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# Exploring SMEs' open innovation practices diversity from four countries.

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**Abstract** – As far as we know, this paper constitutes a first approach to a cross-country comparison of open innovation practices in SMEs, a little explored field whose the surge of articles on this topic has increased significantly in recent years. Recent reviews have highlighted the need to consider context dependencies. Hence, this paper takes the fact that criteria of innovation country performance is a relevant factor into consideration. This paper proposes a meta-analysis to accumulate the results of four different studies, thus, to examine open innovation practices of SMEs in different environments. The aim is to highlight on how open innovation practices in SMEs can be in relationship with to the environment. We find that joint some practices could not be adopted at the same time because they are in relationship with opposite context. Other practices show that even if it is important to consider external characteristics to understand fully the open innovation adoption, contextual effect alone is not enough to explain the diversity in adoption of open innovation. By this way, we confirmed that open innovation is not a universal character.

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**Keywords** – Open innovation, SME, practices, adoption, and contextual effect.

## 1. Context

In unlocking innovation, establishing the appropriate complementarity between internal and external resources is critical (Cohen & Levinthal, 1990). The company's ability to use inflows and outflows knowledge to accelerate internal innovation is named open innovation (Chesbrough, 2003). This concept emphasizes the importance of resources from inside and outside firm boundaries according to the value capture and value creation through three different processes which are outside-in, inside-out and coupled-process (Gassmann & Enkel, 2004). Each process corresponds to a specific strategy and uses different skills. The implementation of open innovation within a structure entails significant impacts on the organization itself and its management (Dodgson, Gann, & Salter, 2006). However, a company's internal structure affects its ability to collaborate and exchange information with external entities (Argote & Miron-Spektor, 2011). Not all models are therefore equally relevant for companies (Gassmann & Enkel, 2004) and some organizational models seem more favourable to open innovation processes than others. Despite the fact that the transition from a fairly closed to a very open world has posed significant challenges, open innovation processes have not been explicitly analysed in the context of SMEs. The concept has been studying for a long time in large firms (Chesbrough, 2006a), such as P&G (Dodgson et al., 2006), IBM (Chesbrough, 2003) or Lindt & Sprüngli (Manzini, Lazzarotti, & Pellegrini, 2017). Its study in SMEs context is a relatively recent phenomenon and shows that this model seems to be especially relevant for them. SMEs organize and manage open innovation in an entirely different way from large companies (Usman, Roijackers, Vanhaverbeke, & Frattini, 2018). Researchers have generated many contributions on open innovation in the context of large enterprises. Hence, SMEs have received only little attention (Kirschbaum, 2005; Ollila & Elmquist, 2011; Usman et al., 2018) and knowledge about open innovation practices in SMEs is still relatively limited. An explicit focus on the SMEs context when studying open innovation is thus warranted. Hence, the purpose of this article is to fill this gap by contributing to the undersanding the open innovation practices adoption in SMEs context. The first step is to

identify existing works on open innovation practices adopted by SMEs and then identify which open innovation practice is the most adopted by SMEs.

## **2. Open innovation and SMEs.**

### *2.1. Relevance of the open innovation model for SMEs.*

Compared to large firms, SMEs have different strengths that would enhance their ability to innovate (Scherer, 1981) like a decentralization of their decisions with an efficiency of their decision-making system due to the low number of hierarchical levels, a strong involvement of their employees, a rapid communication based on tacit information that is conducive to innovation, a mimetic behavior, their speed of learning, which is made possible by the high versatility of workforce (Creton, 1985), a direct and informal relationship with the market to capture ideas (Nonaka, 1994) and their flexibility for initiative and creativity (Rothwell, 1989). Regarding large companies whose processes are generally deliberate and formal and whose strategy is defined for long term, SMEs' strategic processes are incremental and heuristic, and the strategy is defined in short time. So, SME's structure and processes are more simple, flexible and adaptable than large firms (Carrier, 1992; Marchesnay, 1991).

However, SMEs have to face up to a lack of resources (Lee, Park, Yoon, & Park, 2010; Van de Vrande, De Jong, Vanhaverbeke, & De Rochemont, 2009) and competences (Bougrain & Haudeville, 2002; Dahlander & Gann, 2010; Lee et al., 2010; Rahman & Ramos, 2010; Wynarczyk, Piperopoulos, & McAdam, 2013). In fact, SMEs have limited human, financial, technological and information resources (Hausman, 2005), due to an insufficiently qualified or trained staff (Romano, 1990), insufficient knowledge to initiate in-house R&D activities, or information on difficult technologies and markets. This limited resources impacts also the relationship related context : anonymity is more difficult in SMEs than large firms (Carrier, 1994).

Unlike large companies generally more rigid, SMEs' flexibility and unbureaucratic nature make them particularly suited to implement open innovation practices, thus increasing the probability of adopting the approach effectively (Dufour & Son, 2015; González-Benito, Muñoz-Gallego, & García-Zamora, 2016; Parida, Westerberg, & Frishammar, 2012). Several researchers have identified open innovation as a lever strategy to overcome these typical weaknesses of SMEs (Van de Vrande et al., 2009; Verbano, Crema, & Venturini, 2015).

### *2.2. Variety of open innovation practices in SMEs.*

Open innovation consists of three different processes: outside-in, inside-out and coupled-process (Gassmann & Enkel, 2004). Outside-in process stands for capturing assets in external entities and associating them with firm's own resources and skills in order to renew and enrich its knowledge capital and thus energize its innovation process. This involves conducting exploration activities that allow the company to acquire new knowledge or technology from outside. Inside-out process stands for bringing its knowledge and technologies to its external environment. This involves operating activities that allow the company to evaluate unused internal assets by transferring them to other firms. These activities may consist of selling licenses, selling knowledge, transferring part of the business such as spin-off innovation project into the creation of a new innovative company. Coupled-process consists of combining the processes of inside-out and outside-in and sharing them within a network of partners. This approach, which allows companies to jointly develop and market innovations (Enkel & Gassmann, 2010), includes cooperation activities, co-creation through alliances with partners or the creation of joint ventures (Lichtenthaler & Frishammar, 2011; Un, Cuervo-Cazurra, & Asakawa, 2010).

These three open innovation processes are developed by companies to explore themes far from their fields of competence and thus to produce complex innovations that would not have been

possible if they had been developed individually (Almirall & Casadesus-Masanell, 2010). The three processes are implemented by companies through different practices. Based on research work addressing open innovation practices, a list of twelve open innovation practices was obtained (Table 1). The knowledge exchange is not always a two-way flow, but can be a one-time transfer from the environment to the company (inflow) or from the company to the environment (outflow). Also, these practices could be classified according to their knowledge flow direction (Bigliardi & Galati, 2018; Cosh & Zhang, 2011; Jullien & Pénin, 2014; Mazzola, Bruccoleri, & Perrone, 2012).

The activities included in an open innovation process focus mainly on licensing agreements, strategic alliances and scientific and technical services (Bianchi, Cavaliere, Chiaroni, Frattini, & Chiesa, 2011). Nevertheless, companies seem to perform better in activities related to the outside-in process than in those related to the inside-out process (Chesbrough & Crowther, 2006), thus limiting opportunities to capture new benefits (Chesbrough, 2003; van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). Along with collaborations with suppliers, competitors and universities, licensing is one of the most common practices used to acquire external technologies (Tsai & Wang, 2009). Through a study based on the journey that an Italian leading cement manufacturer has undergone to move from a closed to an open innovation paradigm Chiaroni and al. (2011) show how firms implement open innovation in practice. Develop at the same time the two dimensions of open innovation, outside-in and inside-out, is quite difficult. Companies can therefore decide to start by focusing only on one of the two dimensions. Firms seem to be adopting an outside-in process before implementing the inside-out process (Chesbrough & Crowther, 2006; Chiaroni et al., 2011; Gassmann & Enkel, 2004). This can be explained by a first need to explore new areas of knowledge different from those traditionally controlled by the firm. Once the R&D phase is over, companies face difficulties in disseminating their innovation, which triggers the need to implement an internal-out process (Chiaroni et al., 2011).

Flow direction	Practices	Definition	Main references
Outside-in	Licensing-in	Exploit external knowledge to find new ideas and to reduce the time-to-market.	(Burcharth, Knudsen, & Søndergaard, 2014; Chesbrough, 2003; Gassmann, 2006; Lee et al., 2010; Van de Vrande et al., 2009; Wynarczyk et al., 2013)
	Venture	Invest into a venture to capture new ideas	(Kim et al., 2008; Waites & Dies, 2006)
	Acquisition of know-how	Buy R&D services provided by external organizations	(Burcharth et al., 2014; Gassmann, 2006; Harland & Nienaber, 2014; Holzmann, Sailer, Galbraith, & Katzy, 2014; Wynarczyk et al., 2013)
	Networking	Develop relationships or collaborate with external network partners to support the innovation process.	(Lee et al., 2010; Van de Vrande et al., 2009; Wynarczyk et al., 2013)
	Co-conception	Involve the customer in the design process to access to new ideas	(Burcharth et al., 2014; Gassmann, 2006; Van de Vrande et al., 2009; Von Hippel, 1986)
Coupled process	Crowdsourcing	Externalize an activity toward various anonymous stakeholders.	(Howe, 2006; Pénin & Burger-Helmchen, 2012; Schenk & Guittard, 2016)
	R&D collaborative	Conduct R&D activities with external partners	(Burcharth et al., 2014; Chesbrough, 2006b; Gassmann, 2006; Harland & Nienaber, 2014; Holzmann et al., 2014; Lee et al., 2010; Montelisciani, Gabelloni, Tazzini, & Fantoni, 2014; Tennenhouse, 2004; Van de Vrande et al., 2009; Wynarczyk et al., 2013)
	Research consortium	Pool resources and commit to perform services to achieve a contracted research project	(Cassier & Dominique Foray, 2001; Jullien & Pénin, 2014)
	M&A	Absorb corporate knowledge by building or redeeming an alliance strategy.	(Enkel, Gassmann, & Chesbrough, 2009; Gassmann & Enkel, 2004)
Inside-out	Open-source	Make a product accessible for free.	(Chesbrough, 2004; Lerner & Tirole, 2005; Loilier & Tellier, 2004, 2011; Pénin, 2013; West & Gallagher, 2006)
	Licensing-out	Sell licenses or technologies not used by the company to maximize profits.	(Dong & Pourmohamadi, 2014; Gassmann, 2006; Lee et al., 2010; Lichtenthaler & Ernst, 2009; Van de Vrande et al., 2009; Wynarczyk et al., 2013)
	Spin-off	Commercialize disruptive technologies through the creation of a new independent entity	(Kirschbaum, 2005)

Table 1: Open innovation practices according flux direction

### **3. Literature gap and research questions**

As previously mentioned, open innovation paradigm was initially based on large high-tech companies (Chesbrough, 2006a) and research on open innovation in SMEs has quickly grown in recent years (Lee et al., 2010; Van de Vrande et al., 2009). So, the same models cannot be applied to both small and large entities (Stanisławski & Lisowska, 2015) because in the open innovation paradigm, organizational boundaries are porous to promote interaction between the firm and its environment (Chesbrough, 2003; Gassmann, 2006; Gassmann, Enkel, & Chesbrough, 2010; Huizingh, 2011). Hence, it seems plausible that different external contexts lead to variances in SMEs' innovation practices. In this regard, this paper intends to examine the open innovation practices of SMEs in different countries with varying degrees in innovation. The aim is to shed light on how open innovation in SMEs can vary according to the environment. So, the addressed question is: are there some socio-economic and scientific characteristics that influence open innovation practices adoption?

### **4. Methodology: a meta-analytical study.**

#### *4.1. Meta-analysis method.*

Meta-analysis is a method to combine empirical results of individual studies on the same subject in order to formulate conclusions combining all the variables included in these studies and to obtain information that none of these studies taken in isolation could provide (Laroche & Schmidt, 2004). The meta-analytical approach is based on five main steps (Glass, Smith, & McGaw, 1981). The first step consists in formalize a research question and define inclusion and exclusion criteria. The second step is the data collection. An exhaustive search of existing studies must be achieved and studies must to be selected according to criteria previously established. The third step is to ensure the quality of the studies. We need to control the methodological and scientific rigor of the selected studies to avoid bias from original studies, ensure that studies are not too different to prevent selection bias or are based on results issued of a same research to obviate over-representation bias. The fourth step is the statistical analyze. Results of each study must be converted into a common metric, we need to ensure that the independent variable is the same in each study and verify that the data collection method and the definition of variables are similar and can be combined. Finally, verify the impact that the characteristics of the individuals studied can have.

#### *4.2. Selection of the studies.*

The data collection was initiated by searching articles listed on Google Scholar from January 2003 to March 2018 where open innovation practices were examined. Only English and French language sources were considered. Studies were included in the meta-analysis if they met the following criteria: the study was published in a scholarly journal or book and the study provides the percentage or the number of companies that have adopted open innovation practices (Table 2).

<i>Inclusion criteria</i>	
Articles, books' chapter indexed in Google Scholar.	All major journals and other publications indexed in the Google Scholar database.
The study provides the percentage or the number of companies that have adopted open innovation practices	The results of each study must be converted into a common metric and selection bias must be prevented
<i>Exclusion criteria</i>	
Studies published before 2003.	The concept of open innovation was created in 2003. Studies prior 2003 are therefore not taken into account.
Other language than French or English.	Due to language constraints, only articles published in English and French were considered. Publications in other languages were not selected.

*Table 2: Inclusion and exclusion criteria*

Applying these criteria allows to identify four different studies (Table 3) to extract data analysis.

	<b>Van de Vrande et al., 2009</b>	<b>Cosh &amp; Zhang, 2011</b>	<b>Ahn, Minshall, &amp; Mortara, 2015</b>	<b>Bigliardi &amp; Galati, 2016</b>
Country	Germany	Great Britain	Korea	Italy
Sample size	288	923	306	157
Size ranging	10-99 employees	5-99 employees	3-300 employees	1-250 employees
Sector interviewed	manufacturing and business service	manufacturing and business service	manufacturing	manufacturing and service
Survey year	2005	2010	2013	2014

*Table 3 : Descriptive characteristics of the four studies.*

#### *4.3. Dependent variables: open innovation practices.*

One was carried out in December 2005 through telephone interviews in German companies with 10 to 500 employees (Van de Vrande et al., 2009). SMEs with less than 10 employees have not been taken into account, because in Germany this class usually contains many start-ups. Also, the sample was disproportionately segmented across two sectors (manufacturing and business service) and two size classes (10 to 99 employees and 100 to 499 employees). Because our study focuses on SMEs, we will only retain the results collected for the size class 10 to 99 employees, i.e 288 SMEs (Table 4). A second study (Cosh & Zhang, 2011) has focused on open innovation practices of British companies in manufacturing and business services with 5 to 999 employees. The survey was administered by post and posted online between June and November 2010. Answers are grouped into three classes: companies with a size ranging from 5 to 20 employees, companies with a size ranging from 20 to 99 employees, and finally those with more than 100 employees. In our study, we selected two of the three classes, representing 923 SMEs: SMEs with 5 to 20 employees and SMEs with 20 to 99 employees (Table 4). A third survey was carried out by Bigliardi and Galati (Bigliardi & Galati, 2016) between June and September 2014 to identify factors that hinder open innovation adoption in SMEs. To define the concept of SMEs, the web questionnaire was conducted on 157 Italian SMEs from 12 sectors that could be gathered in two main sectors, manufacturing and services. To

characterize SME as a company, authors used the recommendation of the European Commission (Commission, 2003): a payroll of less than 250, a turnover not exceeding 50 million euros or a balance sheet not exceeding 43 million euros. As part of our study, we retained all of Bigliardi and Galati's data (Table 4). The latest study (Ahn, Minshall, & Mortara, 2015) focuses on Korean SMEs. Data were collected via e-mail, using an on-line survey system and during the first trimester of 2013 for companies with a payroll between 3 and 300. As part of our study, we also retained all of Ahn's data (Table 4).

Practices	Percentage of SMEs that have adopted the practice			
	Germany	Great Britain	Korea	Italy
In-sourcing	25%	35%	31%	29%
Joint R&D	95%	35%	54%	15%
M&A	29%	45%	11%	84%
User involvement	98%	72%	35%	61%
Licensing-out	11%	42%	13%	18%
Open-sourcing	/	30%	13%	13%
Know-how acquisition	59%	32%	/	39%

Table 4: Summary of data selected in the four studies.

These studies don't cover all practices previously identified, but they focus on seven practices (in-sourcing, joint R&D, M&A, user involvement, licensing-out, open-sourcing and know-how acquisition) frequently observed with positive effects (Mazzola, Bruccoleri, & Perrone, 2012). An exploratory study (Figure 1) shows that no open innovation practice is mostly adopted and these practices differ from one country to another. Using specific characteristics to define each environment and understand their relationship with the various practices seems to be relevant.

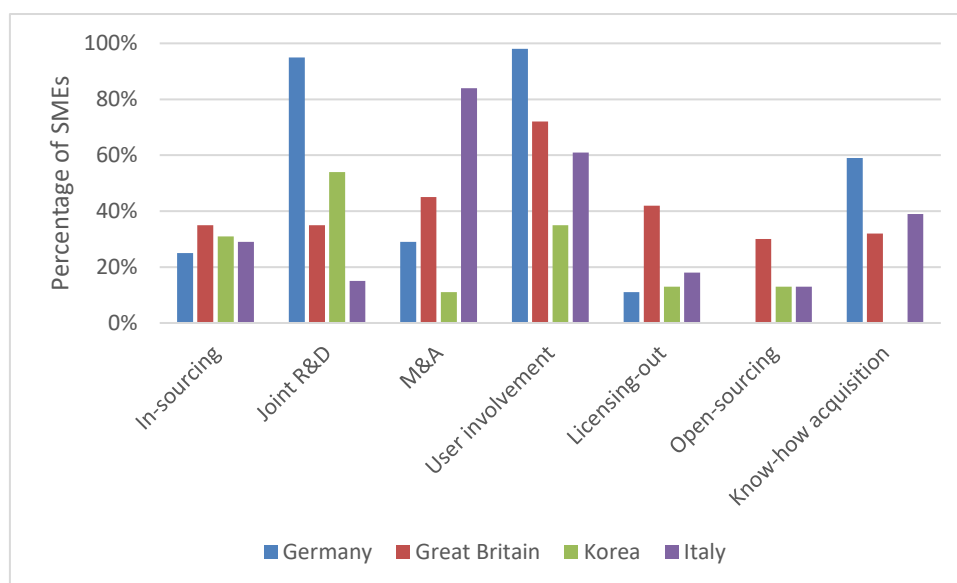


Figure 1: Adoption of OI practices by SMEs in different countries



#### 4.4. Independent variables: criteria of innovation country performance.

To determine if some socio-economic and scientific characteristics influence open innovation practices adoption, we first need to define specific socio-economic and scientific characteristics. To identify them, our approach is based on Global Innovation Index (Cornell University, INSEAD, & WIPO, 2018), and annual ranking of countries by their innovation capacity. The index was started in 2007 and contains 80 detailed indicators, issued from the World Bank database, on the innovation performance of countries. These indicators cover a wide range of areas such as political environment, education, infrastructure or business development. However, as this report was started in 2007 and our first selected study was carried out in 2005, it seems irrelevant to use directly the Global Innovation Index. That is why, we decided to use indicators from the World Bank database related the education, research and development, knowledge creation and creative outputs (Table 5). These sub-pillar will be studied because the level and standard of education and research activity seem to be prime determinant on the innovation capacity. Using data available from the World Bank, for each country in relation with the year of the study, we were interested by the number of patent applications, research and development expenditure, researchers in R&D, the number of scientific and technical journals, the number of trademark applications and the labor force with advanced education.

	<b>Germany</b> 2005	<b>Great Britain</b> 2010	<b>Korea</b> 2013	<b>Italy</b> 2014
<b>Research and development expenditure</b> (% of GDP)	2,4	1,7	4,1	1,3
<b>Researchers in R&amp;D</b> (per million people)	3350	4091	6457	2006
<b>Scientific and technical journal articles</b>	81765	91788	58844	67000
<b>Patent applications</b> (% of total patent applications at the world level)	9,0	2,6	8,7	1,1
<b>Trademark applications</b> (% of total trademark application at the world level)	2,6	1,0	3,3	0,8
<b>Labor force with advanced education</b> (% of total working-age population with advanced education).	25	36	35	19

Table 5: Criteria of innovation for the country performance of the four studies.

#### 4.5. Meta-analytic procedure.

To determine how the open innovation practices are correlated to our criteria of innovation country performance, we applied a correlation test. First of all, the correlation between each independent variables was evaluated using a correlation matrix. The distribution of these variables being non-parametric and non-monotonic, the Kendall correlation was used (Table 6).

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Research and development expenditure	1.00					
(2) Researchers in R&D	0.67	1.00				
(3) Scientific and technical journal articles	-0.33	0.00	1.00			
(4) Patent applications	0.67	0.33	0.00	1.00		
(5) Trademark applications	1.00	0.67	-0.33	0.67	1.00	
(6) Labor force with advanced education	0.33	0.67	0.33	0.00	0.33	1.00

*Table 6: Correlation matrix for independent variables*

To avoid a multicollinearity problem that appears when collinearity exists between at least three variables, we used this correlation test to eliminate two indicators researchers in R&D and trademark applications, as independent variables because they seem to be strongly correlated to the others, e.g. research and development expenditure, scientific and technical journal articles, patent applications and labor force with advanced education. Finally, a correlation matrix was also used to evaluate the dependency between innovation country performance variables and open innovation practices (Table 7). The distribution of these variables being also non-parametric and non-monotonic, the Kendall correlation was used too.

	Research and development expenditure	Scientific and technical journal articles	Patent applications	Labor force with advanced education
In-sourcing	0.00	0.00	-0.33	0.67
Joint R&D	0.67	0.00	1.00	0.00
M&A	-1.00	0.33	-0.67	-0.33
User involvement	0.00	0.67	0.33	0.00
Licensing-out	-0.33	0.33	-0.67	0.33
Open-source	-0.18	0.91	0.18	0.55
Know-how acquisition	0.33	-0.33	0.67	-0.33

*Table 7: Correlation matrix for country performance indicators and open innovation practices*

## 5. Findings

As already mentioned, none of these seven open innovation practices is mainly adopted by these four countries. The issued correlation matrix (Table 7) allows to determine if there is a positive (+), negative (-) correlation or no correlation (0) between each dependent and independent variables (Table 8).

		Research and development expenditure	Scientific and technical journal articles	Number of patents application	Labor force with advanced education
Outside-in	In-sourcing	0	0	0	+
	User involvement	0	+	0	0
	Know-how acquisition	0	0	+	0
Coupled process	Joint R&D	+	0	+	0
	M&A	-	0	-	0
Inside-out	Licensing-out	0	0	-	0
	Open-source	0	+	0	+

*Table 8 : Relationship between different criteria of innovation country performance and open innovation practices in SMEs.*

The results show that in-sourcing is positively correlated with a labor force with advanced education. Also, in-sourcing is adopted by SMEs operating in an environment where working population has an advanced level of education. As open-sourcing, user-involvement is in relationship with the number of scientific and technical journal articles. SMEs use these practices more easily in environments where the number of scientific and technical journal articles is meaningful. However, open-source is mainly developed in environment with an advanced education. M&A and licensing-out are both negatively correlated to the number of patents application, whereas joint R&D and know-how acquisition are both positively correlated to that criteria of innovation country performance. It seems to be reveal that joint R&D and know-how acquisition could not be developed at the same time that M&A or licensing-out. SMEs in environments with a higher number of patents applications adopt joint R&D and know-how acquisition more than M&A or licensing-out. It should be noted that joint R&D is positively correlated to research and development expenditure whereas M&A is negatively correlated to this criteria. Also, unlike know-how acquisition, joint R&D is adopted by SMEs only in environments where the research and development expenditure are significant. Unlike know-how acquisition, M&A is adopted by SMEs only in environment where the research and development expenditure are relatively low.

## 6. Discussion of results

While the adoption of inside-out or outside-in seems to be completely independent from the research and development expenditure, the adoption of coupled process by SMEs is related to research and development expenditure as well as the number of patents application. Chiaroni and al. (2011) explained that developing at the same time outside-in and inside-out approach is quite difficult because firms need to explore new areas before disseminating their innovation. Our study shows that this results is particularly true for know-how acquisition and licensing-out, because they occur under opposite conditions. However, for the other practices, the contextual effect alone is not enough to explain the diversity in adoption of open innovation or process. Also, to have a better understanding of adoption of open innovation practices, it could be interesting to examine the internal characteristics of the SMEs.

This study considers a broad range of SMEs' open innovation practices by including different environment represented by four different countries. To our knowledge, this is among the first study on open innovation to encompass so many practices adopted by SMEs.

## 7. Conclusion

This paper constitutes a first approach to a cross-country comparison of open innovation practices in SMEs, a little explored field whose the surge of articles on this topic has increased significantly in recent years. Recent reviews have highlighted the need to consider context

dependencies. In this regard, this article takes the fact that criteria of innovation country performance is a relevant factor into consideration. This paper proposes a meta-analysis to accumulate the results of four different studies thus to examine open innovation practices of SMEs in different environments. The aim is to shed light on how open innovation practices in SMEs can be in relationship with the environment.

Firstly, we started by defining criteria of literature research where open innovation practices were studied. To realize our study, we selected four papers from the literature review. Based on these four previous studies, this article examines the correlation between open innovation practices developed by SMEs and innovation performance of the environment in terms of socio-economic and scientific characteristics issued from the World Bank database and related the different sub-pillars of the Global Index Innovation. We find that joint R&D and M&A, which are both issued from coupled-process, seem not to be adopted at the same time because they are in relationship with opposite context. For the others practices, even if our results highlight the importance to consider external characteristics to understand fully the open innovation adoption, they also show that the contextual effect alone is not enough to explain the diversity in adoption of open innovation. It seems to be interesting to take account the internal characteristics. By this way, we confirmed that open innovation is not a universal character.

No study is without limitations, and our study has few limitations which could be addressed by future research. For instance, this study encompasses only for different countries in developed countries. It could be completed by studies in emerging countries to have a more diversified context. Future research may also focus on internal characteristics of SMEs that need to be considered to have a full understanding of the adoption of open innovation practices by SMEs.

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