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Accounting for Open Innovation: Evidences from the Bio-Pharmaceutical Industry

Michelino, F., Lamberti, E., Cammarano, A. and Caputo, M.

***Abstract*—The paper provides an accounting framework for measuring the openness degree of innovation processes of companies through the analysis of annual reports. Four openness dimensions are defined - outbound, inbound, economic and financial - based on revenues and costs from open innovation activities and investments and divestments of innovation-related intangibles occurring in either separate acquisitions or business combinations. Throughout the definition of the methodological framework a number of examples referring to bio-pharmaceutical companies will be reported in order to illustrate the specific items disclosures in financial statements. This will allow to underline not only the differences that raise from adopting either IFRS or US GAAP standards, but also, within the same standards framework, the variety of both disclosing methods and terminology. The model is then applied to a sample of 138 R&D intense companies operating in the bio-pharmaceutical industry.**
The paper contributes to the research concerning innovation metrics, by providing an accounting framework for the measurement of what is traded in the innovation market: research and development, intellectual property and know-how.

***Keywords*—innovation metrics, accounting for intangibles, open innovation, annual report, bio-pharmaceutical industry.**

I. Introduction

The term open innovation (OI) was coined in 2003 by Chesbrough [1], who described how companies have shifted from the so-called closed innovation processes towards a new, open way of innovating. Firms may open up their innovation processes on two dimensions, namely inbound and outbound. While the former refers to the acquisition of external technology in exploration processes, the latter describes the outward transfer of technology in exploitation processes. Different studies focused on the development of measurement tools to help firms in managing open innovation. Yet, a comprehensive measure for the degree of openness in innovation processes is lacking, as pointed out by Chesbrough et al. [2].

Francesca Michelino
Antonello Cammarano
Mauro Caputo
Department of Industrial Engineering, University of Salerno
Italy

Emilia Lamberti
Department of Enterprise Engineering, University of Rome "Tor Vergata"
Italy

Thus, the purpose of this paper is to contribute to the existing research on open innovation, by providing a methodology for measuring it. The research questions we aim at answering are: 1) how and to what extent a company can be defined open in its innovation processes, and 2) which are the most suitable indicators for defining the openness degree of a firm. In order to answer to such questions we developed a framework for measuring the degree of openness and defining the nature of open innovation transactions based on the analysis of companies financial statements. Basically, we define open innovation transactions as either economic or financial, depending on whether they affect the income statement or the balance sheet of a company.
The research provides a contribution to the understanding of the OI phenomenon, by describing how companies implement such paradigm from a quantitative point of view, related to objective data gathered from financial statements.
The paper is structured as follows: after a brief literature review on the measurement of innovation, our framework is presented and supported by some evidences from bio-pharmaceutical companies financial statements. The model is then applied to a sample of 138 pharmaceutical and biotechnology companies ranked by their investment in research and development (R&D), according to *The 2011 EU Industrial R&D Investment Scoreboard* [3]. Discussions will point out the differences that raise from adopting either IFRS or US GAAP standards, but also, within the same standards framework, the variety of both disclosing methods and terminology. Limitations and future research will close the work.

II. Literature Review

In order to measure the openness degree of innovation processes of companies, it is necessary to firstly analyze the measure of innovation as a whole. Different perspectives can be adopted to measure innovation: we focus on the distinction between accounting vs. non-accounting indicators.
Accounting metrics can be derived from the financial statement of companies. The most extensively used proxy of innovation effort is no doubt R&D expenditure [4] [5] [6] [7], which is not only used in literature, but also by government entities. A very important role is also played by the value of intangible assets as an investment in innovation capacity [8] [9] [10]: the variation in intangible assets between two periods can be considered as a proxy for current innovation effort [11]. Overall company profitability, incremental revenue from innovation [12] and earnings from the sale of new products [13] [14] are also examples of innovation accounting metrics which focus on innovation results rather than innovation efforts.

Non-accounting indicators can assume very disparate forms: customer satisfaction [12], the uniqueness or novelty of products [15], the number of innovations introduced [13] [14], the number of patents [16] and the ability of the firm of launching new products in a short time [17] are only some of the non-accounting indicators recognized in literature.
Very often, for each non-accounting indicator it is possible to identify a corresponding accounting one (e.g. earnings from the sale of new products and number of new products introduced).
Since our framework is based on accounting proxies of innovation, we focus on literature contributions analyzing accounting for R&D and intangibles [18] [19] [20] [21]. A particular attention is paid in literature to the differences in the treatment of intangible assets between countries - which can seriously limit the comparability of financial statements in an international context [22] [23]. A second area of interest is the capitalization of internally generated intangibles, that, depending on the standards, may be mandatory or optional [21]. Obviously, treating intangibles as either an investment or an expenditure brings out different results, because assets are supposed to provide economic returns even in the future, while expenditure affects only a particular time period [24].
Although a significant theoretical attention has been given to intangibles in the field of financial accounting, few studies are reported in literature on the measurement of innovation based on financial statements and, consequently, on the ability of accounting standards to accurately reflect the innovation activities of companies. Two papers give the most significant contributions. Cañibano et al. [25] focus on the information provided by financial reports, in the attempt of assessing the total innovative effort of companies. The authors point out that financial statements could provide a sound basis for the measurement of innovation if they included more relevant information on the intangible determinants of the companies value. In fact, in most countries, accounting standards prescribe the immediate expensing of the amounts invested in intangible activities and, thus, a significant part of the intangible investments made is absent from the balance sheet of the company. Therefore, in industries in which knowledge is the main source of future benefits, the information provided by financial statements may have little or no relevance at all, as investments in R&D and other innovative activities are not appropriately reflected in them: as a matter of fact, they are either fully expensed as incurred, or amortized over short periods of time. Michalisin [26], by conducting a content analysis of annual report text (ART) data, shows that there is a positive relationship between ART emphasis on innovativeness and two independent measures of innovativeness: the number of trademarks the firm generates and the firm reputation for innovativeness. Therefore, the author underlines that ART data are valid sources of information about firm innovativeness, despite there is the possibility for managers to manipulate them in opportunistic ways and despite the fact that independent auditors provide little, if any, assurance that such data are accurate.
After an open perspective, different studies focused on the development of metrics for the measurement of innovation openness, and the same distinction between accounting vs. non-accounting indicators can be observed.
Accounting metrics for OI include the percentage of sales from external technologies, the percentage of net income generated from proprietary technology licensed to other firms [27] and the investments per year in collaborative R&D [28]. Conversely, the number of projects offered to external parties for further development [27], the number of patents as a result of collaborative projects, the number of collaborative projects in the company per year [28] and the open innovation climate measure [29] are some examples of non-accounting indicators.
Yet, as pointed out by Chesbrough et al. [2], a comprehensive measure for the degree of openness is still lacking. This paper aims at filling such gap, by identifying the openness degree of a company through accounting data. In line with previous literature [25], we focus on innovation-related intangibles disclosed in the balance sheet, but we also introduce the economic dimension of innovation, by measuring costs and revenues from open innovation, disclosed in the income statement. Introducing such dimension allows to partially overcome the problems deriving from the unequal treatment of innovation-related intangibles in different countries.

III. An Accounting Framework for the Measurement of Openness

The accounting framework we suggest is intended to provide a comprehensive measure of open innovation through the quantification of the economic and financial flows characterizing the transactions in the innovation market.
Open innovation transactions can be divided in inbound and outbound ones, the former characterized by innovation-related costs and intangible investments, the latter by innovation-related revenues and intangible divestments (Fig. 1).

In what follows each of the four items will be analyzed by providing examples from annual reports of bio-pharmaceutical companies: the industry was selected given (1) its high R&D intensity and (2) the high relevance OI has in it [30].

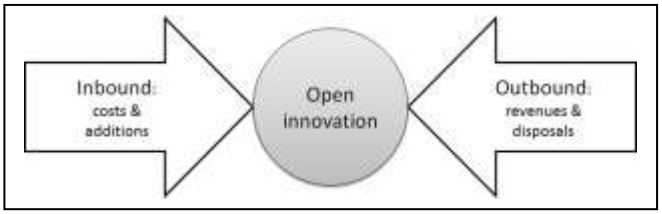

Figure 1. An accounting framework for open innovation.

As to costs, the starting point of our analysis was the research and development cost, which is generally explicitly disclosed in the income statement, when defined by destination. Yet, such figure is not suitable to define the openness effort of a company, for a number of reasons.
First, R&D costs, as disclosed in the income statement, include internal costs, i.e. costs carried for the use of internal resources dedicated to internal R&D activities of the company.

Given that such costs do not have an open nature, they have to be excluded from our analysis. Second, R&D costs also include amortization of capitalized costs which have, once again, only an internal nature. Yet, while excluding amortization is generally a simple matter, since it is disclosed in the notes to the financial statements, the definition of the cost generated by internal resources for internal activities is quite tricky, since even a definition of costs by nature does not explicitly separate internal and external costs: for example, R&D staff costs can refer to costs born for both those employees who work for internal development projects, and for those who are dedicated to external projects for third parties.

Thus, in order to quantify the open nature of R&D costs, rather than subtracting closed items from the total R&D costs, we have to add only items that are definitely open, which can be broadly divided into three categories: 1) collaborative development costs, which refer to joint development projects with third parties[1]; 2) contract development costs, which refer to development projects carried for the company by third parties, generally under a long-term agreement[2]; 3) acquisition of R&D services, which refer to a more spot behavior than the previous one[3]. Actually, R&D costs are not the only innovation-related costs, given that a significant role in open innovation is played by intellectual property (IP) costs, deriving from in-licensing activities: thus, we included in our framework 4) in-licensing costs and royalty fees paid[4].

Obviously, being our perspective open, no costs carried by the company to internally develop intellectual property rights that will be used by the company itself were included in the analysis.

The analysis of open innovation revenues is very similar to that of costs, since they include: 1) collaborative development revenues; 2) contract development revenues; 3) sale of R&D services; 4) out-licensing revenues and royalty fees received. Yet, within revenues, a further item has to be considered which does not have a counterpart in costs: 5) grants received by the company for R&D activities, provided by the government under the form of either research funding or tax credit[5]. Actually, we included grants as open revenues by considering the government as an entity that remunerates the company for its innovation efforts, even if it is not interested to come into possession of the outcomes of such innovation. As a matter of fact, differently from a private entity, the government aims at the development of innovation for the community, rather than for itself.

Within collaborative revenues, a particular consideration has to be done as to the development partners reimbursements: as a matter of fact, such item is always disclosed in the annual reports as an offset from R&D costs[6]. Being a cost that the company bore for the development of a partner's program and that was reimbursed by the partner itself, we considered it as both an open revenue and an open cost for the company.

Our analysis is not limited to only revenues and costs, acknowledging that transactions in the innovation market can also come under the form of investments and divestments of intangibles which occur in either separate acquisition or business combinations, mergers and acquisitions (BCMAs). Actually, not all the intangibles have to be considered, since only some of them are usually traded in the innovation market. In particular, we defined three broad classes of innovation-related intangibles[7]: 1) R&D: development costs and in process research and development (IPR&D); 2) IP: licenses and patents, trademarks and product rights, and technology; 3) goodwill.

The first two categories have a clear connotation within innovation, while the innovative nature of goodwill can be questionable. Given the definition itself of goodwill as "future economic benefits arising from assets that are not capable of being individually identified and separately recognized" (IFRS 3), we think that it can be identified with the skill, the know-how, the technical and organizational expertise of the workforce. After this perspective, goodwill can be defined as a proxy of the know-how transferred from the acquired company to the purchasing one. This is consistent with most of the definitions of goodwill found in the annual reports of companies[8], as well as with the intangibles tri-partition proposed in literature [21]. When a specific reference was made to an acquisition which, rather than being related to innovation, copes with the purchase of distribution and commercial channels[9], we did not include the value of goodwill in the measure of open innovation.

[1] *"In October 2006, the Company entered into a license and collaboration agreement with Bayer HealthCare for the global development and commercialization outside the United States of EYLEA®.… In 2011, 2010, and 2009, the Company recognized as additional research and development expense $47.8 million, $48.9 million, and $37.7 million, respectively, of EYLEA® development expenses that the Company was obligated to reimburse to Bayer HealthCare."* [31].

[2] *"Milestone and upfront payments to our collaboration partners, included within research and development expense, totaled $45.9 million, $68.9 million and $151.5 million for 2011, 2010 and 2009, respectively."* [32].

[3] *"Preclinical and clinical trials costs outsourced to subcontractors and expensed in the profit and loss mainly refer to CB-03-01, CB-17-01 Methylene Blue MMX® and CB-01-17: they decreased from EUR 3,414 thousand to EUR 2,088 thousand."* [33].

[4] "*During 2011, 2010 and 2009, the Company recorded $9.6 million, $9.7 million, and $9.2 million, respectively, in royalty costs related to its various license agreements, which amounts are included in Cost of product sales on the Company's consolidated statements of income."* [34].

[5] *"During the financial year the Novozymes Group has received grants of DKK 24 million for research and development, compared to DKK 33 million in 2010. Government grants are recognized under Other operating income, net. Government grants includes grants from the EU for various research projects and from the US Department of Energy for biomass."* [35].

[6] "*Research and development and sales and marketing expenses are shared equally with Elan and the reimbursement of these expenses is recorded as reductions of the respective expense categories. During the years ended December 31, 2011, 2010, and 2009, we recorded $47.5 million, $49.8 million and $25.3 million, respectively, as reductions of research and development expense for reimbursements from Elan."* [32].

[7] See separate additions of R&D, patents and trademarks, and additions through business combination of goodwill, patents and brands in [36].

[8] 1) "*Goodwill of 5.2 million EUR arises from expected synergy benefits in different areas of drug development as well as from the competent personnel and the integration of functions. Expected synergy benefits will be gained from the possibility to create new drug development projects corresponding to the needs of international pharmaceuticals companies and from the possibility to utilize new knowledge and new technologies for the development of the existing businesses."* [37]; 2) *"The goodwill recognized is attributable primarily to strategic and synergistic opportunities across the entire urology spectrum, expected corporate synergies, the assembled workforce of AMS and other factors."* [38]; 3) *"Management believes that the goodwill mainly represents the synergies expected from combining our research and development operations as well as acquiring Calistoga's assembled workforce and other intangible assets that do not qualify for separate recognition."* [39].

[9] "*On July 1, 2011, the Company terminated its existing distributor agreement in South Africa and completed the purchase from its distributor of all assets related to the selling*

Being interested in what is actually traded between the company and third parties, we excluded all the additions that come from the capitalization of either development costs[10] or internally developed intellectual property rights. Further, none of the following internal accounting adjustments was included:

- impairment charges of IPR&D, e.g. as a consequence of completion or abandonment of R&D projects[11];
- impairment charges of product rights, e.g. related to a marketed product[12];
- impairment charges of goodwill[13];
- IPR&D reclassifications to other intangibles, e.g. IPR&D reclassified to product rights upon receipt of marketing approval[14];
- IPR&D reclassifications from indefinite-lived to finite-lived intangibles[15];
- product rights reclassifications to assets held for sale[16];
- any currency translation adjustment[17].

Note that, in order to have a likely value of the returns from what is divested, disposals are considered net of amortization, but we were not able to include the gains and losses because they were reported as a unique value comprising all intangibles divested and not only the one we were interested in [45] or even both intangible and tangible assets [46]. On the contrary, additions are considered at their gross value, since we are interested in defining the total value of the effort sustained by the company for acquiring new intangibles.

From all the previous considerations, a comprehensive measure of the companies openness degree is defined by both economic and financial metrics, as reported in Table 1.

TABLE I. MEASURES OF OPEN INNOVATION

Revenues and Costs:	Disposals and Additions:
• from collaborative development • from contract development • from sales/acquisitions of R&D services • from grants • from out-/in-licensing	• of development costs and IPR&D • of licenses and patents • of trademarks and product rights • of technology • of goodwill

A. *Ratios for the Measurement of Openness in the Bio-Pharmaceutical Industry*

According to our framework, open innovation is a four-dimensional phenomenon, since it can be defined an outbound vs. inbound nature of the innovation process and an economic vs. financial nature of the transaction. On one hand, outbound processes are characterized by revenues and disposals, inbound ones by costs and additions; on the other hand, economic transactions are characterized by revenues and costs, financial ones by disposals and additions. Thus, in order to define the degree and the nature of open innovation, four basic indicators can be calculated:

$$\text{Revenue ratio}=\text{Revenues from OI}/\text{Total revenues}, \quad (1)$$

$$\text{Cost ratio}=\text{Costs from OI}/\text{Total R\&D and IP costs}, \quad (2)$$

$$\text{Disposal ratio}=\text{Disposals of intangibles}/\text{Total intangibles}, \quad (3)$$

$$\text{Addition ratio}=\text{Additions of intangibles}/\text{Total intangibles}. \quad (4)$$

Note that while *revenue* and *cost ratios* - by comparing what derives from open innovation in the year to total values of the year itself - have a static nature, *disposal* and *addition ratios* provide a dynamic description, since they show how the stock of intangibles is reduced or increased for the effect of open innovation. The four ratios can be combined two by two in order to obtain four second-level ratios:

$$\text{Outbound ratio}=[(\text{Revenue ratio}^2+\text{Disposal ratio}^2)/2]^{1/2}, \quad (5)$$

$$\text{Inbound ratio}=[(\text{Cost ratio}^2+\text{Addition ratio}^2)/2]^{1/2}, \quad (6)$$

$$\text{Economic ratio}=[(\text{Revenue ratio}^2+\text{Cost ratio}^2)/2]^{1/2}, \quad (7)$$

$$\text{Financial ratio}=[(\text{Disposal ratio}^2+\text{Addition ratio}^2)/2]^{1/2}. \quad (8)$$

Further, a total measure of openness can be defined by further combining either outbound and inbound ratios or economic and financial ones:

$$\text{Openness ratio}=[(\text{Outbound ratio}^2+\text{Inbound ratio}^2)/2]^{1/2}= =[(\text{Economic ratio}^2+\text{Financial ratio}^2)/2]^{1/2}=[(\text{Revenue ratio}^2+\text{Cost ratio}^2+\text{Disposal ratio}^2+\text{Addition ratio}^2)/4]^{1/2}. \quad (9)$$

and distribution of the Company's products in South Africa… The purchase of the commercial assets was accounted for as a business combination… The Company acquired assets with a fair value of $11.1 million, consisting of inventories of $5.6 million, an intangible asset of $3.9 million and goodwill of $1.6 million, and assumed accrued liabilities of $0.3 million." [40].

[10] See addition of internally developed R&D in [36].

[11] *"During 2011, the Company recorded IPR&D impairment charges of $587 million primarily for pipeline programs that were abandoned and determined to have no alternative use, as well as for expected delays in the launch timing or changes in the cash flow assumptions for certain compounds."* [41].

[12] "*During 2011, the Company recorded an impairment charge of $118 million related to a marketed product."* [41].

[13] *"Goodwill is tested for impairment on an annual basis and between annual tests if the Company becomes aware of any events occurring or changes in circumstances that would indicate a reduction in the fair value of the goodwill below its carrying amount… During the first quarter of 2011, the Company recorded a reduction to goodwill of $0.3 million due to the adjustment of the original assumptions related to the contingent acquisition consideration payable for the acquisition of LEAD."* [42].

[14] *"During the year ended December 31, 2011, approximately $4.3 million was reclassified from acquired IPR&D to product rights and licenses."* [43].

[15] "*The $2.9 million purchased IPR&D project from CV Therapeutics was completed and reclassified as a finite-lived intangible asset in 2011, and is currently being amortized over its estimated useful life."* [39].

[16] *"On February 3, 2012, the Company sold the IDP-111 and 5-FU products to Mylan Pharmaceuticals, Inc… In connection with the divestitures of IDP-111 and 5-FU, the Company reclassified from intangible assets $54.4 million and $14.8 million of carrying value related to these products, respectively, to assets held for sale in the consolidated balance sheet as of December 31, 2011."* [44].

[17] See exchange difference costs and currency exchange differences depreciations in [36].

All the ratios range from zero to one, corresponding, respectively, to a totally closed and a totally open behavior.
Each company can be represented in the four-dimensional space as a point, whose distance from the origin of the axes is proportional to the openness ratio (Fig. 2): if we project the point in the revenue-cost plane, we can identify the economic openness; in the same way, the projections in the disposal-addition, revenue-disposal and cost-addition planes point out the financial, outbound and inbound dimensions of openness respectively.

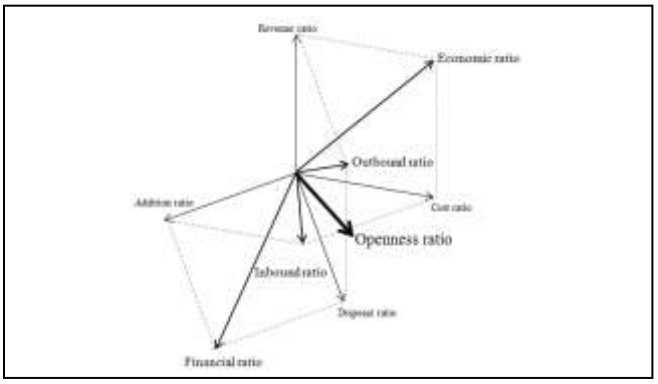

Figure 2. The four-dimensional space of open innovation.

IV. Application of the Framework to the Bio-pharmaceutical Industry

We calculated the ratios for a sample of 138 bio-pharmaceutical companies - ranked by their investment in R&D according to *The 2011 EU Industrial R&D Investment Scoreboard* [3] - and we analyzed their 2011 annual reports[18]. The Scoreboard reports 229 bio-pharmaceutical companies, but 85 companies were excluded because their annual reports from the internet, were either incomplete, with no notes to the consolidated balance sheet and income statement, or not filling IFRS or US GAAP standards. Further, six companies were excluded since their 2011 annual reports were not available on the internet, in most cases because the company was acquired during 2011.
The final sample consists of 84 European companies and 54 non-European ones, 70 pharmaceutical companies and 68 biotechnology ones.

In order to understand the relationships between the four dimensions of openness, we performed both correlation (Tab. 2) and regression analysis (Fig. 3).

Two significant outcomes can be pointed out:

- outbound processes are mostly characterized by economic transactions, inbound processes by financial ones;
- openness degree is more linked to outbound-economic transactions than to inbound-financial ones.

Thus, even if open innovation is a four-dimensional phenomenon, it can be well approximated by only two dimensions, at least in the bio-pharmaceutical industry, where most of outbound transactions have an economic nature (e.g. revenues from R&D collaboration) and most of inbound exchanges are financial (additions of intangibles, in either separate acquisitions or business combinations).

A particular consideration has to be done as to business combinations: even if it is clear that BCMAs allow companies to acquire research and development, intellectual property and know-how from outside, it may be questionable whether it is correct to consider it an "open" behavior. Actually, the industry we investigated is characterized by big pharmaceutical companies acquiring small biotech firms. BCMAs can be considered as hierarchy mechanisms but, if the innovation market were perfect, it would be possible to exchange research and development, intellectual property and know-how in separate acquisitions, with no need of BCMAs. Yet, in order to evaluate all the ways in which a company can incorporate innovation, business combinations cannot be neglected. Since most of the additions, for our sample, occur in business combinations[19], we can conclude that while outbound activities are purely open, inbound ones are still linked to a hierarchy mechanism.

TABLE II. PEARSON'S CORRELATION COEFFICIENTS

	Openness ratio	**Outbound ratio**	**Inbound ratio**	**Economic ratio**	**Financial ratio**
Openness ratio	1	0.819(**)	0.504(**)	0.893(**)	0.362(**)
Outbound ratio		1	-0.039	0.930(**)	-0.175
Inbound ratio			1	0.192(*)	0.811(**)
Economic ratio				1	-0.084
Financial ratio					1

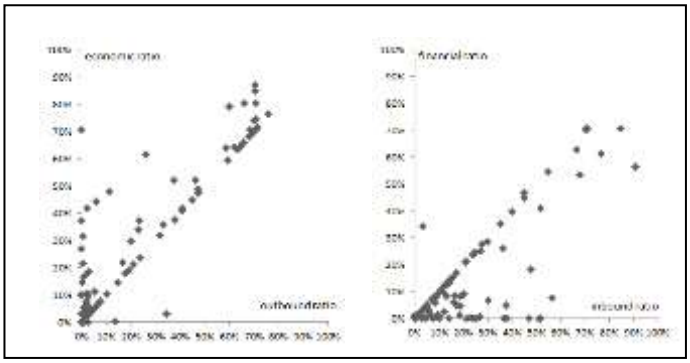

Figure 3. Scatter plots from regression of (a) economic and outbound ratios[20] and (b) financial and inbound ratios[21].

[18] Most of the annual reports refers to the year ended on the 31st December: in this case the 2011 annual report was considered. When the reports refer to the year ended before 30th June, the 2011-2012 annual report was considered, otherwise the 2010-2011 one. All data were converted in euro by using the exchange rates as of 31 December 2011.

[19] 88,8% of total R&D, IP and goodwill additions derive from a BCMA.
[20] Adjusted R square = 0.863; standardized beta = 0.930; t = 29.413 (sig. = 0.000).
[21] Adjusted R square = 0.656; standardized beta = 0.811; t = 15.457 (sig. = 0.000).

V. Discussions

The calculation of the indexes suggested is not trivial, since - despite accounting standards - annual reports can be quite different one from the other in their form.

The first evidence from the application to the bio-pharmaceutical industry is the variety of terminology used within different annual reports to define the same conceptual item.

Further, the disclosing methods can be quite various as well. As to revenues, in some cases those deriving from open innovation are directly disclosed in the income statement exhibited separately from net sales as other income [47], but in most cases revenues composition has to be detected in the notes [48]. Research and development cost composition is never disclosed directly in the income statement and the relative note has to be looked up [49]. Further, some innovation-related costs - such as collaboration profit-sharing or acquired in-process research and development [32] - can be recorded separately from R&D costs in the income statement. In particular, royalties and license fees are disclosed as operating expenses and can be reported as a separate item [50] or included in cost of sales [51] or in R&D costs [48]. Obviously, the denominator of the cost ratio was built by considering all the costs related to the innovation process, even if they were not included in the R&D costs. Furthermore, a particular consideration has to be done as to offsets. We already discussed in §III the offset of R&D costs with development partners reimbursements; other cost offsets occur with research grants[22] and net sales offsets occur with royalties payments[23]. In all these cases we considered the gross value of either R&D costs or revenues as the denominator of the ratios.

As regards disposals and additions of intangibles, two different approaches are used by IFRS and US GAAP standards. While the former explicitly discloses all additions and disposals - internal, in separate acquisitions and in BCMAs - in the note to intangibles [36], the latter only discloses additions from BCMAs in the notes regarding business combinations [53]. Thus, in order to obtain the additions and disposals of separately acquired intangibles, the difference between the gross value at the end of the year, the gross value at the beginning of the year, the value of BCMA additions and any impairment charge or reclassification has to be performed. However, this assessment is approximate, because if the difference is positive, we record a separate addition but some separate disposals of lower value might have occurred and vice versa. Moreover, while in IFRS reports we can detect the value of disposals net of amortization, this is not possible with US GAAP reports.

As to the application of the framework to the bio-pharmaceutical industry, correlation results show that: 1) the openness degree of innovation processes of companies is more related to outbound-economic transactions than to inbound-financial ones; 2) outbound processes are mostly characterized by economic transactions, inbound processes by financial ones. The last preposition is also confirmed by regression analysis. Thus, even if open innovation is a four-dimensional phenomenon, it can be well approximated by only two dimensions, at least in the bio-pharmaceutical industry.

VI. Conclusions

In order to measure the openness degree of innovation processes of companies, it is necessary to firstly analyze the measure of innovation as a whole. The most extensively used proxy of innovation effort is no doubt R&D expenditure, but a very important role is also played by the value of intangible assets. Despite the huge interest accounting for and reporting R&D and intangible assets has raised in literature, few studies are reported on the measurement of innovation based on financial statements and, consequently, on the ability of accounting standards to accurately reflect the innovation activities of companies.

Therefore, the aim of this paper is to fill such gap by providing an accounting framework for measuring the degree of openness in companies innovation processes. The work is based on the analysis of annual reports, defining economic and financial flows related to open innovation transactions: innovation-related costs and revenues and additions and disposals of intangibles.

Some limitations will guide our future research. First, after an economic perspective we compare revenues and costs referring to the same fiscal year, while the financial ratio compares the variation in the year with the cumulative asset value. Thus, the value of the indicator in a year suffers from the values added or disposed in the previous years. Given the long depreciation period of some intangibles, when substantial acquisitions are made in a year, the denominator of the ratio increases for the following years, thus underestimating the value of the indicator. As a consequence, the financial dimension of open innovation is reliable only if calculated over a long period of time, equal or greater than the mean depreciation period of intangibles. Since our application was limited to one year, we obtained a reliable measure of the economic dimension of openness, while future research will be addressed to a longitudinal study in order to better evaluate the financial one.

Second, our framework gives a good description of open innovation in the bio-pharmaceutical industry, but we might have undervaluated some accounting issues concerning other R&D intense industries - such as technology hardware and equipment or automobiles and parts. A widening to other industries might lead to the definition of industry-specific accounting frameworks for open innovation.

[22] *"As of December 2011, the company has netted the research and development expenses for an amount equal to EUR 449 (2010: EUR 559) of which EUR 186 (2010: EUR 443) refers to a programme granted by the Italian government's (M.I.U.R.) and EUR 263 (2010: EUR 116) refers to other minor granted projects."* [52].

[23] *"Royalties were recorded as a reduction to net sales due to the nature of the license agreement and the characteristics of the license involvement by Hind in Lidoderm®…During 2011, 2010 and 2009, we recorded $77.9 million, $86.8 million and $84.9 million for these royalties to Hind, respectively, which we recorded as a reduction to net sales."* [38].

References

[1] H. W. Chesbrough, Open innovation: The new imperative for creating and profiting from technology. Boston: Harvard Business School Press, 2003.

[2] H. W. Chesbrough, W. Vanhaverbeke, and J. West, Open Innovation: Researching a New Paradigm. Oxford: Oxford University Press, 2006.

[3] JRC, The 2011 EU Industrial R&D Investment Scoreboard. Joint Research Centre of the European Commission, 2011.

[4] H. R. Greve, "A behavioral theory of R&D expenditures and innovations: evidence from shipbuilding," Academy of Management Journal, vol. 46, pp. 685–702, 2003.

[5] P. Hemert, and P. Nijkamp, "Knowledge investments, business R&D and innovativeness of countries: a qualitative meta-analytic comparison," Technological Forecasting and Social Change, vol. 77, pp. 369–384, 2010.

[6] T. Koc, and C. Ceylan, "Factors impacting the innovative capacity in large-scale companies," Technovation, vol. 27, pp. 105–114, 2007.

[7] J. A. Leonard, and C. Waldman, "An empirical model of the sources of innovation in the U.S. manufacturing sector," Business Economics, vol. 42, pp. 33–45, 2007.

[8] C. Corrado, C. Hulten, and D. Sichel, Intangible Capital and Economic Growth. Cambridge: National Bureau of Economic Research, 2006.

[9] B. Lev, Intangibles: Management, Measurement, and Reporting. Washington, DC: Brookings Institution Press, 2001.

[10] L. Nakumura, "What is the U.S. gross investment in intangibles? (At least) one trillion dollars a year!," Federal Reserve Bank of Philadelphia–Working Paper, 2001.

[11] M. Rogers, "The definition and measurement of innovation," Melbourne Institute–Working Paper no. 10/98, 1998.

[12] BCG, Measuring Innovation 2009: The Need for Action. The Boston Consulting Group, 2009.

[13] H. Nystrom, Technological and Market Innovation: Strategies for Product and Company Development. Chichester: John Wiley and Sons, 1990.

[14] G. Roehrich, "Consumer innovativeness: concepts and measurement," Journal of Business Research, vol. 57, pp. 671–677, 2004.

[15] A. Ali, R. Krapfel, and D. LaBahn, "Product innovativeness and entry strategy: impact on cycle time and break-even time," Journal of Product Innovation Management, vol. 12, pp. 54–69, 1995.

[16] T. Brenner, and S. Greif, "The dependence of innovativeness on the local firm population – an empirical study of German patents," Industry and Innovation, vol. 13, pp. 21–39, 2006.

[17] H. T. Hurt, K. Joseph, and C. D. Cook, "Scales for the measurement of innovativeness," Human Communication Research, vol. 4, pp. 58–65, 1977.

[18] N. E. J. Høegh-Krohn, and K. H. Knivsflå, "Accounting for Intangible Assets in Scandinavia, the UK, the US, and by the IASC: Challenges and a Solution," The International Journal of Accounting, vol. 35, pp. 243–265, 2000.

[19] S. Penman, "Accounting for intangible assets: There is also an income statement," Abacus, vol. 45, pp. 359–371, 2009.

[20] L. Pozza, A. Prencipe, and G. Markarian, "Capitalization of R&D costs and earnings management: Evidence from Italian listed companies," International Journal of Accounting, vol. 43, pp. 246–267, 2008.

[21] H. Stolowy, and A. Jeny-Cazavan, "International accounting disharmony: the case of intangibles," Accounting, Auditing and Accountability Journal, vol. 14, pp. 477–497, 2001.

[22] R. Brunovs, and R. J. Kirsh, "Goodwill accounting in selected countries and the harmonization of international accounting standards," Abacus, vol. 27, pp. 135–161, 1991.

[23] E. N. Emenyonu, and S. J. Gray, "EC accounting harmonization: an empirical study of measurement practices in France, Germany and the UK," Accounting and Business Research, vol. 23, pp. 49–58, 1992.

[24] A. Gupta, "A study of metrics and measures to measure innovation at firm level and at national level," IMRI (Institut pour le Management de la Recherche et de l'Innovation)–Working paper, 2009.

[25] L. Cañibano, M. García-Ayuso, and M. P. Sánchez, "Shortcomings in the measurement of innovation: Implications for Accounting standard setting," Journal of Management and Governance, vol. 4, pp. 319–342, 2000.

[26] M. D. Michalisin, "Validity of annual report assertions about innovativeness: An empirical investigation," Journal of Business Research, vol. 53, pp. 151–161, 2001.

[27] H. W. Chesbrough, "Managing Open Innovation," Research-Technology Management, vol. 47, pp. 23–26, 2004.

[28] A. Al-Ashaab, M. Flores, A. Doultsinou, and A. Magyar, "A Balanced Scorecard for Measuring the Impact of Industry-University Collaboration," Production Planning & Control, vol. 22, pp. 554–570, 2011.

[29] B. Remneland-Wikhamn, and W. Wikhamn, "Open Innovation Climate Measure: The introduction of a validated scale," Creativity and Innovation Management, vol. 20, pp. 284–295, 2011.

[30] G. P. Pisano, Science Business: the Promise, the Reality, and the Future of Biotech. Boston: Harvard Business School Press, 2006.

[31] Regeneron Pharmaceuticals Inc., Annual report for the fiscal year ended: December 31, 2011, p. F-19 (form 10-K).

[32] Biogen Idec Inc., Annual report for the fiscal year ended: December 31, 2011, p. 40, p. F-48, p. F-2 (form 10-K).

[33] Cosmo Pharmaceuticals, Annual Report as of 31 December 2011, p. 70.

[34] Gen-Probe Incorporated, Annual report for the fiscal year ended: December 31, 2011, p. F-42 (form 10-K).

[35] Novozymes, Annual report for the financial year 1 January to 31 December 2011, p. 83.

[36] Omega Pharma, Annual report on 31 December 2011, p. 45.

[37] Biotie Therapies, Financial statements for January-December 2011, p. 24.

[38] Endo Pharmaceuticals Holdings Inc., Annual report for the fiscal year ended: December 31, 2011, p. 113, p. F-52 (form 10-K).

[39] Gilead Sciences Inc., Annual report for the fiscal year ended: December 31, 2011, p. 118, p. 126 (form 10-K).

[40] Allergan Inc., Annual report for the fiscal year ended: December 31, 2011, p. F-14 (form 10-K).

[41] Merck & Co. Inc., Annual report for the fiscal year ended: December 31, 2011, p. 57, p. 108 (form 10-K).

[42] BioMarin Pharmaceutical Inc., Annual report for the fiscal year ended: December 31, 2011, p. F-21 (form 10-K).

[43] Mylan Inc., Annual report for the fiscal year ended: December 31, 2011, p. 95 (form 10-K).

[44] Valeant Pharmaceuticals International Inc., Annual report for the fiscal year ended: December 31, 2011, pp. F-33, F-44 (form 10-K).

[45] Ipsen, Registration document at 31 December 2011, p. 167.

[46] Gedeon Richter, Annual report on 31 December 2011, p. 47.

[47] Celgene Corporation, Annual report for the fiscal year ended: December 31, 2011, p. 84 (form 10-K).

[48] Medigene AG, Annual report for the period from January 1 to December 31, 2011, pp. 60, 81, pp. 60, 82.

[49] 4SC, Annual report for the financial year from 1 January to 31 December 2011, pp. 78, 90.

[50] NPS Pharmaceuticals Inc., Annual report for the fiscal year ended: December 31, 2011, p. 56 (form 10-K).

[51] The Medicines Company, Annual report for the fiscal year ended: December 31, 2011, pp. F-6, 65 (form 10-K).

[52] Newron Pharmaceuticals, Annual report for the fiscal year ended December 31, 2011, p. 55.

[53] Amgen Inc., Annual report for the fiscal year ended: December 31, 2011, pp. F-10, F-12 (form 10-K).