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## Clustering recent trends in the open innovation literature for SME strategy improvements

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**Abstract:** The literature on Open Innovation is booming. In recent years, more and more contributions have been published in several scientific reviews. This increasing trend calls for an approach that could lead to a classification of the specificities of these contribution contents. This is what this paper aims to do. More specifically, our goal is to provide not a simple catalogue of the hundreds of articles published in this field, but rather it tries by cluster analysis a classification of the most important key features of the typical articles published in the field of Open Innovation, with a specific focus on implemented methods in SMEs. Notwithstanding the limitations of our attempt, the cluster analysis results provide a reference paradigm to compare existing as well as future contributions and add new insights. This paper highlights how a path dependence approach in the literature has influenced the companies Open Innovation implementation, but some recent attempts at overcoming this process are arising. This recent trend focuses on SMEs as the real key challenge.

**Keywords:** open innovation; methods for SMEs; path dependence.

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## **1 Introduction**

Starting from Chesbrough's (2003) book, in recent years we have observed an increasing interest in Open Innovation (OI) advantages for companies. From current research, Open Innovation has moved towards a mainstream research area (Gassmann et al., 2010). The range of situations where the concept is applicable is widening (Enkel et al., 2009; Gassmann et al., 2010) and nowadays it is a topic largely debated in innovation and technology management literature (e.g. Chesbrough, 2005; Asakawa et al., 2010; Chiaroni et al., 2010; Bianchi et al., 2011; Chiaroni et al., 2011; Huizingh, 2011). This is further confirmed by several dedicated special issues<sup>1</sup> with contributions from diverse industries (Mortara and Minshall, 2011).

Since the number of contributions in the Open Innovation field has increased recently, the literature is fragmented and difficult to analyse (Dahlander and Gann, 2010). Thus, a clear and comprehensive classification of research trends is necessary. In this paper, we aim at clustering a set of articles specifically focused on Open Innovation and published between 2002 and 2011. Some other literature reviews exist (e.g. Dahlander and Gann, 2010, that reviewed 150 Open Innovation papers). Nevertheless, our investigation focuses in particular on SMEs, which are under-researched in the OI literature (Bianchi et al., 2010; Gassmann et al., 2010; Mortara and Minshall, 2011; Spithoven et al., 2011; Parida et al., 2011). More specifically, the aim of this paper is to investigate the trends of OI more or less recent contributions in order to highlight their main specificities as well as suggest some useful guidelines for OI implementation especially in SMEs. This paper classifies the literature contributions based on the size of the firm, the exploratory nature of research, and the applicability of the solutions for OI implementation. Following the literature review as well as the cluster analysis results, our investigation clearly highlights a path dependence process in the OI literature that, in our opinion, predetermined the trajectory of OI implementation by companies. In particular, it seems that the literature focuses on qualitative aspects and mainly towards large firms; this may be the main reason of a general lack of OI methods besides a scant attention on SMEs. But, interestingly, a recent trend led by European researchers focuses on practical OI applications for European SMEs.

The paper is structured as follows. Section 1 presents a wide literature review investigating definitions, organisational modes, methods as well as open questions up to wondering on OI emerging conditions. Section 2 describes the methodology applied to

rigorously analyse literature and the output of the analysis. With a specific focus on SMEs, a cluster analysis investigates the existence of potential similarities as well as differences among the articles analysed. Finally, Section 3 discusses the results and Section 4 highlights our conclusions.

## **2 OI definitions, organisational modes and methods**

The most diffused and cited general definition of OI is the one provided by Chesbrough (2003, 2005, p.2), even if more recent ones exist: “Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively”. Looking at the innovation funnel, closed processes imply that “projects can only enter in one way at the beginning and can only exit in one way by going into the market”; open processes instead assume that “projects can be launched from either internal or external technology sources, and new technology can enter into the process at various stages. In addition, projects can go to market in many ways” (Chesbrough, 2005, p.4). More recent definitions exist in the literature (e.g. Lichtenthaler, 2011, p.77) but the core meaning of the concept has not been modified.

It is evident, hence, the possibility of a paradigm shift (Chesbrough, 2003, 2004) in the innovation management. Poot et al. (2009) provided just conditions for which this shift tends to occur in shocks instead of manifesting itself as a continuous process over time. It depends on company innovation modalities and differs among industries. This is the reason why Chiaroni et al. (2010) argue that company’s organisation (in terms of inter-organisational networks, organisational structures, evaluation processes and knowledge management systems) can be the most impacted from changes in the transition from closed to Open Innovation. Huizingh (2011) instead views at the OI as a continuum of openness thinking, rather than a dichotomy between open and closed, with varying degrees of openness both in the processes and in the outcome of innovation. This continuum can occur in management modalities and in time, up to observe in the reality that companies all along follow a not-fully closed innovation process (Spithoven et al., 2011). Chiaroni et al. (2011) suggest in this continuum that the organisational change process for OI implementation should occur through an unfreezing-moving-institutionalising sequence. The ‘unfreezing’ phase focuses on the need for change, the establishment of a team for leading change, the communication of the new vision to stakeholders. The ‘moving’ phase implies the actual implementation of change through the creation of new procedures and patterns of behaviour with a trial-and-error approach. The ‘institutionalising’ phase involves the consolidation of the improvements achieved (Chiaroni et al., 2010; Chiaroni et al., 2011).

Actually, in spite of these several contributions on theoretical aspects published on OI, one of the main gaps in the literature is the one about OI implementation modes (i.e. perspectives and approaches) and methods (i.e. methodologies and tools). Much work has still to be done on the practical implementation of these concepts. Huizingh (2011) and Gassmann et al. (2010) note that what is missing is a useful ‘*cookbook*’, an integrated framework that helps large, as small, companies to decide when, how and which OI practices apply. And according to Enkel et al. (2009, p.312) “we still lack a clear understanding of the mechanisms, inside and outside of the organization, when and how to fully profit from the concept”.

Concerning implementation *modes*, in the literature they are seen and treated from different points of view. Chesbrough (2003a) identifies the modes in specific activity areas: funding, generating and commercialising innovation. Van de Vrande et al. (2009) focus more on the role of technology and split up OI activities into two core practices: technology exploitation and technology exploration. Many other authors instead, looking at the processes, refer to *inbound* and *outbound* modes. The former, also known as outside-in processes, are essentially in-licensing, minority equity investments, acquisitions, joint ventures, R&D contracts and research funding, purchase of technical and scientific services and non-equity alliances (Bianchi et al., 2011). The latter, also known as inside-out processes, are licensing out, spinning out of new ventures, sale of innovation projects, joint ventures for technology commercialisation, supply of technical and scientific services, corporate venturing investments and non-equity alliances. Gassmann and Enkel (2004) and Enkel et al. (2009, p.313) add to these two categories the *coupled* process, which “refers to co-creation with (mainly) complementary partners through alliances, cooperation, and joint ventures during which give and take are crucial for success”. Lazzarotti and Manzini (2009, pp.622–623) instead add specialised and integrated collaborations to close and open modes. “The former corresponds to companies that are able to work with many different partners, but concentrate their collaborations at a single point of the innovation funnel [...]; the latter are preferred by companies that open their whole innovation funnel, but only to contributions coming from a few types of partners”. Lichtenthaler (2008) finally splits up modes to innovate even in six classes, of which only one concerns really OI. Two types of closed innovators exist: the former employing a closed innovation strategy with very limited external technology acquisition and external technology exploitation, the latter involving acquisition from external sources but not in the sense of OI. They can respectively be identified by absorbing innovators, who acquire but not commercialise external technology, and desorbing innovators, that, on the contrary, commercialise external technology without acquiring it. Balanced innovators use both types of transactions while open innovators undertake very open approach on both dimensions.

Concerning *methods*, some specific case studies describe methodologies or propose the application of specific tools for particular phases of the OI implementation process, but they are few. Among them, some focus on the regional dimension of OI systems (Santoro and Conte, 2009; Belussi et al., 2010; Schaffers and Santoro, 2010), others investigate the involvement and the role of the intermediary in the OI process (e.g. Chesbrough, 2006; Huston and Sakkab, 2006 with the Procter&Gamble case study); finally, others investigate specific tools to support decisions (Bergman et al., 2009; Bianchi et al., 2010) as well as existing IT solutions for OI (Kajmakoska et al., 2010). What emerges as worthy of note are the *living labs* and the *intermediaries*. “Living labs are Open Innovation environments in real-life settings, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures in a regional harmonised context” (Santoro and Conte, 2009, pp.1–4). Where this is not possible, the intermediaries play their main role. They can play a role as agent for email proposals (i.e. NineSigma), as an IT platform for online interchanges (i.e. InnoCentive) or even work as concept co-developer (such as Big Idea Group). Otherwise, intermediaries can broker ideas (InnovationXChange) or IP (such as Shanghai Silicon IP Exchange, Ocean Tomo).

Beyond the difficulty of finding practical examples of OI modes and methods, really other intriguing ‘open questions’ are discussed in the literature.

### *2.1 Open questions in the open innovation field*

The main open questions have been advanced by Chesbrough first that wondered on the enduring contribution to our understanding of innovation of the OI process and applicability in industry. The evidence is taken from US-based companies, while “the relevance to companies operating outside the US remains to be demonstrated” (Chesbrough, 2005, p.6). Similar conclusions on the relevance and applicability were also obtained by Bianchi et al. (2011), Mortara and Minshall (2011), Chiaroni et al. (2010, 2011). It is in fact worth noting that notwithstanding the increasing interest for the positive benefits and consequences of the OI phenomenon, some open questions in the form of ‘criticisms’ are also emerging (Lichtenthaler, 2011). Trott and Hartmann (2009, p.715) criticise Chesbrough’s (2003, 2006) OI paradigm as the only alternative to a closed innovation model. OI describes the limits of closed innovation principles, but it is wrong in believing that firms nowadays follow completely these principles. R&D managers know that not all knowledge and expertise resides within their firm; cooperation and alliances between firms are nothing new; the ability to capture ideas from R&D is better than too much R&D expenditure. Nonetheless, trying to gain access to a technology that is already licensed is difficult because of competition rules and IPR. Therefore, it is really difficult to identify in the reality a dichotomy or an alternative between closed and Open Innovation (Enkel et al., 2009).

Another interesting open question stressed by Huizingh (2011) is the one about the reasons why firms open up their innovation processes, meaning offensive or defensive motives, and whether they are early adopters or not. Chesbrough and Crowther (2006) and Van de Vrande et al. (2009) found that offensive reasons, like stimulating growth, were more important than defensive ones. In general, Dahlander and Gann (2010, p.706) wondered “why are some firms profiting more than others from openness? This is a fundamental question on which there is surprisingly limited evidence”. Another research field not deeply investigated yet is the one about risks and barriers faced by companies when they invest in OI activities: loss of knowledge, high coordination costs, loss of control, high complexity, lack of time and resources are among the most cited risks and barriers (Enkel et al., 2009). It is also not clear how intellectual property protection can be reconciled with OI activities (Dodgson et al., 2006; Keupp and Gassmann, 2009). Henkel (2006) suggests to strike the right balance between sharing and protection, but what is this right balance still needs to be understood.

Nevertheless, definitively OI effectiveness in relation to company performance (Huizingh, 2011; Lichtenthaler, 2011) has to be investigated better. Some contributions consider the relation with OI costs (Dodgson et al., 2006; Keupp and Gassmann, 2009; Dahlander and Gann, 2010) and some others argue a negative impact of too much openness on company performance (e.g. Laursen and Salter, 2006), but much more could be said on this aspect.

## 2.2 Emerging conditions for OI

Another open issue for future research is related to the emerging conditions (structural features and environmental circumstances) that enable OI adoption.

Surely, among structural features that can be analysed, size is the most intuitive one. Following the original idea of Schumpeter (1942), that observed mainly large firms, Chesbrough (2003, 2004, 2005) first focused on large firms in defining the OI paradigm and successively a scant attention on SMEs characterises OI literature. At the moment, SMEs are considered as simple 'solvers' of problems cast by large firms (Lichtenthaler and Ernst, 2009; Van de Vrande et al., 2009; Bianchi et al., 2011; Mortara and Minshall, 2011) even if small companies could gain a lot by OI (Huizingh, 2011; Parida et al., 2011). Nonetheless, some of their typical features can heavily constrain SMEs in OI implementation. Liability of smallness (Gassmann et al., 2010) or newness (Gilbert et al., 2006; Sofouli and Vonortas, 2007; Schwartz and Hornych, 2010), the general attitude towards autonomy and independence (Venkataraman et al., 1990; Miles et al., 1999; Van Gelderen et al., 2005; Gilbert et al., 2006; Katz and Green, 2006), the cost of building and maintaining collaborative networks or dedicated organisational structures (Kirschbaum, 2005; Lichtenthaler and Ernst, 2009; Lichtenthaler, 2011) make OI for SMEs quite challenging. It is still not clear, hence, whether large firms benefit from OI more than small firms, or whether the more adoption of OI processes by large firms is casual or temporary and small companies will catch up soon (Huizingh, 2011).

Among the environmental conditions, investigating the presence of correlation between 'industry sectors' and OI could be useful. Some articles focus on specific industries (Christensen et al., 2005; Sarkar and Costa, 2008; Hughes and Wareham, 2010; Ili et al., 2010; Bianchi et al., 2011), while some other ones focus on specific company cases (e.g. Procter & Gamble by Huston and Sakkab, 2006; Dodgson et al., 2006; Xerox by Chesbrough and Rosenbloom, 2002; IBM by Chesbrough and Appleyard, 2007; Nokia by Dittrich and Duysters, 2007; Deutsche Telekom by Rohrbeck et al., 2009). In general, starting from the high-tech sector (Chesbrough and Rosenbloom, 2002; Chesbrough, 2003; Chesbrough, 2004; Gassmann and Enkel, 2004; Chesbrough, 2005; Henkel, 2006; West and Gallagher, 2006) a new trend emerges to investigate OI potentials in the low-tech sectors (Chesbrough and Crowther, 2006; Laursen and Salter, 2006; Bergman et al., 2009; Ili et al., 2010; Sieg et al., 2010; Bianchi et al., 2011; Chiaroni et al., 2011). It would seem that companies in high-tech contexts are more used to apply OI strategies (Huizingh, 2011), but really one contribution that confirms any neat correlation does not still exist in the literature.

Besides industry sectors, 'spatial impacts' of OI ideas should be deepened. Teirlinck and Spithoven (2008, p.689) investigate the predisposition to OI in more or less urbanised contexts. Innovative firms in urban areas could have business models that favour OI, because knowledge resources are predominantly concentrated in urban areas. Nonetheless, firms in less urbanised areas show a higher degree of openness. Nevertheless, the analysis supports the idea that (open) innovation is spatially organised and, in line with this idea, the general relationship between regionally asymmetric knowledge capabilities and OI has been investigated by Cooke (2005).

Besides these basic subjects, some other issues related to OI remain unexplored. Few authors investigated the cultural aspects and employee attitudes and skills (e.g. Chesbrough, 2003; Laursen and Salter, 2006; Dodgson et al., 2006; Lichtenthaler and Ernst, 2009; du Chatenier et al., 2010; Ili et al., 2010; Lichtenthaler, 2011; Mortara

and Minshall, 2011), as well as the organisation required (West and Lakhani, 2008; Fichter, 2009; Lichtenthaler and Lichtenthaler, 2009) and the role of ICT and new technologies in supporting the movement towards OI (Dodgson et al., 2006; Huston and Sakkab, 2006).

To sum up, “the question is: how far will Open Innovation go and how long will it last?” (Gassmann et al., 2010, p.215). This question will probably not find an answer until the open questions mentioned above will find an answer. This paper obviously cannot give an answer to all of them: the aim is to investigate which way recent contributions are pointing in order to provide some useful guidelines for the OI implementation (that now is quite missing) especially in SMEs.

### **3 Recent trends in literature: methodology and results**

Starting from the theoretical framework described, we attempted at classifying the many OI contributions cited. In order to categorise these contributions, we had to take into account the overall contents of every article, book chapter or conference paper, as well as the limitation of our analysis given by the impossibility to investigate deeply the universe of the OI contributions. Given the increased number of contributions focused on OI, we first of all selected papers by the existence or not of newness and specificities in the contents. Second, we investigated the usefulness of these particularities as variables for an overall classification. The idea was to consider papers in such a way that they can be considered as ‘typical OI academic papers’ and to take into account that this classification should be comparable with other existing and future contributions.

#### *3.1 Clustering the literature: methodological insights*

The first concrete problem has been to identify the number of articles. We have started from the first contributions of Chesbrough (2003, 2004, 2005) and then searched articles in several scientific reviews specialised in innovation in general, and in special issues on OI. In this way, we have built up our final list that comprises 60 papers, reported in Appendix 3 (for the final list of our sample journals, see Appendix 1). Following this data collection, we have identified the main general recurrent features that emerged from a first reading of the articles. The contents have been examined in light of the above OI literature review and a first draft table of the variables for the comparison among the articles included in our sample has been drawn up. Then, we have identified the most specific variables. Table 1 provides a list of the final variables used for clustering the articles. In this list we have definitively structured the comparison variables further used for partitioning and for the classification. These variables have been chosen taking into account not only the main literature insights into the OI phenomenon but also a specific focus on practical modes and methods suggested till now in the literature, in particular for SMEs. More specifically, comparison variables have been extracted considering general and formal aspects (such as year of publication, number of authors, origin, number of references) as well as specific methodological characteristics (such as qualitative-quantitative, survey-case study, focus on large firms or SMEs, focus on industry sector or on geographical location) or content features (such as theoretically

oriented if the article defines aspects of OI or practically oriented if it proposes specific methods). Furthermore, an explorative orientation with open questions, a critical approach with some criticism about OI or a visionary attitude with policy suggestions and issues for future research have been taken into account.

**Table 1** Definitions of variables used for cluster analysis

|       |   |
|-------|---|
| Var01 | Article published in the last five years (1 = yes; 0 = no)          |
| Var02 | Article written by one or two authors (1 = yes; 0 = no)             |
| Var03 | Authors' origin from Europe (1 = yes; 0 = no)                       |
| Var04 | Number of references not over 50 (1 = yes; 0 = no)                  |
| Var05 | Qualitative (1 = yes; 0 = no)                                       |
| Var06 | Use of case-study (1 = yes; 0 = no)                                 |
| Var07 | Use of interviews (1 = yes; 0 = no)                                 |
| Var08 | Use of data from databanks (1 = yes; 0 = no)                        |
| Var09 | Focus on large firms (1 = yes; 0 = no)                              |
| Var10 | Focus on SMEs (1 = yes; 0 = no)                                     |
| Var11 | Focus on firms in a specific location (1 = yes; 0 = no)             |
| Var12 | Definition of OI (1 = yes; 0 = no)                                  |
| Var13 | Comparison between Closed and Open Innovation (1 = yes; 0 = no)     |
| Var14 | Suggestion of an OI solution/method (1 = yes; 0 = no)               |
| Var15 | Policy suggestions (1 = yes; 0 = no)                                |
| Var16 | Open questions (1 = yes; 0 = no)                                    |
| Var17 | Criticism about OI (1 = yes; 0 = no)                                |
| Var18 | Classification of OI modes, perspectives, streams (1 = yes; 0 = no) |

More specifically, Table 1 highlights that variables about formal aspects investigate the old or recent publication of the paper, whether or not it is the result of a joint work of a group of researchers from EU or extra-EU universities, and whether or not the number of references is quite wide. These formal aspects are completed by investigating the qualitative or quantitative approach and the main tools of investigation. Given the specific aim of our research, this approach is linked to a focus on large firms or SMEs located in a specific country or not. Last but not least, given the increasing interest in the phenomenon, we thought useful to investigate whether or not these contributions provide an OI definition compared with a closed approach, whether or not they criticise the OI concept, whether or not they provide policy suggestions with issues for future research. Always linked to the specific aim of our research, this framework has been completed with an investigation on the presence or absence of a specific OI mode or method and a classification of existing OI perspectives and streams.

To sum up, this list of recurrent variables, emerged from reading the selected 60 papers, provides a comprehensive overview of the general contents of these contributions and of the specific features useful for the aim of our analysis. Building on these assumptions, this table has been analysed through a cluster analysis approach.

The cluster analysis method has been considered the most suitable one because it allows the identification of groups with small within-cluster variation for discriminating variables and high variation between clusters. The qualitative variables have been

transformed into quantitative ones, with 1 = yes and 0 = no, and the variables that showed a high degree of correlation (i.e. use of a questionnaire and focus on a specific industry sector) have been avoided. These last variables have been instead further used besides the results of the cluster analysis in order to improve the comparison of the groups.

The result of a cluster analysis can, and usually does, depend on the method and technique, the set of objects under investigation and the variables used to describe these objects. Therefore, the differences among the groups as highlighted by the cluster analysis results should be used to gain further understanding of the set of objects under study, by a sort of heuristic method (Hogeweg, 1976). This is the reason why several iterations with diverse hierarchical and partition methods and different measures have been performed; they resulted at the end in the application of the *k*-means technique. Most widely used, it is a partitional clustering technique, prototype-based, that attempts to find a user-specified number of clusters (*k*), which are represented by their centroids. The metric used has been the Euclidean ( $L_2$ ) distance and the sum of the squared error (SSE).

### 3.2 *Main outputs from the cluster analysis*

Cluster analysis proposed diverse alternatives for the grouping divisions: from two to six groups. As shown in Table 2, according to the Calinski/Harabasz pseudo-F index (Calinski and Harabasz, 1974; Milligan and Cooper, 1985), a two group partitioning is suggested. By verifying also correlation among variables, no correlation problems emerged (see Appendix 2).

**Table 2** Results for Calinski/Harabasz pseudo-F index

| <i>Number of clusters</i> | <i>Calinski/Harabasz pseudo-F</i> |
|---------------------------|-----------------------------------|
| 2                         | 8.91                              |
| 3                         | 7.57                              |
| 4                         | 7.61                              |
| 5                         | 6.39                              |
| 6                         | 6.26                              |

Table 3 describes the analysis of variance results for the grouping into two clusters. It highlights the variables that most contribute towards the identification of the two clusters. Table 4, instead, provides a description of the mean values of the variables in the two groups.

As one can see the variables ‘qualitative approach’ and ‘focus on firms in a specific geographical location’ (var05 and var11 in Table 1) have resulted to be the most significantly influential ones. As seen in Table 4, the key features of the two clusters are identified. Some specific variables characterise each group more than others. In Cluster 1, a qualitative approach with policy suggestions is the key characteristics (var 05 and 15 in Table 1). In Cluster 2, a definition of OI with policy suggestions and open questions are the key variables (var 12, 15, and 16 in Table 1).

**Table 3** ANOVA results for the grouping into two clusters

| <i>Number of obs. = 60</i> |                   | <i>60 R-squared = 0.8208</i> |                               |          |                  |
|----------------------------|-------------------|------------------------------|-------------------------------|----------|------------------|
| <i>Root MSE = .244226</i>  |                   |                              | <i>Adj R-squared = 0.7422</i> |          |                  |
| <i>Source</i>              | <i>Partial SS</i> | <i>df</i>                    | <i>MS</i>                     | <i>F</i> | <i>Prob&gt;F</i> |
| Model                      | 11.2045002        | 18                           | .622472235                    | 10.44    | 0.0000           |
| var1                       | .128843834        | 1                            | .128843834                    | 2.16     | 0.1493           |
| var2                       | .000972191        | 1                            | .000972191                    | 0.02     | 0.8990           |
| var3                       | .044062532        | 1                            | .044062532                    | 0.74     | 0.3951           |
| var4                       | .034316823        | 1                            | .034316823                    | 0.58     | 0.4525           |
| var5                       | 1.02263262        | 1                            | 1.02263262                    | 17.14    | 0.0002           |
| var6                       | .003238175        | 1                            | .003238175                    | 0.05     | 0.8169           |
| var7                       | .023710465        | 1                            | .023710465                    | 0.40     | 0.5319           |
| var08                      | .339188754        | 1                            | .339188754                    | 5.69     | 0.0218           |
| var09                      | .005260855        | 1                            | .005260855                    | 0.09     | 0.7680           |
| var10                      | .000869247        | 1                            | .000869247                    | 0.01     | 0.9045           |
| var11                      | .886706778        | 1                            | .886706778                    | 14.87    | 0.0004           |
| var12                      | .314234689        | 1                            | .314234689                    | 5.27     | 0.0269           |
| var13                      | .001574858        | 1                            | .001574858                    | 0.03     | 0.8717           |
| var14                      | .281344422        | 1                            | .281344422                    | 4.72     | 0.0357           |
| var15                      | .000938842        | 1                            | .000938842                    | 0.02     | 0.9008           |
| var16                      | .115154397        | 1                            | .115154397                    | 1.93     | 0.1722           |
| var17                      | .002927875        | 1                            | .002927875                    | 0.05     | 0.8258           |
| var18                      | .076755781        | 1                            | .076755781                    | 1.29     | 0.2632           |
| Residual                   | 2.44549976        | 41                           | .059646336                    |          |                  |

**Table 4** Summary statistics: mean values of variables by cluster

|       |   | <i>Cluster 1</i> | <i>Cluster 2</i> | <i>Total</i> |
|-------|---|------------------|------------------|--------------|
| Var01 | Article published in the last five years      | .6410256         | .952381          | .75          |
| Var02 | Article written by one or two authors         | .7692308         | .3333333         | .6166667     |
| Var03 | Authors' origin from Europe                   | .6666667         | .9047619         | .75          |
| Var04 | Number of references not over 50              | .6153846         | .4285714         | .55          |
| Var05 | Qualitative                                   | .9230769         | .2380952         | .6833333     |
| Var06 | Use of case-study                             | .4615385         | .2857143         | .4           |
| Var07 | Use of interviews                             | .3333333         | .5238095         | .4           |
| Var08 | Use of data from databanks                    | .2564103         | .8095238         | .45          |
| Var09 | Focus on large firms                          | .5897436         | .8571429         | .6833333     |
| Var10 | Focus on SMEs                                 | .3333333         | .6190476         | .4333333     |
| Var11 | Focus on firms in a specific location         | .2307692         | .8571429         | .45          |
| Var12 | Definition of OI                              | .6410256         | 1                | .7666667     |
| Var13 | Comparison between Closed and Open Innovation | .4358974         | .4761905         | .45          |

**Table 4** Summary statistics: mean values of variables by cluster (continued)

|       |   | Cluster 1 | Cluster 2 | Total    |
|-------|---|-----------|-----------|----------|
| Var14 | Suggestion of an OI solution/method               | 0         | .1428571  | .05      |
| Var15 | Policy suggestions                                | .9230769  | 1         | .95      |
| Var16 | Open questions                                    | .6666667  | 1         | .7833333 |
| Var17 | Criticism about OI                                | .1025641  | 0         | .0666667 |
| Var18 | Classification of OI modes, perspectives, streams | .3589744  | .4285714  | .3833333 |

Starting from these general considerations, to achieve a better understanding of the results and to identify the specificities of the two clusters, we have examined each cluster alone for other features, included or not in the data set, like the variables excluded for correlation problems. Thus, according to the *k*-means partition clustering method applied, Cluster 1 comprises 39 articles, a few written in the last five years but many others written before, with a clear prevalence of contributions written by one-two authors working in a European university or outside Europe. These authors carried out a qualitative analysis providing a definition of OI and a classification of OI perspectives and focused on policy suggestions as well as open questions and comparisons between open and closed innovation. According to their strong qualitative nature, these articles did not suggest a method or a mode of OI implementation: variable 14 had no influence (see Tables 1 and 4). We can label Cluster 1 '*explorative and theoretically-oriented*'.

Cluster 2 comprises 21 articles, nearly all written in the last five years by a group of authors for the most part working in a European university, that not only provided a definition of OI, a comparison between open and closed innovation, policy suggestions and open questions, but also focused on large firms and/or SMEs with a specific geographical location (in general an European country) and through the use of data taken from questionnaires, interviews, databank. Therefore, these articles show a more practical approach, with an attempt at analysing whether and how OI is implemented in practice by companies and they are most of all the result of the joint work of a group of researchers. These articles do not provide a criticism of the OI concept – in fact variable 17 did not influence this Cluster (see Tables 1 and 4). This is not surprising, given their aim of applying the OI approach and in fact some of them describe in details the OI method adopted by the companies investigated. The suggestion of a method (var 14) has zero influence in Cluster 1, as well. Following this description, we can label Cluster 2 '*prospector and practically-oriented*'. Table 5 provides a summary of the key features identifiable in the two clusters.

All these findings have been further confirmed by the comparison of the mean value of each variable in the two clusters. We can look, for example, at the methods of investigation: the presence of case-study, interviews and data from databanks (var 06, 07, and 08 in Table 1). While articles with case-studies description are equally distributed in both the Clusters, in Cluster 2 there is a prevalence of articles with an analysis of interview results and a strong prevalence of data taken from databanks – the contrary can be observed in Cluster 1. Furthermore, it emerged that nearly all the articles with a questionnaire investigation are included in Cluster 2. Looking at the focus on companies, while an attention for large firms is observable also in Cluster 1, a stronger interest for SMEs, a higher focus on specific industries, and geographical locations can be observed more in articles included in Cluster 2 compared to the ones in Cluster 1.

**Table 5** Main features of Cluster 1 and Cluster 2

| <i>Cluster 1 (39 articles)</i>   | <i>Cluster 2 (21 articles)</i>   |
|--|--|
| <i>Explorative and theoretically oriented</i>                          | <i>Prospector and practically oriented</i>   |
| Qualitative orientation (var 5)  | Practical and quantitative attitude (var 14)   |
| Less recent contributions (var 1)                                      | More recent contributions (var 1)  |
| Articles written by 1–2 authors from worldwide universities (var 2, 3) | Articles written by a group of researchers, most from European universities (var 2, 3)           |
| More focused on large firms than on SMEs (var 9)                       | More focused on SMEs from specific industries and locations, especially from Europe (var 10, 11) |
| Definition of OI (var 12)  |  |
| Comparison between Open and Closed innovation (var 13)                 |  |
| Policy suggestions (var 15)  |  |
| Open questions (var 16)  |  |
| Criticism of the OI paradigm (var 17)                                  | No criticism of the OI paradigm  |
| No OI method suggested   | Suggestion of an OI solution/method (var 14)   |
| Description of OI perspectives (var 18)                                | Data analysis (interviews, questionnaires, databanks), var 7–8                                   |

#### 4 Discussion and policy suggestions

Cluster 1 – ‘explorative and theoretically-oriented’ – includes those contributions that are closer to the Chesbrough (2003, 2004, 2005) seminal ones. Notwithstanding, Cluster 2 – ‘prospector and practically-oriented’ – includes those contributions of team of researchers with a prevalent origin from European universities and that focus on companies, especially SMEs, in specific industries and located mostly in Europe. This cluster highlighted an interesting more recent trend in the OI literature, that means an attempt at suggesting practical OI modes and methods for specific case-studies analysed, mostly through the collaboration of more than two researchers. In particular, the fact that these articles are focused also on SMEs through data analyses and that they try to suggest practical methods/modes could be a key evidence of the necessity to find new and useful solutions for the kind of firms that are the strength of the European economy.

Chesbrough first focused on qualitative approaches and large firms and Cluster 1 would suggest a ‘path dependence’ identifiable in OI literature and related to company applications. This, in our opinion, predetermined the trajectory of OI implementation by companies. In particular, it seems that the literature worldwide focuses on qualitative aspects and mainly towards large firms; this may be the main reason of a general lack of OI methods besides a scant attention on SMEs. But, interestingly, a recent trend led by European scientific communities focuses on practical OI applications for European SMEs. They could have been less influenced by the seminal contributions of Chesbrough. Therefore, they could have started to investigate the OI paradigm looking since the beginning at more practical solutions like OI modes and methods. Last but not least, we have to take into account the ‘importance of context’ (Pfeffer and Salancik, 1978; Aldrich and Ruef, 2006). The European Commission argued that “SMEs are the

backbone of European economy [...] In most EU Member States, SMEs make up over 99% of enterprises and do generate a substantial share of GDP, are a key source of new jobs and, as well, are a breeding ground for entrepreneurship and new business ideas” (Nachira, 2002, p.3). Cultural and mind attitude of European scientists could be more influenced by SMEs gaps and needs. All these aspects highlight a clear attempt at going beyond the path dependence of Cluster 1.

Nevertheless, it is also worth noting that this is a recent and rather slow trend: contributions on practical OI methods with an overall applicability are still missing and further suggestions from literature would be useful for small as well as for large companies. In fact, the nearly absence of general implementation guidelines foster just the ‘trial and error’ approach described by Huizingh (2011), Laursen and Salter (2006) and Gassmann et al. (2010). This implies neglecting the natural knowledge capitalisation that would come from a more structured approach. As highlighted by Gassmann et al. (2010, p.219), “there is a need for a consistent Open Innovation theory” that integrates the several streams and perspectives into a larger theory. Case-study analysis is a useful starting point, but it is not enough. Now, OI needs efficient and effective quantitative studies that take into account main characteristics and differences between SMEs and large firms as well as context dependencies (Huizingh, 2011).

In our opinion, the real challenge in Europe is to build a suitable and effective OI method for SMEs, taking into account the specificities of this kind of firm. Notwithstanding the general autonomy propensity and strong independence attitude (Venkataraman et al., 1990; Miles et al., 1999; Gilbert et al., 2006; Katz and Green, 2006; van Gelderen et al., 2005), small firms have strengths that cannot easily be replicated by a large firm, such as entrepreneurial dynamism on average (Gilbert et al., 2006), internal flexibility, and specialised expertise. Furthermore, it is well known that SMEs focus more on technological aspects than on business and managerial ones: the emerging OI paradigm could be a useful solution for filling these gaps. Therefore, SMEs could benefit deeply from the ecosystem-promoting actions suggested by Almirall and Casadesus-Masanell (2010), obviously strictly including a learning period at the beginning (Lichtenthaler, 2011). In fact, an important aspect to be taken into account is the one on managerial capabilities needed for establishing OI strategies and management education in the OI field. Companies need to develop particular organisational capabilities for implementing OI activities through an initial learning period. This framework implies that a specific OI method for SMEs with concrete chances of practical and lasting application needs a deep survey of the SMEs world in a given multi-country geographic area in order to catch many different SMEs with different characteristics, needs and gaps. The work should be focused on their perceptions and opinions about the OI paradigm, it could highlight what could be really appreciated and how it should be introduced. In this way any myopic replication would be avoided. Path dependence is common in academic literature (think for instance about the painful application of Lean in Europe from Japan), but when the OI research community officially recognises this path dependence and agrees on considering OI as “a work in progress” (Trott and Hartmann, 2009, p.731), a real chance to suggest effective OI methods and useful perspectives for SMEs implementation will be possible. In the era of ‘Open Innovation’ the role of SMEs is significant (Zeng et al., 2010), and given the fact that “Open Innovation generally is superior to closed innovation when complexity is not high” (Almirall and Casadesus-Masanell, 2010, p.28), SMEs are a suitable kind of firms for OI adoption.

Huizingh (2011, p.7) wondered about “what will be the future of Open Innovation? My prediction is that we should not be surprised to learn that within a decade, the term will fade away[...] because it has been fully integrated in innovation management practices”, while Gassmann et al. (2010, p.214) argued that “the era of Open Innovation has just begun”. Who is right? The following decades will provide a clear answer to this question. In the meantime, we can try to lead the OI path such that “Open Innovation seems to be a sustainable development rather than a management fashion” (Lichtenthaler, 2011, p.89). To this aim, our cluster analysis provided clear evidence of an attempt at overcoming the traditional flow of qualitative and less recent literature contributions in order to focus more on practical implementation of the OI paradigm with specific attention to OI modes and methods in the SMEs world and especially in the European context.

## **5 Conclusions**

In recent years we have assisted to an increasing development of the OI literature. Theoretical contributions have emerged with a trend ever increasing, without a comparable and similar level of empirical investigations. The main consequence is that this literature is fragmented, difficult to analyse and suggestions for practice are not so evident.

This paper attempted at providing an investigation of the recent trends in OI literature through applying a cluster analysis on a sample of 60 OI contributions. The results of the cluster analysis have evidenced the strong and qualitative orientation besides the focus on large firms of the less recent OI literature (Cluster 1) on the one hand, and a prospector and more practical attitude of more recent contributions, especially in Europe and with a focus on SMEs (Cluster 2) on the other hand. This means that a recent and emerging trend towards a more practical application of OI activities, especially in the SME world at EU level, with case-study analyses is emerging. This finding may be indicative of a concrete interest towards an application of the potentialities of the OI paradigm in a particular kind of firm, like SMEs, that are the real strength of the European economy. These firms have such characteristics, well known and underlined in the literature that they could really benefit from an implementation of OI activities. But, to this aim they need to be educated and sustained with methods and modes suited to their specific requirements. In our opinion, an appropriate balance of the OI approach that fosters the potentialities and advantages of the OI paradigm, but, at the same time, builds on company specificities, may be really effective.

In conclusion, we have also to take into account that “Open Innovation is not a panacea. The best way to avoid this from happening is to consider Open Innovation as a work in progress” (Trott and Hartmann, 2009, p.731). When the literature officially recognises the path dependence process and agrees on considering OI as ‘a work in progress’, it will be possible to suggest effective OI methods replicable elsewhere and OI will have a real chance to become an efficient innovation theory.

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## References

- Aldrich, H.E. and Ruef, M. (2006) *Organizations Evolving*, Sage publications, London.
- Almirall, E. and Casadesus-Masanell, R. (2010) 'Open versus closed innovation: a model of discovery and divergence', *Academy of Management Review*, Vol. 35, No. 1, pp.27–47.
- Asakawa, K., Nakamura, H., and Sawada, N. (2010) 'Firms' open innovation policies, laboratories' external collaborations, and laboratories' R&D performance', *R&D Management*, Vol. 40, No. 2, pp.109–123.
- Belussi, F., Sammarra, A. and Sedita, S.R. (2010) 'Learning at the boundaries in an "Open Regional Innovation System": a focus on firms' innovation strategies in the Emilia Romagna life science industry', *Research Policy*, Vol. 39, No. 6, pp.710–721.
- Bergman J., Jantunen A. and Saksä J. (2009) 'Enabling open innovation process through interactive methods: scenarios and group decision support systems', *International Journal of Innovation Management*, Vol. 13, No. 1, pp.139–156.
- Bianchi, M., Campodall'Orto, S., Frattini, F. and Vercesi, P. (2010) 'Enabling open innovation in small and medium-sized enterprises: how to find alternative applications for your technologies', *R&D Management*, Vol. 40, No. 4, pp.414–431.
- Bianchi, M., Cavaliere, A., Chiaroni, D., Frattini, F. and Chiesa, V. (2011) 'Organisational modes for open innovation in the bio-pharmaceutical industry: an exploratory analysis', *Technovation*, Vol. 31, No. 1, pp.22–33.
- Calinski, T. and Harabasz, J. (1974) 'A dendrite method for cluster analysis', *Communications in Statistics-Simulation and Computation*, Vol. 3, No. 1, pp.1–27.
- Chesbrough, H.W. (2003) *Open Innovation, the new Imperative for Creating and Profiting from Technology*, Harvard Business Press, Boston, MA.
- Chesbrough, H. (2003a) 'Open platform innovation: creating value from internal and external innovation', *Intel Technology Journal*, Vol. 7, No. 3, pp.5–9.
- Chesbrough, H.W. (2004) 'Managing open innovation', *Research Technology Management*, Vol. 47, No. 1, pp.23–26.
- Chesbrough, H.W. (2005) 'Open innovation: a new paradigm for understanding industrial innovation', in Chesbrough, H.W., Vanhaverbeke, W. and West, J. (Eds): *Open Innovation: Researching a New Paradigm*, Oxford University Press, Oxford.
- Chesbrough, H.W. (2006) *Open Business Models: How to Thrive in the New Innovation Landscape*, Harvard Business Press, Boston.
- Chesbrough, H.W. and Appleyard, M. (2007) 'Open innovation and strategy', *California Management Review*, Vol. 50, No. 1, pp.57–76.
- Chesbrough, H.W. and Crowther, A.K. (2006) 'Beyond high tech: early adopters of open innovation in other industries', *R&D Management*, Vol. 36, No. 3, pp.229–236.
- Chesbrough, H.W. and Rosenbloom, R.S. (2002) 'The role of the business model in capturing value from innovation: evidence from Xerox corporation's technology spin-off companies', *Industrial and Corporate Change*, Vol. 11, No. 3, pp.529–555.
- Chiaroni, D., Chiesa, V. and Frattini, F. (2010) 'Unravelling the process from closed to open innovation: evidence from mature, asset-intensive industries', *R&D Management*, Vol. 40, No. 3, pp.222–245.
- Chiaroni, D., Chiesa, V. and Frattini, F. (2011) 'The open innovation journey: how firms dynamically implement the emerging innovation management paradigm', *Technovation*, Vol. 31, No. 1, pp.34–43.
- Christensen, J.F., Olesen, M.H. and Kjær, J.S. (2005) 'The industrial dynamics of open innovation – evidence from the transformation of consumer electronics', *Research Policy*, Vol. 34, No. 10, pp.1533–1549.
- Cooke, P. (2005) 'Regionally asymmetric knowledge capabilities and open innovation exploring 'globalisation 2' – a new model of industry organisation', *Research Policy*, Vol. 34, No. 8, pp.1128–1149.

- Dahlander, L. and Gann, D.M. (2010) 'How open is innovation', *Research Policy*, Vol. 39, No. 6, pp.699–709.
- Dittrich, K. and Duysters, G. (2007) 'Networking as a means to strategy change: the case of open innovation in mobile telephony', *Journal of Product Innovation Management*, Vol. 24, No. 6, pp.510–521.
- Dodgson, M., Gann, D. and Salter, A. (2006) 'The role of technology in the shift towards open innovation: the case of Procter & Gamble', *R&D Management*, Vol. 36, No. 3, pp.333–346.
- du Chatenier, E., Verstegen, J., Biemans, H., Mulder, M. and Omta, O. (2010) 'Identification of competencies for professionals in open innovation teams', *R&D Management*, Vol. 40, No. 3, pp.271–280.
- Enkel, E., Gassmann, O. and Chesbrough, H.W. (2009) 'Open R&D and open innovation: exploring the phenomenon', *R&D Management*, Vol. 39, No. 4, pp.311–316.
- Fichter, K. (2009) 'Innovation communities: the role of networks of promoters in open innovation', *R&D Management*, Vol. 39, No. 4, pp.357–371.
- Gassmann, O. and Enkel, E. (2004) 'Towards a theory of open innovation: three core process archetypes', *Proceedings of the R&D Management Conference (RADMA)*, pp.8–9.
- Gassmann, O., Enkel, E. and Chesbrough, H.W. (2010) 'The future of open innovation', *R&D Management*, Vol. 40, No. 3, pp.213–221.
- Gilbert, B.A., McDougall, P.P. and Audretsch, D.B. (2006) 'New venture growth: a review and extension', *Journal of Management*, Vol. 32, No. 6, pp.926–950.
- Henkel, J. (2006) 'Selective revealing in open innovation processes: the case of embedded Linux', *Research Policy*, Vol. 35, No. 7, pp.953–969.
- Hogeweg, P. (1976) 'Iterative character weighing in numerical taxonomy', *Computers in Biology and Medicine*, Vol. 6, No. 3, pp.199–211.
- Hughes, B. and Wareham, J. (2010) 'Knowledge arbitrage in global pharma: a synthetic view of absorptive capacity and open innovation', *R&D Management*, Vol. 40, No. 3, pp.324–343.
- Huizing, K.R.E.E. (2011) 'Open innovation: state of the art and future perspectives', *Technovation*, Vol. 31, No. 1, pp.2–9.
- Huston, L. and Sakkab, N. (2006) 'Connect and develop – inside Procter & Gamble's new model for innovation', *Harvard Business Review*, March, 11p.
- Ili, S., Albers, A. and Miller, S. (2010) 'Open innovation in the automotive industry', *R&D Management*, Vol. 40, No. 3, pp.246–255.
- Kajmakoska, B., Koeck, A.M. and Willfort, R. (2010) 'Computer-based solutions for open innovation processes', *MC&OI and the Financial Crisis – Challenge and Opportunity, 4th International Conference on Mass Customization and Personalization in Central Europe*, 22–24 September, Novi Sad, Serbia.
- Katz, J.A. and Green, R. (2006) *Entrepreneurial Small Business*, McGraw-Hill Irwin, Boston.
- Keupp, M.M. and Gassmann, O. (2009) 'Determinants and archetype users of open innovation', *R&D Management*, Vol. 39, No. 4, pp.331–341.
- Kirschbaum, R. (2005) 'Open innovation in practice', *Research-Technology Management*, Vol. 48, No. 4, pp.24–28.
- Laursen, K. and Salter, A. (2006) 'Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms', *Strategic Management Journal*, Vol. 27, No. 2, pp.131–150.
- Lazzarotti, V. and Manzini, R. (2009) 'Different modes of open innovation: a theoretical framework and empirical study', *International Journal of Innovation Management*, Vol. 13, No. 4, pp.615–636.
- Lichtenthaler, U. (2008) 'Open innovation in practice: an analysis of strategic approaches to technology transactions', *IEEE Transactions on Engineering Management*, Vol. 55, No. 1, pp.148–157.

- Lichtenthaler, U. (2011) 'Open innovation: past research, current debates, and future directions', *Academy of Management Perspectives*, Vol. 25, No. 1, pp.75–93.
- Lichtenthaler, U. and Ernst, H. (2009) 'Opening up the innovation process: the role of technology aggressiveness', *R&D Management*, Vol. 39, No. 1, pp.38–54.
- Lichtenthaler, U. and Lichtenthaler, E. (2009) 'A capability-based framework for open innovation: complementing absorptive capacity', *Journal of Management Studies*, Vol. 46, No. 8, pp.1315–1338.
- Miles, G., Preece, S.B. and Baetz, M.C. (1999) 'Dangers of dependence: the impact of strategic alliance use by small technology-based firms', *Journal of Small Business Management*, April, pp.20–29.
- Milligan, G.W. and Cooper, M.C. (1985) 'An examination of procedures for determining the number of clusters in a data set', *Psychometrika*, Vol. 50, No. 2, pp.159–179.
- Mortara, L. and Minshall, T. (2011) 'How do large multinational companies implement open innovation?', *Technovation*, Vol. 31, Nos. 10/11, pp.586–597.
- Nachira, F. (2002) 'Towards a network of digital business ecosystems fostering the local development', *European Commission Discussion Paper*, Bruxelles.
- Parida, V., Westerberg, M. and Frishammar, J. (2011) *Effect of Open Innovation Practices on SMEs Innovative Performance: An Empirical Study*. Available online at: <http://www.icsb2011.org/>
- Pfeffer, J. and Salancik, G.R. (1978) *The External Control of Organizations: A Resource Dependence Perspective*, Harper&Row, New York.
- Poot, T., Faems, D. and Vanhaverbeke, W. (2009) 'Toward a dynamic perspective on open innovation: a longitudinal assessment of the adoption of internal and external innovation strategies in the Netherlands', *International Journal of Innovation Management*, Vol. 13, No. 2, pp.177–200.
- Rahman, H. and Ramos, I. (2010) 'Open innovation in SMEs: from closed boundaries to networked paradigm', *Issues in Informing Science and Information Technology*, Vol. 7, pp.471–487.
- Rohrbeck, R., Holzle, K. and Gemunden, H.G. (2009) 'Opening up for competitive advantage – how Deutsche Telekom creates an open innovation ecosystem', *R&D Management*, Vol. 39, No. 4, pp.420–430.
- Santoro, R. and Conte, M. (2009) 'Living labs in open innovation functional regions', *ESoCE-Net*. Available online at: <http://ami-communities.net/pub/bscw.cgi/d441945/>
- Sarkar, S. and Costa, A.I.A. (2008) 'Dynamics of open innovation in the food industry', *Trends in Food Science & Technology*, Vol. 19, No. 11, pp.574–580.
- Schaffers, H. and Santoro, R. (2010) 'Living labs and open innovation policy in regions for the benefit of SMEs', *CO-LLABS Workshop*, 27th January, Brussels, Available online at: <http://w.ami-communities.eu/pub/bscw.cgi/d506128/>
- Schumpeter, J. (1942) *Capitalism, Socialism, and Democracy*, HarperCollins, New York.
- Schwartz, M. and Hornych, C. (2010) 'Cooperation patterns of incubator firms and the impact of incubator specialization: empirical evidence from Germany', *Technovation*, Vol. 30, Nos. 9/10, pp.485–495.
- Sieg, J.H., Wallin, M.W. and von Krogh, G. (2010) 'Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry', *R&D Management*, Vol. 40, No. 3, pp.281–291.
- Sofouli, E. and Vonortas, N.S. (2007) 'S&T parks and business incubators in middle-sized countries: the case of Greece', *Journal of Technology Transfer*, Vol. 32, No. 5, pp.525–544.
- Spithoven, A., Clarysse, B. and Knockaert, M. (2011) 'Building absorptive capacity to organise inbound open innovation in traditional industries', *Technovation*, Vol. 31, No. 1, pp.10–21.

- Teirlinck, P. and Spithoven, A. (2008) 'The spatial organization of innovation: open innovation, external knowledge relations and urban structure', *Regional Studies*, Vol. 42, No. 5, pp.689–704.
- Trott, P. and Hartmann, D. (2009) 'Why "Open Innovation" is old wine in new bottles', *International Journal of Innovation Management*, Vol. 13, No. 4, pp.715–736.
- van Gelderen, M., van der Sluis, L. and Jansen, P. (2005) 'Learning opportunities and learning behaviours of small business starters: relations with goal achievement, skill development and satisfaction', *Small Business Economics*, Vol. 25, No. 1, pp.97–108.
- van de Vrande, V., de Jong, J.P.J., Vanhaverbeke, W. and de Rochemont, M. (2009) 'Open innovation in SMEs: trends, motives and management challenges', *Technovation*, Vol. 29, Nos. 6/7, pp.423–437.
- Venkataraman, S., Van de Ven, A.H., Buckeye, J. and Hudson, R. (1990) 'Starting up a turbulent environment: a process model of failure among firms with high customer dependence', *Journal of Business Venturing*, Vol. 5, No. 5, pp.277–297.
- West, J. and Gallagher, S. (2006) 'Challenges of open innovation: the paradox of firm investment in open-source software', *R&D Management*, Vol. 36, No. 3, pp.319–331.
- West, J. and Lakhani, K.R. (2008) 'Getting clear about communities in open innovation', *Industry & Innovation*, Vol. 15, No. 2, pp.223–231.
- Zeng, S.X., Xie, X.M. and Tam, C.M. (2010) 'Relationship between cooperation networks and innovation performance of SMEs', *Technovation*, Vol. 30, No. 3, pp.181–194.

## Note

- 1 R&D Management (2000, 2009, 2010); Industry & Innovation (2008); Technovation (2010); International Journal of Technology Management (2010); International Journal of Innovation Management (2010); European Journal of Innovation Management (2011); Analysis & Strategic Management (2011); International Journal of Technological Learning, Innovation and Development (2012).

**Appendix 1 List of reviews**

- 1 *Academy of Management Perspective*
- 2 *Academy of Management Review*
- 3 *California Management Review*
- 4 *Creativity and Innovation Management*
- 5 *Harvard Business Review*
- 6 *IEEE Transactions on Engineering Management*
- 7 *Industrial and Corporate Change*
- 8 *Industry & Innovation*
- 9 *International Journal of Innovation Management*
- 10 *Issues in Informing Science and Information Technology*
- 11 *Journal of Management Studies*
- 12 *Journal of Product Innovation Management*
- 13 *Long Range Planning*
- 14 *MIT Sloan Management Review*
- 15 *R&D Management*
- 16 *Regional Studies*
- 17 *Research Policy*
- 18 *Research Technology Management*
- 19 *Strategic Management Journal*
- 20 *Technovation*
- 21 *Trends in Food Science & Technology*

**Appendix 2 Correlation matrix (corr var1 var2 var3 var4 var5 var6 var7 var8 var9 var10 var11 var12 var13 var14 var15 var16 var17 var18 (obs=60))**

|       | var1     | var2    | var3    | var4    | var5    | var6    | var7    | var8    | var9    | var10   | var11   | var12   | var13   | var14   | var15  | var16  | var17  | var18  |  |
|-------|----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|--------|--------|--------|--|
| var1  | 1.0000   |         |         |         |         |         |         |         |         |         |         |         |         |         |        |        |        |        |  |
| var2  | -0.2969  | 1.0000  |         |         |         |         |         |         |         |         |         |         |         |         |        |        |        |        |  |
| var3  | 0.2889   | -0.2969 | 1.0000  |         |         |         |         |         |         |         |         |         |         |         |        |        |        |        |  |
| var4  | 0.0193   | 0.0448  | -0.0580 | 1.0000  |         |         |         |         |         |         |         |         |         |         |        |        |        |        |  |
| var5  | -0.1448  | 0.2002  | -0.1448 | 0.1764  | 1.0000  |         |         |         |         |         |         |         |         |         |        |        |        |        |  |
| var6  | -0.11571 | -0.0560 | 0.1571  | -0.0821 | 0.3364  | 1.0000  |         |         |         |         |         |         |         |         |        |        |        |        |  |
| var7  | 0.0000   | 0.2659  | 0.3143  | -0.2188 | -0.0293 | 0.4444  | 1.0000  |         |         |         |         |         |         |         |        |        |        |        |  |
| var8  | 0.0580   | -0.2515 | 0.1354  | -0.3266 | -0.3925 | 0.0821  | 0.2872  | 1.0000  |         |         |         |         |         |         |        |        |        |        |  |
| var9  | 0.1448   | -0.0209 | 0.1862  | -0.1116 | -0.2323 | 0.2633  | 0.2633  | 0.3277  | 1.0000  |         |         |         |         |         |        |        |        |        |  |
| var10 | 0.0388   | -0.1407 | 0.2719  | 0.0473  | -0.2723 | -0.1648 | -0.0961 | 0.1555  | 0.0169  | 1.0000  |         |         |         |         |        |        |        |        |  |
| var11 | 0.1354   | -0.3893 | 0.2128  | 0.0774  | -0.3205 | -0.0547 | 0.2188  | 0.1919  | 0.2557  | 0.1555  | 1.0000  |         |         |         |        |        |        |        |  |
| var12 | 0.1365   | -0.1918 | -0.0455 | -0.3406 | -0.3756 | -0.1126 | 0.2091  | 0.3406  | 0.1327  | 0.0053  | -0.0554 | 1.0000  |         |         |        |        |        |        |  |
| var13 | -0.0193  | 0.2308  | 0.0580  | -0.1246 | -0.1764 | -0.1915 | 0.0821  | -0.0774 | 0.0396  | 0.0879  | -0.1448 | 0.3406  | 1.0000  |         |        |        |        |        |  |
| var14 | 0.1325   | -0.2910 | -0.0442 | -0.2536 | -0.0082 | 0.1249  | 0.1249  | 0.0999  | -0.0082 | 0.1080  | 0.2536  | 0.1266  | -0.0538 | 1.0000  |        |        |        |        |  |
| var15 | 0.2208   | -0.1809 | 0.0442  | -0.2075 | -0.1562 | 0.0312  | 0.1873  | 0.2075  | 0.0082  | 0.2006  | -0.0999 | 0.2350  | 0.2075  | 0.0526  | 1.0000 |        |        |        |  |
| var16 | 0.3504   | -0.0818 | 0.2569  | -0.2318 | -0.2711 | -0.2312 | -0.0661 | 0.1504  | -0.0101 | 0.2966  | .2318   | 0.0032  | 0.1504  | 0.1207  | 0.2506 | 1.0000 |        |        |  |
| var17 | 0.1543   | 0.2107  | 0.1543  | -0.1612 | 0.1819  | -0.0818 | -0.0818 | -0.2417 | -0.1053 | 0.0360  | -0.1074 | -0.1685 | 0.2955  | -0.0613 | 0.0613 | 0.1406 | 1.0000 |        |  |
| var18 | 0.1385   | -0.0129 | 0.0594  | 0.0241  | -0.0528 | 0.0560  | -0.0840 | -0.0241 | 0.0209  | -0.0669 | 0.1137  | 0.1108  | 0.1137  | 0.1337  | 0.0236 | 0.1650 | 0.0641 | 1.0000 |  |

### Appendix 3 Articles used in the Cluster Analysis

- Almirall, E. and Casadesus-Masanell, R. (2010) 'Open versus closed innovation: a model of discovery and divergence', *Academy of Management Review*, Vol. 35, No. 1, pp.27–47.
- Asakawa, K., Nakamura, H., and Sawada, N. (2010) 'Firms' open innovation policies, laboratories' external collaborations, and laboratories' R&D performance', *R&D Management*, Vol. 40, No. 2, pp.109–123.
- Badawy, M.K. (2011) 'Is open innovation a field of study or a communication barrier to theory development? A perspective', *Technovation*, Vol. 31, No. 1, pp.65–67.
- Belussi, F., Sammarra, A. and Sedita, S.R. (2010) 'Learning at the boundaries in an "Open Regional Innovation System": a focus on firms' innovation strategies in the Emilia Romagna life science industry', *Research Policy*, Vol. 39, No. 6, pp.710–721.
- Bergman J., Jantunen A. and Saksä J. (2009) 'Enabling open innovation process through interactive methods: scenarios and group decision support systems', *International Journal of Innovation Management*, Vol. 13, No. 1, pp.139–156.
- Bianchi, M., Campodall'Orto, S., Frattini, F. and Vercesi, P. (2010) 'Enabling open innovation in small and medium-sized enterprises: how to find alternative applications for your technologies', *R&D Management*, Vol. 40, No. 4, pp.414–431.
- Bianchi, M., Cavaliere, A., Chiaroni, D., Frattini, F. and Chiesa, V. (2011) 'Organisational modes for open innovation in the bio-pharmaceutical industry: an exploratory analysis', *Technovation*, Vol. 31, No. 1, pp.22–33.
- Chesbrough, H.W. (2003) *Open Innovation, the new Imperative for Creating and Profiting from Technology*, Harvard Business Press, Boston, MA.
- Chesbrough, H.W. (2004) 'Managing open innovation', *Research Technology Management*, Vol. 47, No. 1, pp.23–26.
- Chesbrough, H.W. (2005) 'Open innovation: a new paradigm for understanding industrial innovation', in Chesbrough, H.W., Vanhaverbeke, W. and West, J. (Eds): *Open Innovation: Researching a New Paradigm*, Oxford University Press, Oxford.
- Chesbrough, H.W. and Appleyard, M. (2007) 'Open innovation and strategy', *California Management Review*, Vol. 50, No. 1, pp.57–76.
- Chesbrough, H.W. and Crowther, A.K. (2006) 'Beyond high tech: early adopters of open innovation in other industries', *R&D Management*, Vol. 36, No. 3, pp.229–236.
- Chesbrough, H.W. and Rosenbloom, R.S. (2002) 'The role of the business model in capturing value from innovation: evidence from Xerox corporation's technology spin-off companies', *Industrial and Corporate Change*, Vol. 11, No. 3, pp.529–555.
- Chesbrough, H.W. and Schwartz, K. (2007) 'Innovating business models with co-development partnerships', *Research-Technology Management*, Vol. 50, No. 1, pp.55–59.
- Chiaroni, D., Chiesa, V. and Frattini, F. (2010) 'Unravelling the process from closed to open innovation: evidence from mature, asset-intensive industries', *R&D Management*, Vol. 40, No. 3, pp.222–245.
- Chiaroni, D., Chiesa, V. and Frattini, F. (2011) 'The open innovation journey: how firms dynamically implement the emerging innovation management paradigm', *Technovation*, Vol. 31, No. 1, pp.34–43.
- Christensen, J.F., Olesen, M.H. and Kjær, J.S. (2005) 'The industrial dynamics of open innovation – evidence from the transformation of consumer electronics', *Research Policy*, Vol. 34, No. 10, pp.1533–1549.
- Cooke, P. (2005) 'Regionally asymmetric knowledge capabilities and open innovation exploring 'globalisation 2' – a new model of industry organisation', *Research Policy*, Vol. 34, No. 8, pp.1128–1149.
- Dahlander, L. and Gann, D.M. (2010) 'How open is innovation', *Research Policy*, Vol. 39, No. 6, pp.699–709.

- Dittrich, K. and Duysters, G. (2007) 'Networking as a means to strategy change: the case of open innovation in mobile telephony', *Journal of Product Innovation Management*, Vol. 24, No. 6, pp.510–521.
- Dodgson, M., Gann, D. and Salter, A. (2006) 'The role of technology in the shift towards open innovation: the case of Procter & Gamble', *R&D Management*, Vol. 36, No. 3, pp.333–346.
- du Chatenier, E., Verstegen, J., Biemans, H., Mulder, M. and Omta, O. (2010) 'Identification of competencies for professionals in open innovation teams', *R&D Management*, Vol. 40, No. 3, pp.271–280.
- Enkel, E., Gassmann, O. and Chesbrough, H.W. (2009) 'Open R&D and open innovation: exploring the phenomenon', *R&D Management*, Vol. 39, No. 4, pp.311–316.
- Fichter, K. (2009) 'Innovation communities: the role of networks of promoters in open innovation', *R&D Management*, Vol. 39, No. 4, pp.357–371.
- Frey, K., Luthje, C. and Haag, S. (2011) 'Whom should firms attract to open innovation platforms? The role of knowledge diversity and motivation', *Long Range Planning*, Vol. 44, Nos. 5/6, pp.397–420.
- Gassmann, O. (2006) 'Editorial – opening up the innovation process: towards an agenda', *R&D Management*, Vol. 36, No. 3, pp.223–228.
- Gassmann, O. and Enkel, E. (2004) 'Towards a theory of open innovation: three core process archetypes', *Proceedings of the R&D Management Conference (RADMA)*, pp.8–9.
- Gassmann, O., Enkel, E. and Chesbrough, H.W. (2010) 'The future of open innovation', *R&D Management*, Vol. 40, No. 3, pp.213–221.
- Henkel, J. (2006) 'Selective revealing in open innovation processes: the case of embedded Linux', *Research Policy*, Vol. 35, No. 7, pp.953–969.
- Hughes, B. and Wareham, J. (2010) 'Knowledge arbitrage in global pharma: a synthetic view of absorptive capacity and open innovation', *R&D Management*, Vol. 40, No. 3, pp.324–343.
- Huizing, K.R.E.E. (2011) 'Open innovation: state of the art and future perspectives', *Technovation*, Vol. 31, No. 1, pp.2–9.
- Huston, L. and Sakkab, N. (2006) 'Connect and develop – inside Procter & Gamble's new model for innovation', *Harvard Business Review*, March, 11p.
- Kajmakoska, B., Koeck, A.M. and Willfort, R. (2010) 'Computer-based solutions for open innovation processes', *MC&OI and the Financial Crisis – Challenge and Opportunity, 4th International Conference on Mass Customization and Personalization in Central Europe*, 22–24 September, Novi Sad, Serbia.
- Keupp, M.M. and Gassmann, O. (2009) 'Determinants and archetype users of open innovation', *R&D Management*, Vol. 39, No. 4, pp.331–341.
- Kirschbaum, R. (2005) 'Open innovation in practice', *Research-Technology Management*, Vol. 48, No. 4, pp.24–28.
- Laursen, K. and Salter, A. (2006) 'Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms', *Strategic Management Journal*, Vol. 27, No. 2, pp.131–150.
- Lazarotti, V. and Manzini, R. (2009) 'Different modes of open innovation: a theoretical framework and empirical study', *International Journal of Innovation Management*, Vol. 13, No. 4, pp.615–636.
- Lee, S., Park, G., Yoon, B. and Park, J. (2010) 'Open innovation in SMEs – an intermediate network model', *Research Policy*, Vol. 39, No. 2, pp.290–300.
- Lichtenthaler, U. (2008) 'Open innovation in practice: an analysis of strategic approaches to technology transactions', *IEEE Transactions on Engineering Management*, Vol. 55, No. 1, pp.148–157.
- Lichtenthaler, U. (2011) 'Open innovation: past research, current debates, and future directions', *Academy of Management Perspectives*, Vol. 25, No. 1, pp.75–93.

- Lichtenthaler, U. and Ernst, H. (2009) 'Opening up the innovation process: the role of technology aggressiveness', *R&D Management*, Vol. 39, No. 1, pp.38–54.
- Lichtenthaler, U. and Lichtenthaler, E. (2009) 'A capability-based framework for open innovation: complementing absorptive capacity', *Journal of Management Studies*, Vol. 46, No. 8, pp.1315–1338.
- Mortara, L. and Minshall, T. (2011) 'How do large multinational companies implement open innovation?', *Technovation*, Vol. 31, Nos. 10/11, pp.586–597.
- Parida, V., Westerberg, M. and Frishammar, J. (2011) *Effect of Open Innovation Practices on SMEs Innovative Performance: An Empirical Study*. Available online at: <http://www.icsb2011.org/>
- Poot, T., Faems, D. and Vanhaverbeke, W. (2009) 'Toward a dynamic perspective on open innovation: a longitudinal assessment of the adoption of internal and external innovation strategies in the Netherlands', *International Journal of Innovation Management*, Vol. 13, No. 2, pp.177–200.
- Rahman, H. and Ramos, I. (2010) 'Open innovation in SMEs: from closed boundaries to networked paradigm', *Issues in Informing Science and Information Technology*, Vol. 7, pp.471–487.
- Rohrbeck, R., Holzle, K. and Gemunden, H.G. (2009) 'Opening up for competitive advantage – how Deutsche Telekom creates an open innovation ecosystem', *R&D Management*, Vol. 39, No. 4, pp.420–430.
- Santoro, R. and Conte, M. (2009) 'Living labs in open innovation functional regions', *ESoCE-Net*. Available online at: <http://ami-communities.net/pub/bscw.cgi/d441945/>
- Sarkar, S. and Costa, A.I.A. (2008) 'Dynamics of open innovation in the food industry', *Trends in Food Science & Technology*, Vol. 19, No. 11, pp.574–580.
- Schaffers, H. and Santoro, R. (2010) 'Living labs and open innovation policy in regions for the benefit of SMEs', *CO-LLABS Workshop*, 27th January, Brussels, Available online at: <http://w.ami-communities.eu/pub/bscw.cgi/d506128/>
- Serhan, I., Albers, A. and Miller, S. (2010) 'Open innovation in the automotive industry', *R&D Management*, Vol. 40, No. 3, pp.246–255.
- Sieg, J.H., Wallin, M.W. and von Krogh, G. (2010) 'Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry', *R&D Management*, Vol. 40, No. 3, pp.281–291.
- Spithoven, A., Clarysse, B. and Knockaert, M. (2011) 'Building absorptive capacity to organise inbound open innovation in traditional industries', *Technovation*, Vol. 31, No. 1, pp.10–21.
- Teirlinck, P. and Spithoven, A. (2008) 'The spatial organization of innovation: open innovation, external knowledge relations and urban structure', *Regional Studies*, Vol. 42, No. 5, pp.689–704.
- Trott, P. and Hartmann, D. (2009) 'Why "Open Innovation" is old wine in new bottles', *International Journal of Innovation Management*, Vol. 13, No. 4, pp.715–736.
- van de Vrande, V., de Jong, J.P.J., Vanhaverbeke, W. and de Rochemont, M. (2009) 'Open innovation in SMEs: trends, motives and management challenges', *Technovation*, Vol. 29, Nos. 6/7, pp.423–437.
- Van der Meer, H. (2007) 'Open innovation – the Dutch treat: challenges in thinking in business models', *Creativity and Innovation Management*, Vol. 16, No. 2, pp.192–202.
- Vanhaverbeke, W., Van de Vrande, V. and Chesbrough, H.W. (2008) 'Understanding the advantages of open innovation practices in corporate venturing in terms of real options', *Creativity and Innovation Management*, Vol. 17, No. 4, pp.251–258.
- West, J. and Gallagher, S. (2006) 'Challenges of open innovation: the paradox of firm investment in open-source software', *R&D Management*, Vol. 36, No. 3, pp.319–331.
- West, J. and Lakhani, K.R. (2008) 'Getting clear about communities in open innovation', *Industry & Innovation*, Vol. 15, No. 2, pp.223–231.