First of all, with regard to the size of SME, the analysis reveals a positive and significant relationship at the 5% level ($\beta = 0,126$; $t = 2,578$; $p = 0,011$). This result stipulates that the size of the company favors the degree of openness of the innovation process in SMEs. This result is already highlighted by several research studies such as [31], [42] and [23] as well as [40]. With regard to the age of the firm, the coefficients shown in the table do not support a positive relationship with a satisfactory level of significance that was well above 10% ($t = 1,589$; $p = 0,114$). This finding contradicts the result found by [40] that approved a positive and significant association between the variables. As a result, the age of the enterprise cannot be considered as an explanatory factor for the adoption of open innovation in Tunisian manufacturing companies, particularly SMEs.

V. DISCUSSION AND CONCLUSION

The objective of this paper is threefold by studying the degree of openness of SMEs under the aegis of the inbound dimension of the open innovation model. In particular, it is intended to clarify the concept of the degree of openness, explore the behaviour of SMEs when approaching inbound practices of open innovation and also explain the degree of openness of the innovation process through the effect of motivations.

Based on relevant literature, we first of all proposed an innovative conceptualization of the degree of openness while expanding Laursen and Salter's unique conceptual effort [27], through the breadth and depth dimensions, to include the majority of inbound practices. These practices concern the search for external information, the collaboration of the SME with external actors and the acquiring of external resources. This new conceptualization constitutes the first contribution assigned to this research paper.

In the light of this new conceptualization of the degree of openness and by referring to the dimensions of breadth and depth, it was possible to propose a configuration of SMEs pertaining to the Tunisian manufacturing sector on the basis of a classification analysis. The results categorize 141 innovative SMEs into four homogeneous groups that differ according to their overall degree of openness. These are respectively the "Closed", "Supervisors", "Engaged" and "Open" groups.

The results of the classification analysis corroborate to a certain extent those proposed by [23]. Thus, the authors proposed four groups of companies based on a classification analysis that differ according to their degree of openness. These are Scouts, Professionals, Explorers and Isolationists. Comparing the SME classes in our study with those in the study of [23], it can be said that the "Closed" SMEs class corresponds to that of "Isolationists" and the "Open" SME

class to that of "Professionals". In addition, it can be stated that the "Supervisory" SME class is very similar to the "Explorers" class. However, it was not possible to determine the existence of the "Engaged" SMEs class in the classification work of [23]. This may be due to the way in which firms' openness to inbound practices has been used in this study and in that of [23]. It should be noted that these authors considered openness only in reference to the use of external information sources, which was not the case in this study since a new conceptualization of openness was used through the internalization of three aforementioned inbound opening practices.

In the Tunisian context, we can see from the results of this empirical study that a significant proportion of manufacturing SMEs, almost 1/3, are involved in the closed model in the management of innovation. The other classes of SMEs resulting from the typology, i.e. 2/3, have moved towards open innovation, but with different degrees of openness. These SMEs then move away from the closed model by focusing on opening up their borders in order to access a much broader range of knowledge and ideas than can be obtained internally.

In addition, the analysis shows a high proportion of size in favour of supervisory and engaged SMEs (75 companies) compared to open SMEs (21 companies). This disproportion between SME classes shows that the adoption of the open innovation model in the Tunisian context is not as marked by total openness towards inbound opening practices.

This study is in line with the research on the open innovation model and confirms the conclusions of the literature that the degree of openness of the innovation process is defined from a continuum perspective ranging from a less open degree to a very open degree, while passing through various other degrees. Thus, we can confirm the configuration approach through the results of the classification analysis, which verified that, besides a closed approach and a purely open innovation behaviour, it seems that other opening strategies for SMEs engaged in the open innovation model can be exploited.

Exploring the way in which SMEs actually deploy the innovation process through a multidimensional conceptualization of the degree of openness is an interesting contribution to the development of theoretical and empirical knowledge about the open innovation model in the context of SMEs.

In order to better understand the behaviour of SMEs when adopting inbound openness practices, we have deepened the analysis by proposing another research question that aims to explain why some SMEs opt for a more open innovation process than others by studying the impact of the sources of motivation on the degree of openness of the innovation process.

In terms of results achieved, the degree of adoption of inbound practices is stimulated by a range of internal incentives, such as creating new knowledge, accessing additional resources, creating new value for customers and sharing costs and risks.

In addition, barriers to innovation need to be reconsidered. Widely regarded as factors inhibiting the development of innovations, today they must change their posture by acting as a source of motivation, thus encouraging companies to opt for inbound opening practices in order to face up to them.

The results of this paper have practical implications for both managers and political organisations involved in sustaining innovation. Indeed, based on the results of the classification, managers could determine the extent to which their approach to innovation is open. They could position their company in the most appropriate configuration and, therefore, envisage the imperatives necessary to stimulate a more open innovation management approach given the benefits of inbound open innovation.

In addition, to stimulate open innovation within their company, managers must be aware of the main advantages of opening organizational boundaries to explore and use new resources in the external environment (ideas, information, knowledge, technologies, etc.) and incorporate it with the internal base to stimulate the innovation process. Innovation project managers must pay more attention to the various obstacles to innovation by considering them, not as an obstacle to the development of innovations but rather as a motivation for openness. In fact, open innovation should be considered as a solution to overcome innovation barriers. Being aware of both the benefits of open innovation and the obstacles to innovation allows managers to make good decisions in innovation management.

On the other hand, and given that the results have shown that the adoption of the open innovation model in the Tunisian context is not as marked by a high level of openness towards inbound openness practices, public institutions supporting innovation should more valorize the role of different openness practices in their programmes promoting innovation in SMEs. In terms of results, they must make efforts to encourage more adoption of these open practices, in particular by strengthening links between actors in the economic and academic spheres.

Despite his contributions, this work contains some limitations that can be sources of research perspectives. At first, in this paper, one dimension linked to the model of open innovation was considered. Although the inbound dimension remains the most favoured by SMEs, it does not, however, reflect all the alternatives linked to the new model of open innovation. In this framework, future studies should explore these dimensions in the context of SMEs, such as the study of the combined effects of inbound and outbound dimensions on innovation in SMEs. In addition, this paper did not take into account the risks related to openness degrees, particularly in terms of costs related to the resources required to manage the open process. Thus, given the scarcity of resources, a more open approach consumes resource investments. It is therefore considered relevant for future studies to propose analytical frameworks highlighting the extent to which an open approach is considered interesting in terms of costs and benefits. It's like studying the moments when you had to stop openness. As a result, it is relevant to adopt a process analysis

approach to the conduct of innovation from a longitudinal perspective.

Finally, to understand open innovation in the context of SMEs, we recommend to analyze the determinants of openness with greater depth while emphasizing both internal and external factors and to study the impact of the openness degree on innovation performance in SMEs.

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