University of Messina

DEPARTMENT OF ECONOMICS

PhD in Economics, Statistics and Management

XXXI Cycle

A.Y. 2017/2018

The technological outsourcing and the moderation effect of firm size in the transactional market for technology

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Introduction

In the conclusive part of Cassiman and Veugeler's paper "In search of complementarity in innovation strategy: internal R&D and external knowledge acquisition" (Cassiman, Veugeler, 2006), the authors specified the necessity to improve academic researches on whether and how firm characteristics could affect the complementary relationship between insourcing and outsourcing. More recent studies have faced this issue (Hermosilla, Wu, 2018; Berchicci, 2013). In line with this stream of research, and considering the lack of studies in this area in more recent years we run our PhD thesis.

We investigated whether firm size could affect outsourcing strategy. We discuss whether firm size moderates the complementary relationship between insourcing and outsourcing strategies. In addition, we concentrated our efforts in studying technological outsourcing, because we wanted to understand whether small technological firms could have a high level of innovation with lower transaction costs with respect to large organization dealing with innovation as well.

In the last decades, large organizations dealing with innovation were supposed to have a high level of internal R&D activities. The high level of internal R&D of large firms were supposed to be possible in the case of large organizations just because of their size. It implied that large size was synonymous of large financial resources to invest in research and development, in specialized equipment and personnel, technical and specific machineries, and those tools that small firms, given their size could not have. In its turns, this implied that small firms could not develop research and development.

However, taking into consideration the spread of new innovative start-up, we wanted to understand whether this traditional theoretical framework was still actual and proper in describing the reality of the technological R&D outsourcing strategy in the transactional market for technology. This is the general topic of the entire PhD thesis.

As far as the setting of this PhD thesis is concerned, it is divided into three papers. The first chapter is a literature review regarding the problem of the technology outsourcing within the market for technology. We decided to set first of all a definition of outsourcing. Outsourcing is considered not having a univocal meaning, giving its large usage in a several fields. Then what we did was that of reporting some definitions that for us were important in order to describe this economic practise. Then, we encounter the need to describe this market and decided to introduce this relevant framework. This framework is relevant for us because underlines the relational nature of both the market for technology and the strategy of the outsourcing itself: as a logic of the classical dilemma of make-or-buy, it is strictly correlated to the lens of the Transaction Costs Theory. This is the reason why we tried to give a transactional interpretation of the outsourcing in the light of what authors such as Williamson (Williamson 1985), Aubert and Rivard (Aubert, Rivard, 1996) and others claimed with regards of this issue.

Within the literature, most of the time, we can still observe how authors face the problem of outsourcing in terms of a binary decision. On the contrary, we claim that insourcing and/or outsourcing should not be considered as two perfect substitutive alternatives because this is not a binary decision (Aubert et al. 1996, 3003; Spithoven, Teirlinch, 2014).They are complementary decisions (Veugeler and Cassiman, 2005) that can be taken simultaneously, having regard with the market for technology condition (Arora Gambardella and Fosfuri, 2001), especially taking into account whether it is efficient or not. Since this decision and the complementarity itself are strongly related with the firm size, we decided also to include this element, in order to make sure that the size, as a moderator, plays a crucial role today, that matters moreover when innovative firms are small firm if not just start-up.

The market for technology is the principal context within which the technological outsourcing can be developed and where it finds its own and proper nature. Nowadays, given its increasing growth, the transactional market for technology (Arora, Gambardella, and Fosfuri, 2000), or the market for ideas, (Guns and Stern, 2003) is going to give economic agents an important challenge with respect to the trade of technology that was not common in the past (Arora, Gambardella, Fosfuri, 2000). In the past the technology was marketed in the goods market because it was considered an asset. In the past as well as nowadays, commercializing innovation and technology (that is, applying technological outsourcing) involves different problems related to the commercialization

of goods. The difference with the past is that nowadays academic literature has better understood that outsourcing (that is, buying) is not an alternative to perform part of internal activities internally (that is, making). For that reason, the market for technology, during the last 20 years, has been growing up. This kind of market is an important challenge to the firm (Arora, Gambardella, Fosfuri, 2000). The challenge is related to many factors: some implications that the idea of market for technology implies in terms of firm's corporate strategies when using outsourcing, the role of companies, that became both users of technology and suppliers of technology, the idea of complementarity between insourcing or outsourcing innovation, and the role that the absorptive capacity and the size of firms play within this context.

The way in which market for technology impacts the role of firm is also a challenge for firms, because it makes firms behaving both as user of technology and/or suppliers of technology. When being users, firms are buying technology from other firms, that is those firms that behave as suppliers of technology. In this case firms are selling technology.

According to the traditional mindset, the only way in which technology could be available was that of the inhouse R&D. It means that if firms had internal financial resources to develop technology in-house, they could implement and introduce it within the market. Otherwise, it was not conceivable to sell technology. In addition to this, when a firm wished to introduce a new technology, entry barriers were very severe, more than today, because technology, as a product of R&D, was not affordable for every firms.

According to this way of changing the role of firms, what changes is the context within which firms act: the market itself and the supply of technology. The traditional mindset of the technology trade context changed (Arora, Gambardella, Fosfuri, 2000).

Connected to this point, the problem of transaction costs can be observed as well. Teece (Teece, 1988) has been claiming that when innovation and technology are transferred, knowledge is transferred as well. This is that transfer of knowledge that involves transaction costs. Transaction costs are involved because the technology market is arm's length-oriented (Arora, Gambardella, Fosfuri, 2000).

From a theoretical point of view, the way in which the technology outsourcing and the market for technology interact to each other depends on the fact that the Transaction cost theory provides the most important theoretical framework for the field of outsourcing (Lacity and Hirschheim, 1993; Aubert *et al*., 1996, 1998).The lens of the Transaction Costs-based approach with respect to the make or buy dilemma is based on the fact that the pillar assumptions of bounded rationality, opportunistic behaviour and uncertainty (Williamson, 1979, 1985, 1999) are those obstacles for creating, developing and spreading new innovation in the market for technology (Arora, Fosfuri, Gambardella 2000) and the market for ideas (Gans, Stern, 2003). The idea that moves us to use the lens of the transaction cost theory is based on the make or buy decision, which is the nature contained in the idea of outsourcing.

Very recent researches affirm that the transaction costs approach today is no longer relevant to explain the relationship between buyers and suppliers of technology (Lacity et al. 2011; Scherman et al. 2016; Karimi, 2011). Market for technology has indeed several problems. Under uncertainty, transaction costs are a function of investment: it implies that if the level of transaction costs is higher, the level of investment is low (Lacity et al. 2011; Scherman et al. 2016; Karimi, 2011). If small and medium enterprises have entered the market under a condition of uncertainty, even though the incumbent will not avoid them to enter it, small and medium enterprises will have some initial costs, i.e. transaction costs and financial constraints to be paid. (Lacity et al. 2011; Scherman et al. 2016; Karimi, 2011)

The relation between transaction costs and innovation is implicit rather than being explicit (Remneland-Wikham and Knoght, 2012). Therefore, if the traditional approach of transaction costs can be contextualized today, the transaction costs approach would have to face a post- bureaucratic economic context which is no longer the institutional setting of the period in which these theories have been conceived. (Remneland-Wikham and Knoght, 2012).

The second chapter provides a review for practitioners. It is based on an analysis about the current situation of the market for technology and innovative firms that exploit technological outsourcing. The paper is aimed to provide some insight for practitioners in order to illustrate what is in practice the outsourcing decision, what are the risks connected with this strategy and how to overcome them strategically.

The actual economic context is different with respect to the past. It is characterized by a high level of instability and thus by a high level of uncertainty. Then, the risk of asymmetries among economic agents is a matter of fact (Zimmerman, 2018). Indeed, companies had to develop innovation in order to survive within the market and, in addition had to develop adaptive capabilities with respect to the context itself (Zimmer,an, 2018). Firms are in fact stressed by the need to open their boundaries to other companies and behave in a collaborative way. This stress makes transaction costs increasing (Remneland-Wikham and Knoght, 2012).

Therefore, disagreeing with some current studies about the irrelevance of transaction costs (Lacity et al. 2011; Scherman et al. 2016; Karimi, 2011), but in line with those studies referring to traditional transaction costs that find in the traditional studies a certain continuity with the correlation between Transaction costs and knowledge (Spithoven, 2014), it could be possible to argue that lower transaction costs are supposed to drive outsourcing decisions and strategies, and then to commercialize technological innovation within the market for technology. (Remneland-Wikham and Knoght, 2012, Arora, Gambardella and Fosfuri, 2001; Gambardella and Fosfuri, 2008; Guns and Stern, 2003, 2008; Hermosilla, Wu, 2018; Spithoven, 2014)

As a natural progression of our theoretical horizon related to the transaction cost theory and the market for technology, the relationship between firm size and R&D is considered as well. What makes R&D investment different from the other types of investment is the fact that that R&D creates knowledge (Binz et al, 2008). Knowledge, in its turn, produces innovation (Binz et al., 2008)

As a matter of facts, even though large firms usually spend a large part of their private investment in R&D, nonetheless the role of small firm could be considered relevant in terms of the innovative contribution they can do for technological progress when dealing with R&D activities (Guns and Stern, 2003). The last chapter is, in fact, an empirical analysis on how firm size impact the outsourcing decision. The empirical analysis concerns the moderation effect of the firm size on the outsourcing decision within the market for technology, we decide to move the empirical analysis as consequent step of our thesis.

We obtained a significant but negative result for the interaction term, which is the variable we used for identifying the technology market size multiplied by the small firm dummy variable. The idea behind the relationship between firm size and R&D is that higher investment in R&D foster the firm growth thanks to the economies of scale. The major existing literature, indeed, is characterized by a consensus view according to which firm size is linked to an increasing level of R&D (Levinthal, 1985). This result is in line with the literature. According to Koufteros and Cheng, not only the firm size has a positive and significant effect (as we fund in our results), but also its moderating "effect for small firms [is] statistically significant, but negative" (Koufteros and Cheng, 2007, p864).

Acknowledgment

We would like to thank all the Professors and members of the PhD course, who permitted us to continue our studies. Especially, we want to express our deep gratitude to Prof. Fabrizio Cesaroni. Without his guide, support, and treasure of teachings we could not get the opportunity to learn and grow up alongside our path. A heartful thank is addressed to my colleagues Mariagrazia Fallanca, Houda Lamrani, and Alessandra Insana, just for their presence in my life.

Chapter 1

Technological outsourcing in the market for technology: A transactional analysis

Technological outsourcing in the market for technology: a transactional analysis

1. Introduction

The aim of this paper is to provide a literature review regarding the relationship between the technology outsourcing and the transactional market for technology (Arora, Gambardella, Fosfuri, 2001).

Time by time scholars have been trying to find feasible solutions to the make-or-buy dilemma. We can observe it through the following conceptual ideas. Firms have been created to use the market as efficiently as it could be (Coase, 1937). However, the market changes every time and it should be controlled, and contractual relationships are not the best way to manage the market (Williamson, 1985). Trustworthiness could be a good solution, but not the only one (Dyer, 1984).

Scholars, in fact, as well as managers, starting from 1980's tried to implement the practice/ strategy of outsourcing to overcome these problems. Problems that still exist. This evidence represents the reason why we want to study the economic phenomenon of outsourcing, especially the technological outsourcing.

Technological outsourcing is nowadays relevant because it is a practice that is largely spreading among firms that try to innovate the market for technology by trading innovation and by behaving as buyers and sellers of technology. Within the conceptual idea of make-or-buy decision, which is the core facet of outsourcing, technology outsourcing reveals a great importance in the field of Management.

In addition, the fact that the meaning of technology outsourcing is not univocal, as well as those mechanisms that regulate the way in which outsourcing works, tells us that keep on studying this phenomenon is still required.

As far as the methodology is concerned, we conducted a systematic research using the Web of Science database. The key words we selected are "internal R&D", "technology outsourcing", and "market for technology". In the preliminary research, filters we applied in our selection are: "English" for the choice of the language; "articles" for the choice of the document type; and "Management" for the option of research area. From

this preliminary research we obtained 844 articles. However, we furtherly filtered the sample we got by choosing the options “Management” and “Operations Research Management Science” categories. These criteria gave us a set of 279 articles, published between 2000 and 2018.

What emerged from this analysis refers to three great concepts that are:

1) The idea of market for technology;

2)The relationship between market for technology and outsourcing;

3)The idea of Complementarity between outsourcing and insourcing R&D.

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The paper is composed of 6 sections. The second section focuses on the definition of outsourcing according to the existing literature. We reported some definitions to give a theoretical direction alongside which we conducted our analysis. This section is followed by the third one, according to which we do not only give a definition of market for technology, but also, we tried to link the second section to the third one because it seems that we cannot give a univocal definition of technology outsourcing without contextualizing it in its market. In the fourth section we tried to include the main approaches with which the academic literature analysed the problem of outsourcing, describing, also, the idea of the market for technology efficiency. We wanted to describe how the firm size moves firms to act strategically according to their dimension, to underline the relevance that the firm size can play in affecting technology outsourcing strategies. Conclusions end this paper.

2. Technology outsourcing: in search of a definition

We start our dissertation with a little analysis on the general meaning of the word outsourcing in order to better reflect on the nature of this economic phenomenon.

Outsourcing is an economic phenomenon whose meaning relates to the idea of externalization. Externalization is an expression used to indicate that firms try to perform part of their internal production process externally. In this case, externally means that these firm establish relationships with other firms to produce externally that part of production that cannot be performed internally (in-house) (Aubert et al., 1998; Spithoven and Tierlinck, 2015) However, even though the words outsourcing today is well known, nonetheless its economic meaning keeps resting not univocal and still questionable

(Spithoven and Tierlinck, 2015; Philajama et al., 2015; Badillo, Lorente and Moreno, 2014/17).

From a micro-economics viewpoint, outsourcing could be conceived as a new way of interpreting the traditional question conceived by Coase in his seminal paper The Nature of Firm (R. Coase, 1937). This new way refers to the identification of those factors that impact the firm decision to choose what to produce in-house, what to perform externally (Aubert et al., 1998; Spithoven and Tierlinck, 2015), and how to use the market size at which cost (Gambardella and Fosfuri, 2008). In other words, outsourcing relates to the classical "make-or-buy" dilemma (Cesaroni, 2004). From this point of view, what is required is to identify those changing factors that necessarily redefine firm borders. Indeed, Williamson (Williamson, 1985), within the field of the firm theory, developed the conceptual idea of transaction costs, externalization, and other means to face and to overcome those problems linked to 1) vertical integration, and 2) hierarchies, in order to minimize higher transaction costs due to the wide spread of information technology, uncertainty and moral hazard (Sherman et al., 2016). In this sense, not only outsourcing is strictly correlated with the transaction costs theory, but also it is set alongside a continuum, on which the choice between internal or external production depends on the market conditions, or on the cost of using the market itself (Bensanko, 2012). With this general contextualization of the problem, we want to report some definition that literature used to describe outsourcing.

1) The "make-or-buy decision [is] a paradigmatic problem for analysing transaction costs […]. Make-or-buy decision determine the firm's level of vertical integration, since each decision specifies which operations the firm will engage in and which it will contract out to a supplier" (Walker, Weber, 1984, pp. 373, 374).

2) "Outsourcing is a typical example of a make-or-buy decision" (Aubert, Rivard, Patry, 1996, p.51).

3) "Outsourcing is the handover of an activity to an external supplier; it is an alternative to internal production" (Aubert, Rivard, Patry, 2004, p.922).

4) “We define strategic outsourcing as the organizing arrangement that emerges when firms rely on intermediate markets to provide specialized capabilities deployed along a firm’s value chain” (Holcomb, Hitt, 2007, pp. 466, 467).

According with these perambulatory definitions, we tried to indicate what we intend for technological outsourcing. The idea of externalization refers to the idea of acquiring externally tools, capabilities, knowledge, innovation, technologies, etc. necessary for the innovative performances of firms.
All the intangibles that firms need to exploit need to be commercialized. Thus, we intend technological outsourcing as purposive use of inflows and outflows process of knowledge among innovative firms (Philajama, Kaipia, Saila, Tanskane, 2017; Chesbrough, 2006).

As far as the inflow and outflow process of knowledge is concerned, acquiring external knowledge improves internal R&D activities (Philajama, Kaipia, Saila, Tanskane, 2017). The improvement of internal R&D through external knowledge is a knowledge flow or sourcing as well, that creates new ideas (Philajama, Kaipia, Saila, Tanskane, 2017). In this exchange, the transactional nature of technological outsourcing can be furtherly explained. Moreover, in the process of external acquisition of external knowledge that is going to be integrated internally, the transactional nature underlines the level of absorptive capacity of firms (Philajama, Kaipia, Saila, Tanskane, 2017).

Firm technological capability can be improved either by internal R&D, or by external R&D (Badillo, Llorente, Moreno, 2017). Moreover, external source of knowledge gives firms the opportunity to acquire new ideas and to learn new competences. This allows firms “to gain greater technological innovation” (Badillo, Llorente, Moreno, 2017, p. 4) opportunities. Especially when and if the R&D outsourcing in the market for technology are used and exploited as inflow and outflow process of knowledge to share and diffuse innovation.
This sharing and diffusion of both knowledge and, thus, of innovation permits complementarity between insourcing and outsourcing. Indeed, the literature confirms that “interdependence and […] complementarities matter for the firm’s […] innovative performance” (Badillo, Llorente, Moreno, 2017, p.4).

The framework behind the outsourcing decision relates the problem of maximizing profit and minimizing costs by selecting among competing strategic options. Within the framework of the transaction costs theory, if cost reduction motivates outsourcing, then transaction costs reduction does (Williamson, 1985). The logic of the make-or-buy decision typical of the transaction costs approach can be related not only to the decision between internal or external R&D (Veugeler, 1997). Indeed, it is just the logic of efficiency that guarantees the choice of the activity to be outsourced and also the choice of those activity to keep in-house (Aubert et al., 1998). It is just this rational that allows us to link the path of outsourcing reinterpreted under the transaction costs-based approach to the path of the relationship between firm size and R&D investment decision (Cassiman and Veugeler, 2005).

3. The transaction costs theory: new theoretical trajectories through the market for technology

The transaction cost approach is the theoretical framework within which the outsourcing phenomenon is positioned (Spithoven and Tierlink, 2015). Nonetheless, other researches (Scherman et al., 2016; Lacity et al., 2011; Karim et al., 2011) affirm that the transaction costs approach today is no longer useful to explain the relationship between buyers and suppliers in terms of sharing of information.

In the paper *The role of Transaction Cost Economics in Information Technology Outsourcing Research: A Meta-analysis of the Choice of Contract Type*, published in 2016 on the *Journal Of Strategic Information System*, indeed, Scherman et al. argued that transaction costs approach has a scarce relevance for sharing knowledge. Even though transaction costs approach was useful in order to manage the costs of the firm, nonetheless they could not explain the relationship between buyers and suppliers.

This trajectory is arguable: it seems that, in order for the firm to manage its own organization, both transaction costs and knowledge must be reduced. Nevertheless, both of them are concerns to be faced. In both cases, the goal of investing in R&D would not be achieved, being related to knowledge and information in the former case, and reduced transaction costs in order to have that necessary market information in order to invest in R&D in the other. This is the reason why open innovation outsourcing could be

considered as a strategic managerial tool in order to minimize transaction costs and invest in R&D.

Conversely, the transaction costs approach has developed in his very recent studies a new trajectory towards the knowledge-based approach. This new trajectory seems to be in line and consistent with the traditional Williamsonian and Coasean approaches. Indeed, behind their approaches, sharing of knowledge and information was a strategic management trick to contrast both uncertainty and opportunistic behaviour, i.e. the classical behavioural assumptions the Transaction Costs Economics are based one. (Whickam and Knhights, 2011). Starting from this point, it can be observed how the sharing of information can yield to a creation of knowledge (Whickam and Knhights, 2011).

The relationship between transaction costs and innovation is considered implicit (Cesaroni, 2004; Wikhamn and Knight, 2011). If the traditional approach of transaction costs can be contextualized today, the transaction costs approach has to face the contemporary post-bureaucratic context (Wikhamn and Knight, 2011). Indeed, the institutional setting of today's economy is much different from the one within which the traditional approach was developed. In particular, industries and firms had to develop innovative and adaptive capabilities, being stressed on the fact that they need to open up organizational boundaries for collaborative purposes, with the implication of increasing transaction costs (Wikhamn and Knight, 2011).

Then, regardless of this structural change and given the consequent increase of transaction costs, their approach application seems to be related to the technological outsourcing. In this sense, transaction costs could be the driver for innovation itself (Wikhamn, and Knights, 2011). Innovation is needed in order for the firm to develop, but research for innovation is costly.

In our opinion, transaction costs can still represent a tangible element that characterize the transactional nature of the market for technology. According to Arora and Gambardella, "markets for technology are bound by transaction costs […]. Markets for technology have grown considerably in recent years" (Arora and Gambardella, 2008, p.7), however, if transaction costs remain higher, transaction costs will represent "one of

the main limitations" (Arora and Gambardella, 2008, p. 7) to the expansion of the markets for technology (Arora and Gambardella, 2008).

This horizon implies the efficiency of the market for technology. The efficiency of the market for technology is related to the level of the transaction costs. It means that when transaction costs are low, then technology outsourcing can be exploited, R&D technology is traded and firms behave as buyers and sellers of technology. In other word what happens under this profile is that when transaction costs are lower (Arora and Gambardella, 2008) the commercialization of new ideas is possible (Guns and Stern, 2003).

Indeed, if the market for technology is efficient, it implies that the market for technology is continuously increasing and growing. If the market for technology is increasing it means that technology is continuously trading. If innovation is continuously traded, the market for technology value will be positive, implying that transaction costs will be lower. In other words, when technology is highly commercialized, transaction costs are lower because the technology market size is positive. Then, according to this conceptual novelty, transaction costs could be conceived as driver for innovation itself (Wikhamn, and Knights, 2011) and, in addition to this, they can be reduced by exploiting the efficiency of the market for technology, by exploiting, in its turn, outsourcing strategies. Inefficiency of the market for technology is given by bounded rationality and uncertainty.

The Simsonian interpretation of bounded rationality is basic for the Williamson's intuition: although firms exist because of market exchange costs, uncertainty characterizes the market itself. Then, in order for the firms to overcome this problem, the contractual behaviour is needed. In this sense, for Williamson rationality is bounded because it is constrained by the uncertainty of the market and by the fact that if firms can act within such a market, they do within a legal framework they build (contracts) for surviving in the market.

Then, the concern of opportunism mixed with the problem of bounded rationality and uncertainty emerged as the defining features of the inefficiency of the market (Hardt, 2009).

It is on this trail of the firm's theory that Williamson established his "transaction costs approach". Later, literature started emphasizing the role of knowledge formation and sharing in defining the way transactions could be an organizational method in order for the firm be

managed. Williamson's contribution in this aspect implicitly (Wikhamn B. R., and Knights D., 2011, and Hardt, 2009) assumes that knowledge can be shared on the market and among firms because knowledge often has a tacit nature and needs a stable environment to be efficiently created.

As far as bounded rationality is concerned, due to a lower affordability in employing expertise, specialized staff, external information and a lack of experience, smaller firms are rationality bounded. From this concept, opportunistic behaviour and uncertainty follow. As far as opportunistic behaviour is concerned, Nooteboom (Nooteboom, 1993) distinguished two related concepts of uncertainty: the internal uncertainty, and the external one. Internal uncertainty relates the behaviour of the transaction partners; this behaviour contemplates opportunism and moral hazard. The external uncertainty considers those contingencies linked to what happens outside the relationships among the transaction partners. In this sense, firms are highly sensitive to opportunistic behaviour, that can be exploited by a single transaction partner. Even though the exercise of such an opportunistic behaviour could affect the reputation of the firm acting in such a way, nonetheless, SMEs cannot safeguard against opportunism but managerial strategies. Then, SMEs, by relying on partners with a high level of reputation, increase their dependence and the price of transaction costs they have to pay. This produces low capacity level for absorption of external information in functional fields such as technology, marketing, advertising, planning, finance, and personnel is due to financial constraints.

The relation between knowledge and transaction costs became more evident in a modern economy more technologically advanced. Hence, the consideration that the firm's role was that of *creating knowledge*. [1]

Under this interpretation, firms and their economic role could be interpreted as a creator of positive value because they can share information at zero cost. The introduction of knowledge issues within the field of the firm theory, has changed the treatment of firms in economics

[1] Now, we can observe two directions of this last approach, one quantitative, and the other qualitative. Indeed, the empirical studies and some recent econometric methodologies have been applied, together with a theoretical approach based on the qualitative consideration that transaction costs are related to the sharing of information and open innovation outsourcing. In this case, the qualitative approach in researches can be highlighted in the sense that transaction costs are not conceived as a mere variable. Indeed, such a research give an evaluation of the current findings out about transaction costs. Nonetheless, these two approaches can be conceived as two different faces that are both needed in order for the studies to be furtherly implemented and developed.

(Grant 1996), because the way in which transactions are organized does not depend only on the asset specificity, the uncertainty, and the frequency of contracting[2].

According to the new horizon of the literature, the correlation between transfer of knowledge and the transaction costs approach is more evident. We can find a new approach that is defined as "Knowledge based transaction" (Jain, Thiertart, 2013). According to this theory transaction cost is no longer useful in describing contractual hazard as the determinant of firms' boundary. On the contrary, the current relevance of this approach is that the knowledge base transaction costs affect the decision to outsource. In addition, this approach confirms the fact that transaction costs approach generates the transfer of knowledge, reversing "what are commonly understood to be two opposing theories: transaction costs economics […] and the knowledge based view, are in fact complementary to each other" (Jain, Thiertart, 2013, p. 2)

4. The transactional market for technology: demand for external technology, profiting from innovation

Given its transactional nature (Arora, Gambardella, and Fosfuri, 2001; Arora and Gambardella, 2008; Spithoven and Thierlink, 2015) the market for technology is the core context within which technology outsourcing can be exploited. The market for technology is not efficient when bounded rationality and external uncertainty affect it, and therefore innovation and technology are not tradeable.

Firms make outsourcing if they do not have those necessary financial resources to face the internal cost of internal R&D. It means that they cannot internally pay the cost of specialized personnel, row materials for conducting R&D and so on and so forth. When

[2] In Williamson's point of view, any economic organization comes from the necessity for the firm to minimize costs in a situation characterized by incomplete contracts, specific investments, bounded rationality and opportunism. Then, the goal of every economic capitalistic institution is to reduce transaction costs, i.e. *ex ante* transaction costs and *ex post* transaction costs, and their interdependence. According to this position, firms born as an institutional solution to the market failure under a situation of incomplete information process. This means that firms is an *avoider of negatives* (Conner 1991), such as high exchange costs on the market, risks, and opportunistic market relations (Hardt 39). More specifically, firms try to avoid negatives because of a lack of knowledge due to information asymmetries. Then, they cannot use efficiently knowledge and, given the uncertainty condition, investment in R&D are costly.

the cost of using the market is high, it is not convenient to stipulate an R&D outsourcing contract with another independent firm, because costs would increase.

Contrary to the past, trading in technology and the consequent flows of knowledge represent nowadays a matter of fact (Gambradella and Fosfuri, 2008). This particular kind of exchange has permitted the emergence and the development of this kind of market. In terms of corporate strategy this has an important implication with respect to outsourcing or insourcing R&D, in particular for buyers and sellers engaged in contractual relationships aimed to buy or to sell new technology. Within this trading market, the goods produced, sold, and bough are intangible goods and the contractual relationships, moving around this economic space has changed the traditional way of thinking of R&D and innovation.

In the past it was indisputable and unquestionable the fact that in order for a firm to introduce an innovative good within the market, it had to be produced in-house, nowadays this is no longer true. Nowadays, on the contrary, if firms produce R&D to be sold to another independent firm and if the latter is in search of new technology to buy, the classical rational is completely reversed.

This reversion is due to the firm strategy to outsource R&D and the firm strategy to sell R&D, both on demand side and on the supply side. As far as the supply side is concerned, today the market for technologies and the markets for ideas make possible for competitors and incumbents to access R&D from different supply sources (Arora, Fosfuri, Gambardella, 2000). Within this framework, when the cost of using the market is low, market for technologies make barriers to entry lower, and at the same time it can permit the existence of competitiveness among firms transacting in innovation. Given this latter point the strategies and the firm decision whether outsourcing and/or insourcing are required.

Thus, low cost of using the market makes commercialization of innovations more likely avoiding the property right wars and diffusion of monopolies. It permits the coexistence of heterogeneous firms and fosters development and growth, cooperation among heterogeneous firms and, at the same time, it would be in line with the Williamsonian idea of incomplete contracts and monopoly (Williamson, 1985).

Within this theoretical framework, different kinds of strategies have been studied. When technology is intended to be tradeable, firms become buyers and sellers of technology innovation (Arora and Gambardella, 2008). The Guns and Stern's paper (Guns and Stern, 2003) describes commercialization strategies for start-up dealing with new technological innovation in the market for technology. In particular, authors focus their attention on the drivers for commercialization of new ideas that allow industrial dynamics.

Their scientific contribution is based on the link between the microeconomic and strategic decision of firms, the commercialization environment within which these firms act and the transformation of new ideas into a response that firms make to answer customers demand. Guns and Stern's analysis (Guns and Stern, 2003) points out that the incoming of an innovator within the market for technology generates competitiveness but it is the market for ideas that generates competitive interaction between innovative start-up and large companies dealing with the production of new innovative technologies.

The reason why Guns and Stern focused on the commercialization of new technology in the market for ideas depends on the fact that the spread of small firms and start-up dealing with innovation generated an increment in the technology entrepreneurship (Guns and Stern, 2003). As a consequence, these new entrants represented a "significant potential commercial application" (Guns and Stern, 2003, p.333) within the market for technology. Their action could be, in fact, disruptive with respect to large companies. However, small firms and start-up, given their age and size, are supposed to have no experience to face the market within which they want to introduce their innovation. Then, "a key management challenge is how to translate promising technologies into a stream of economic returns for their founders, investors and employees" (Guns and Stern, 2003, p. 333). Saying differently, according to Guns and Stern, the problem of the outsourcing technology in the market for technologies is not represented by the problem of innovation per se, but, on the contrary, the commercialization of innovation.
The inflow and outflow process of knowledge is the result of interaction between suppliers and sellers of tradable innovation in the market for technology (Guns and Stern, 2003; Arora, Gambardella, and Fosfuri, 2001; Philajama, Kaipia, Saila, Tanskane, 2017).

Cesaroni finds out that firms decide to outsource R&D in presence of a large market for technology (Cesaroni, 2004). While Guns and Stern positioned their study on the supply side of the market (Cesaroni, 2004), Cesaroni, by positioning his study on the demand perspective, discusses what he defined as "the possibility to purchase (not commercialise) technology" (Cesaroni, 2004, p.1), and how the demand side of innovation, in the market for technology, influences the decision of firms to outsource technological innovation. The author assesses "whether a larger market for process technology induces" (Cesaroni, p. 2) firms to outsource technology innovation. Even though the past literature strongly claimed that the transfer of innovation generates higher transaction costs, he affirms that if innovation is commercialized transaction costs become less severe because the market for technology emerges (Cesaroni, 2004). Which is confirmed nowadays by the new literature trajectory (Spithoven and tierlinck, 2015, Hermosilla and Wu, 2018).

In line with the ratio between demand of technology and supply of technology, it is possible to state that the market for technology is the market in which transactions generate technological innovation (Arora, Gambardella, and Fosfuri, 2001; Cesaroni, 2004; Hicks, Hedge, 2005; Spithoven and Tierlinck, 2015). If the commercialization of innovation in the market for technology and the demand of technological outsourcing is the result of the inflow and outflow process of knowledge among firms, if these firms behave as buyers and sellers of technological innovation in the market for technology, if the market for technology is a market transactions of tradeable innovation, then the technological outsourcing is the results of interaction of buyers and sellers of technology, who, behaving as suppliers and sellers of technological innovation make the market for technology emerging. This is the core conceptual nature of technological outsourcing that can be observed within the make-or-buy decision.

The "market for technology refers to the transaction for the use, diffusion and creation of technology" (Arora, Gambardella, Fosfuri, 2000, p. 5). The market for technology defined, in a broad sense, as a transactional market which is arm's length and that involves the trade of technological innovation. Arm's length means that the nature of the market is transactional because there exist relational and contractual relationships between parties, who are buyers and sellers, that act as they were independent, without collusion with third parties.

5.Firm size in the market for technology

Arora, Gambardella and Fosfuri cited the traditional mindset, represented by Porter (Porter, 1985, 1990). Accordingly, firms get their competitive advantage by differentiating their production with respect to their competitors. However, the product diversification is given by R&D activities, which should be implemented in-house by using internal assets. The internal asset firms need to differentiate are assets involving technology that could not be easily bought and sold because of their cost. Then, since many firms did not have, "market for these assets may not exists" (Arora, Gambardella, Fosfuri, Ashish, 2000, p. 7). The not-existence of the market for these assets implies that the only way to innovate is just to rely, if there are, on internal financial resources by exploiting R&D activities in-house.

According to Arora, Gambardella and Fosfuri (Arora, Gambardella and Fosfuri, 2000), the immediate effect of such a mindset implied the consequence that innovator had to choose for technology in-house. In this way the possibility to acquire external knowledge would not possible and moreover technology would have been available just for large firms. This was due to the fact that only large firms were supposed to have superior access to those assets necessary to acquire and exploit technology and conversely, "smaller firms [would have faced] major hurdles in developing and commercializing technology" (Arora, Gambardella and Fosuri, 2000, p. 8).

When investing in technology and R&D, there exist some extensive and risky sunk R&D expenses. Moreover, this is true when firms have to compete within the market for technology. In this case, what happens is that firms would rely on external linkage. External linkage creates some external networks that could be pervasive. In this case pervasive means that when a firm is creating and producing innovation this innovation is going to be spread. When it is spread, if there exist uncertainty and information asymmetries and a higher market power of the other companies within the network, the firm that created innovation is subjected to a loss.

Considering the fact that R&D technology is tradeable, thus it can be exploited and acquired by both large and smaller firms, not only the latter behave as buyers and sellers of technology. What changes is also their strategies. In other words, insourcing and outsourcing become two different decisions that are not referring to the traditional dilemma of the make-or-buy-decision

Firm size is a variable that can be defined as an indicator describing something intangible. Indeed, there exists such a physical or tangible element directly relating to the size *per se*.

The academic debate about the influence and the role of the size in explaining profitability and firm value started with Sheferd in 1972 and Sherer in 1973, by emphasizing the importance of the economies of scale. A positive relation between firm size and firm profitability has been shown by Hall and Weiss in 1967. According to Baumol (1967), the advantages of larger firms depends on their market power as well as their greater access to the capital market. According to Capon et all (2011), size could be used as a proxy variable of resources. Indeed, in line with the neoclassical approach, larger firms are better equipped because they have more organizational resources. According to Lee (2009), the absolute firm size is the key determinant in explaining firm profitability, in particular, firm size plays a driving role to describe profitability variations. According to Papadognas, firm profitability is positively influenced by firm size (Papadognas, 2007).

According to Pagano and Schivardi (Pagano and Schivardi, 2003), firm size matters in terms of growth through the channel of innovation, because by investing in R&D it allows them to grow up and hence to create job and to enhance competition by bringing new products within the markets. According to this part of the theoretical framework, large firms are associated with faster growth in terms of productivity because faster growth produces larger firms and higher R&D activities produces faster growth. According to Shefar and Frenkel (2003), R&D investments spawn innovation. Innovation fosters growth. In order to innovate, R&D investments (in-house or outsourcing) are required. It seems that there exists reverse causality. Nonetheless, Pagano and Schivardi demonstrated that this hypothesis is ruled out because of the influence of the size on growth. Consequently, it seems that not only a full exploitation of innovation benefits from the presence of large firm, but also that R&D activities are influenced by the firm size. Therefore, as it has been shown by Shefer and Frenkel (2003), the positive relation between size and growth increases through the channel of R&D intensity.

This last aspect is strongly related to the concept of innovation. It is known that without innovation firms cannot grow up, as well as without R&D there would not be otherwise the possibility to get innovation. Indeed, it is the innovation improving the capital structure of the firm. Firms that want to grow up need to invest in R&D and tent to exploit it. This should be the case of small firms, dealing with technology, pharmaceutical or automotive sectors. In these cases, the field of production maters too. As a matter of fact, small firms tend more than old and large firms to take riskier investment; similarly, it is not a case the fact that large firms are not incentivized to invest in R&D because they already reached the market place they wanted and perhaps they also reached the optimum firm size.

According to Tangen (2003), Berger and Di Patti (2006), Majdumdar and Chhibber (1999), and Shen and Rin (2012), corporate size is positively correlated to profitability and market value: the larger the size, the better their performances because, as Surajit and Saxen (2009) pointed out, thanks to the economies of scales firm size determines the firm success. This result has been shown in 2012 by Pervan and Visic too: firm size has a significant positive influence on firm profitability. In studying the impact of firm size on profitability, the found out that larger firms, thanks to their market power and their economies of scales are able to charge higher prices and hence higher profit. In addition to this, larger firms have a higher negotiating power such that they can obtain more favourable financing conditions than small firms.

However, the economic structure of the market is characterized by capital market imperfections, information asymmetries and externalities (Williamson, 1985). A way firms apply to adapt is research and development as a strategic to tool to improve their own performances in terms of production of innovative goods. This argument fosters a relationship between innovation and firm size, that varies across industries depending on their level on innovation investment affordability and market conditions, technological opportunities and absorptive capacity from R&D investment (Levinthal, 1985, p.2). Moreover, this topic relates to the market transactions as well.

For small companies, the idea behind the investment decision in R&D concerns the fact that in order to invest in R&D, absorptive capacity is required. Absorptive capacity has to match firm-specific issues: the costs of R&D personnel, the wages of researchers and the costs of their training, in addition to the sunk costs. The other cost firms must face

depend on this chain: information asymmetries between investors and managers, which produces uncertainty. Uncertainty, then, influences firms' financial restrictions, and so, the affordability to invest in R&D. This kind of constraints depends on the firm characteristics, such as size.

Opportunistic behaviour of large firm affects the advantages or the disadvantages of small firms. As far as bounded rationality is concerned, due to a lower affordability in employing expertise, specialized staff, external information and a lack of experience (Spithoven Tierlink, 2015), smaller firms are rationality bounded. From this concept, opportunistic behaviour and uncertainty follow. This rationale is different for large sized firms. While the small firms are obliged to rely on a disadvantage position, as it has been observed, large firms, by exploiting their dominant position, can decide their conditions and impose their goals during negotiating contractual step. In addition, they can exploit information asymmetries and opportunism. In addition to the market power, another discriminant element that makes larger firm choosing at the same time insourcing and outsourcing R&D is the market within which they operate ad that incentive them to implement both make and buy decision: the market for technology (Arora, Fosfuri Gambardella, 2000).

In sum, small firms have a lower bargaining power with respect to large firms. The only strategy they have to resist opportunism and competitiveness, is deciding to outsource R&D. Small firms can outsource by exploiting the cost of using the market, when the cost of using the market is low. In such a situation the barriers to entry in the market for technology are lower too. In doing so, small firms can get the aim of efficiency. Indeed, in order to exploit conveniently the cost of using the market, firms should look at the market conditions. Considering the market conditions means considering the cost of using the market on the one hand, and the internal capability of a firm on the other one. For the small firms' case, giving their low bargaining power, taking into account the market conditions implies to consider also internal capability of firm to absorb new knowledge, how to manage the acquisition of new knowledge and ho to exploit it once they decide the entry the market for technology with a new innovation.

However, this is not true when technological innovation can be sold, in the presence of the market for technology (Arora, Gambardella and Fosuri, 2000; Cesaroni, 2004). If technology is traded, both large and small firms can have access to R&D technology. If

technology R&D is thought as tradeable, this implies that R&D is no longer something that is the output of internal firms effort, but it is an output that does not represent anymore the competitive advantage for a firm in itself, but the object of the new market, that is the market for technology. In this sense, the market for technology changes the way in which firms behave. If technology becomes tradeable, and technology is an asset that can be sold, thus firms can behave as buyers and sellers of technology. This is the impact of the market for technology.

6. Conclusions

In the transaction costs approach, the make-or-buy-decision idea can be applied to those firms that are demanding technological innovation. When firm are buyers of technology the literature affirms that transaction costs became higher. However, when technological innovation is traded, the market for technology emerges and the transaction costs become lower. Lower transaction costs foster the commercialization of technological innovation. Then the relationship between the technological outsourcing and the market for technology is given by the presence of demand and supply of technology itself. This is a challenge because buyers and sellers are no longer the classical client, but the firms that behave as buyers and sellers of technology. In this sense, cooperation among firms in buying and selling technology make firms choosing for technological outsourcing in the market for technology. This involves the transactional nature of the market for technology, which is correlated with the transaction cost approach. The market for technology is a transacting market of innovative technologies, aimed to create knowledge and spread it within a logic of flows of innovation (Arora, Fosfuri Gambardella, 2000). Indeed, according to the traditional way of thinking, just large sized firm could produce in-house an innovative good, because of their size. Indeed, the Schumpeterian literature pointed out the fact that it was the size generating R&D, by specifying that only larger firms could that given their financial resources. However, while during the past decades small sized firm could not afford innovation, or anyway during the first step of their economic activities it was hard to be financed, nowadays, thanks to this new literature trajectory. In addition, while in the past the access to new technology was in fact a privileged option just for larger firms, nowadays thanks the nature of the transacting market for innovation, small firms can afford innovation as well

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Appendix A

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Soumitra Dutta,Philippe Evrard	1999	Information Technology and Organisation within European Small Enterprises	European Management Journal
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Xuan Bai, Shibin Sheng, Julie Juan Li	2016	Contract governance and buyeresupplier conflict: The moderating role of institutions	Journal of Operations Management
Michael Schermann, Philip Yetton b, Helmut Krcmar	2016	A response to ‘‘Transaction Cost Economics on Trial Again"	Journal of Strategic and Information System

B. A. Aubert, S. Rivard	2016	A Commentary on: ‘‘The role of transaction cost economics in information technology outsourcing research: A meta-analysis of the choice of contract type”	Journal of Strategic Information System
Nidthida Lin, Timothy M. Devinney, Tim R. Holcomb	2016	Examining Managerial Preferences and Choices: The Role of Value Creation and Value Appropriation Drivers in Strategic Outsourcing	Long Range Planning
B. Mahadevan, Jishnu Hazra, Tarun Jain	2017	Services outsourcing under asymmetric cost information	European Journal of Operational Research
Shan Liu, Lin Wang, Wei (Wayne) Huang	2017	Effects of process and outcome controls on business process outsourcing performance: Moderating roles of vendor and client capability risks	European Journal of Operational Research
Wenwen Zhu, Stephen C.H. Ng, Zhiqiang Wanga, Xiande Zhao	2017	The role of outsourcing management process in improving the effectiveness of logistics outsourcing	Int. J. Production Economics
C. Annique U	2017	Absorptive capacity and R&D outsourcing	J. Eng. Technol. Manage
Mary Lacity, Leslie Willcocks	2017	Conflict resolution in business services outsourcing relationships	Journal of Strategic Information Systems
Xiaoge Meng, Zhong Yao a,b, Jiajia Nie, Yingxue Zhao	2018	Make or buy? It is the question: A study in the presence of carbon tax	International Journal of Production Economics
Yajun Zhang, Shan Liu b,Jing Tan, Guoyin Jiang, Qing Zhu	2018	Effects of risks on the performance of business process outsourcing projects: The moderating roles of knowledge management capabilities	International Journl of Project Managemnt
Cher-Hung Tseng, Liang-Tu Chen	2018	Firm capabilities as moderators of transaction cost factors and subsidiary domestic outsourcing	Management Decision

Chapter 2

Buyers and Sellers of technology: a review for practice

Buyers and sellers of technology: a review for practice

1. Introduction

Nowadays there is an increasing trend for new technology development (Kamuriwo, Baden-Fuller, 2016) carried out through "networks of specialized firms" (Kamuriwo, Baden-Fuller, 2016, p. 1031), which can be seen as a key component of the market for technology (Arora, Gambardella, Fosfuri, 2000). The market for technology is characterized by the presence of firms that behave as buyers and sellers of technology or R&D (Arora, Gambardella, Fosfuri, 2000). When firms act as buyers of R&D, they are implementing the strategy of outsourcing for R&D and innovative technologies within the market for technology. In this case the R&D outsourcing strategy is based on external partnership.

An outsourcing strategy based on external partnership is based on the availability of external suppliers of innovation, R&D, and technology. These suppliers must be, and they in fact are, specialized firms. Typically, those specialized firms need a system of patents and licences in order to maintain the value that they create when commercializing new ideas (Guns and Stern, 2003). In establishing this partnership, buyers and specialized suppliers provide complementarity capabilities. This demonstrates that in-sourcing and outsourcing of R&D are complementary activities (Lockwood Howells, Gagliardi, Malik, 2012; Cassiman and Veugelers, 2005).

Some of the principal actors moving within the market for technology, among the others, are those firms dealing with pharmaceutical and biotechnological products. In this paper we focus on Pharmaceutical and biotech sectors because in the last years registered an important increment of traded technology, with I high level of knowledge transferred through the market for technology. Considering this increasing growth of these sectors within which the practice and the strategy of outsourcing is applied, given the great importance that nowadays technology outsourcing within the market for technology is going to acquire, a review for practitioner is required. In line with this, the aim of this paper is providing a review for those practitioners who are interested in exploiting technology outsourcing in the market for technology.

According to what we focused in the previous chapter, we want to give practitioners some insights about the outsourcing strategy. Especially, what we want to show are the

advantages and disadvantages of outsourcing, and why it can be important within the market for technology. We shall describe these points by reporting a description of what is happening in pharmaceutical and biotechnological industry. We shall report some statistical data in order to give a tangible idea of the reality of global outsourcing market size and its transactions. We will see that one of the most important part of outsourcing transactions for R&D and innovation is intensively exploited in Usa. Therefore, most of the time, data we report refers to the Usa market. Nonetheless, in the last years the massive growth of academic spin-off and joint ventures have incentivized the enlargement of the market for technology in pharma and biotech sectors out of the Usa borders.

Most of the time, innovative R&D products for small firms (but very often also for large firms) are patented or the management of such an activity are kept secret in accordance with the firm policy, to avoid to lose competitive advantage. Very often this is true for small sized firms. Nonetheless, we got information about the Italian market for technology, and we fund in particular a concrete case of a small sized firms that exploit the strategy of outsourcing by implementing the transfer for technology, in addition to other two British case studies that make evidence of the weight that there exist in the make-or-buy dilemma (Cesaroni, 2004).

As far as the methodology is concerned, we searched for the last relevant technology outsourcing papers within the ESCOBhost database. We looked for Magazine paper, newspapers and the keyword we used in the databases is “technology outsourcing”. The outcome we obtained has been carried out in a sample of 200 papers about, spanning over the last 5 years about. After this preliminary research, we reviewed the result obtained and kept those articles that met these criteria: 1) commercialization of new ideas; 2) outsourcing strategy; 3) R&D outsourcing. Finally, we proceeded working as follows. We run a descriptive analysis of the R&D outsourcing trend, both the global trends and the Italian one. We focused on the specific case of Pharma/Biotech sector because it seems to be the more developed sector that has in creased in the last years. We analysed the case of three companies, one is an Italian firm, the other are two UK firms. We described these three case studies to better underline the motivations that move firms to implement outsourcing strategy and those obstacles that have to be faced.

The paper is composed of six sections. In the first two sections we explain the motivations that move firms to outsource, and both risks and advantages in exploiting outsourcing, trying to give a road map of this managerial and economic issue. In the other sections of this paper we describe the global trend of R&D outsourcing, focusing, in particular, on the pharmaceutical and on the biotech sector. This part is followed by the sixth section, within which we reported the Italian trend of R&D outsourcing in sectors of biotech and pharmaceutical. In addition, we reported also a case study of TTFactor, a small firm sized, engaged in the transfer of technology as model to implement biotech R&D outsourcing on the market for technology. Conclusions ends this chapter.

2. Advantages and disadvantages of R&D outsourcing strategies

According to Benoit et al, (Benoit, Aubert, Rivard Pastry, 1996, p. 1) "[o]utsourcing is a typical example of a make-or-buy decision". The outsourcing strategy allows firms to keep their internal key resources in-house, developing their core competences (Tierlink, 2015). At the same time, outsourcing allows firms to establish their external enforcement such that firms can acquire externally those competences that they would not obtain otherwise, moreover in terms of knowledge and assets (Kamuriwo, Baden-Fuller, 2016). This is possible through outsourcing contracts (Lacity et al., 2011).

Outsourcing contracts, indeed, give companies the opportunity to create networks and cooperation among companies when dealing with R&D activities. R&D activities are very costly operations, moreover when performed internally (Benoit, Aubert, Rivard Pastry, 1996, Cassiman and Veugeler, 2005). In this case the total cost of R&D activities relies on the company itself. On the contrary, when performed externally, by exploiting the commercialization of R&D or through the flow of knowledge, the cost of R&D diminishes (Benoit, Aubert, Rivard Pastry, 1996; Cassiman and Veugeler, 2005; Tierlink, 2015). So, by exploiting outsourcing, firms reinforce their core competences that make them different from each other. In addition, firms keep on actively operating within the market. The academic scenario dealing with the problem of outsourcing is not homogenious, both in terms of stream of research and in terms of practices analysed in the literature itself.

In the last 20 years, the academic literature has focused deeply on the strategy of outsourcing (Baraldi, Proença, de Castro, 2014; Gadde, Hulthén, 2009; Liang, Wang,

Yajiong, Cui, 2015, Caniels, Roeleveld, 2009, Wu, 2010; Lacity et al., 1992; Tierlink, 2015). According to the theoretical framework based on the efficiency-based perspective, firms have to maximize profit and minimize costs by selecting among competing strategic options. Within the framework of the transaction costs theory, transaction costs' reduction motivates outsourcing (Benoit, Aubert, Rivard Pastry, 1996). The make-or-buy decision concept is the direction towards which the transaction costs approach moves. Nowadays, transactional relationstipnship concept and practice are transferred in the market for technology when dealing with the relationships between internal and external acquisition of R&D, innovation and technology (Veugelers, 1997; Cassiman, Veugelers, 2001).

The exploitation of the outsourcing strategy has been applied for the first time during 1980s, several novelties have been developed. If in the past outsourcing strategy was a managerial decision regarding the so called non-core activities, step by step it became a strategic decision regarding moreover the core activities with the production process of firms. Outsourcing is nowadays related also to some activities such as business process, services providing, and to other fields such as medical, touristic and banking, together with geographical relationships among suppliers from different countries and finally the context of the market for technology.

The increment of this practise and its development in several new sectors is documented by Zimmerman (2018, www.smartceo.com), according to whom "more than 2 million U.S. jobs were outsourced in 2013, including 12 percent of call center work, 38 percent of research & development, and 43 percent of IT services. In the information services industry alone, the contract value exceeded $28.5 billion, and that's a relatively small portion of the $104 billion Business Process Outsourcing (BPO) market, made up in greater part by financial services and manufacturing, and to a lesser degree by human resources, customer services, administrative services, energy, healthcare, retail, logistics, travel and telecom" (www.smartceo.com)

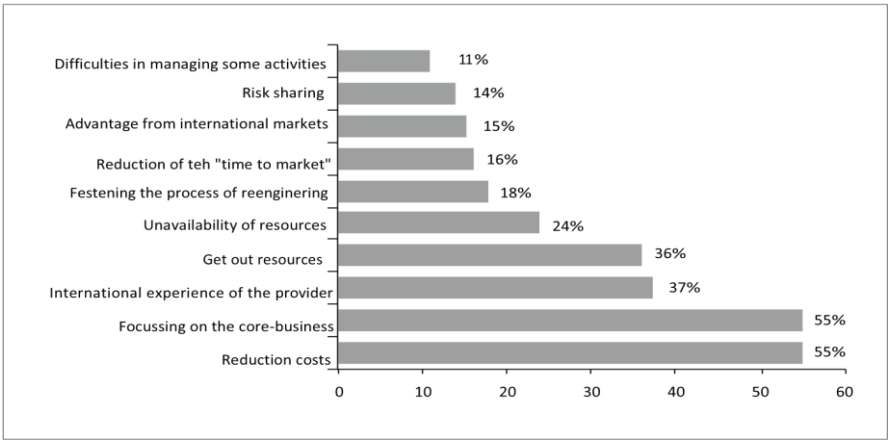
Relying on outsourcing allows firms to get competitive advantage on the long time (Barney, 1991; Tierlink, 2015). Firms get competitive advantage because every firms that rely on contractual relationship between buyers and seller try to get advantage in the complementarity between the external competences and internal capabilities (Kamuriwo, Baden-Fuller, 2016). Then, all the actors involved in outsourcing contracts

allow each partner to exploit their own core competences within the market. In other words, investments are concentrated on the areas within which every firm is a leader in the market. As a consequence of this practice, performance, returns, efficiency productivity and outputs increase, and firms can profit and grow up (Isfol Report, 2012). In addition, outsourcing is also a protective strategy that firms exploit to avoid the incumbency of competitors. In so doing, firms increase competition, but this competition, in its turn, allows all actors to increase the trade within the market and to develop new strategies to survive the market itself (Veugeler, 1997).

The principal reasons that pushes firms to outsource are both tactic and strategic (Wu,2010). Managers can take care of the need of the firm and trying to overcome immediately current problem underestimating the expected result on the long time. Otherwise, managers strategically decide to concentrate their effort on the long-time, looking at the competitive advantage (Barney, 1991, Tierlink, 2015). In this second case, managers will focus on the activities in-house by looking at their specialization of their internal core competences and will outsource those activities that the firm would not implement.

Isfol (2012) reported an empirical analysis conducted by the Outsourcing Institute[3]. This empirical analysis was conducted on a sample of 1200 North-American firms in order to identify motivations to outsource. Researchers found the following reasons, which are also summarized in Figure 1:

Figure 1 – Motivations to outsource



Source: Isfor Report, 2012

[3] *http://www.outsourcing.com*

Figure 1 shows that the reduction of costs and the need to focus on the core business are the two most important and principal indicators used to explain the motivation to adopt outsourcing. This result confirms what we have explained before. In addition, we find other reasons motivating the exploitation of outsourcing.

Outsourcing can be used as a tool to overcome difficulties in managing and/or controlling some specific activities. It is also used to overcome the problem of the lack of specific skills or competencies. In this latter case, since internal skills are less in terms of professional capabilities, managers can outsource, and then exploit the core competences of other firms in order to overcome the internal gap. Another reason to implement outsourcing is that of reducing operational costs. In this case we can observe a tactic facet in the usage of outsourcing: it refers to the management of the fixed costs of the firm when the firm is growing, whit the aim to avoid the increment of those costs. In this case, outsourcing allows a change in the costs structure of the firm. On the one hand, the impact of variable costs increases, but, on the other side, the impact of fixed costs diminishes thanks to economy of scales, the advantages of the specialized suppliers that allow to reduce the total operational costs (Isfol report, 2012). Overcoming financial difficulties represents another motivation. In this case, outsourcing implies that the suppliers are assigned the transfer of some activities, licences, or materials having an economic value. This allows firms to profit (Isfol Report, 2012).

As far as the organizational perspective is concerned, when firms rely on external specialized suppliers, on the one hand firms can make technical resources circulating, to be used to increase their own core competences. On the other side, internal resources are improved thanks to the fact that investments are concentrated on core asset specificity. The use of outsourcing strategies also has an impact on the financial needs of companies relative to the fixed capital component. The divestment of investments in fixed structures and the consequent sale of certain activities outside, frees up resources for alternative investments and makes companies more flexible with respect to environmental changes.

As a strategy, outsourcing entails some risks when not correctly applied (R&D Magazine, Isfol Report, 2012, Zimmerman, 2018). Indeed, the results of the research conducted by The Outsourcing Institute reveals that outsourcing has been implemented in order for the firm to reduce the managerial risk to lose control of the company

(Zimmerman, 2018; R&D Magazine). Then, many of those companies that answered the survey stated their dissatisfaction with respect to the obtained results by applying outsourcing (Isfol Report, 2012). However, the reason of this dissatisfaction is due to the fact that outsourcing should be applied in a proper way: the managers' approach should be based on the evaluation of the causes that create a problem, then proceeding to the implementation of outsourcing (Zimmermn, 2018).

As far as the technological innovation development is concerned, it is probably that the specialized suppliers already know about the global trend of innovation (R&D Magazine, Zimmerman, 2018). Then, specialized suppliers will exploit knowledge by producing an innovative product. The advantage in this case is having investments and innovations from suppliers because, given their specificity, they are asset difficult to be produced in-house.

As far as the definition of risk in the context of technology outsourcing is concerned, we are referring to some negative outcomes as a result of an incorrect application of this practice/strategy within the management of a firm. So risk represents an exposure of the firm to financial losses, loss of novelty when producing innovation, loss of innovative performance (Aubert, Patry, Rivard, 1998). In the figure 2, formulated by Aubert Patry and Rivard, (Aubert, Patry, Rivard, 1998), we report a list of risks caused by outsourcing:

Figure 2_– Risks of outsourcing

1.	Assess the loss due to undesirable outcomes:
•	Identify the potential undesirable outcomes for a given project;
•	Evaluate the magnitude of the potential loss due to each negative outcome;
2.	Assess the risk probability:
•	Identify the risk factors that might lead to undesirable outcomes;
•	Identify the links between risk factors and undesirable outcomes;
•	Assess the extent to which each risk factor is present in the project.

Source: Aubert, Patry, Rivard, 1998

On the basis of this table and according to the authors, related to the outsourcing there exist two concerns that firms have to deal with: on the one hand, we can find undesirable outcomes; on the other one, the probability of the occurrence of a risk. As far as undesirable outcomes are concerned, authors include in their paper a clear list. In order to make more schematic the list of the risks they face, we report the figure 3:

Figure 3 – Disadvantages of outsourcing

Hidden costs	Hidden transaction costs and management costs Hidden service costs
Contractual difficulties	1) Costly contractual amendments 2) Disputes and litigation 3) Difficulties in renegotiating contracts
Service Debasement	1) Diminished quality of service 2) Increased costs of services
Loss of organizational competencies	1) Loss of innovative capacity 2) Loss of control of the activity 3) Loss of competitive advantage

Source: Aubert, Patry, Rivard, 1998

Several researches focused on the risks that are associated with IT outsourcing phenomenon (Earl, 1996; Aubert *et al*., 1998; Willcocks *et al*., 1999). Aubert, Patry and Rivard identified some risks factors that they list. For brevity they created also in this case a table listing these factors. In the figure 4 table we report their results:

Figure 4 – List of risk factors

Agent	Opportunism: moral hazard, adverse selection, imperfect commitment Lack of experience and expertise with the activity to be outsourced Lack of experience and expertise in managing outsourcing contracts Number of suppliers
Principal	Lack of experience and expertise with the activity to be outsourced Lack of experience and expertise in managing outsourcing contracts
Transaction	Asset specificity Uncertainty Measurement problems Frequency Interdependence of activities

Source: Aubert, Patry, Rivard, 1998

3. The global trend of R&D outsourcing

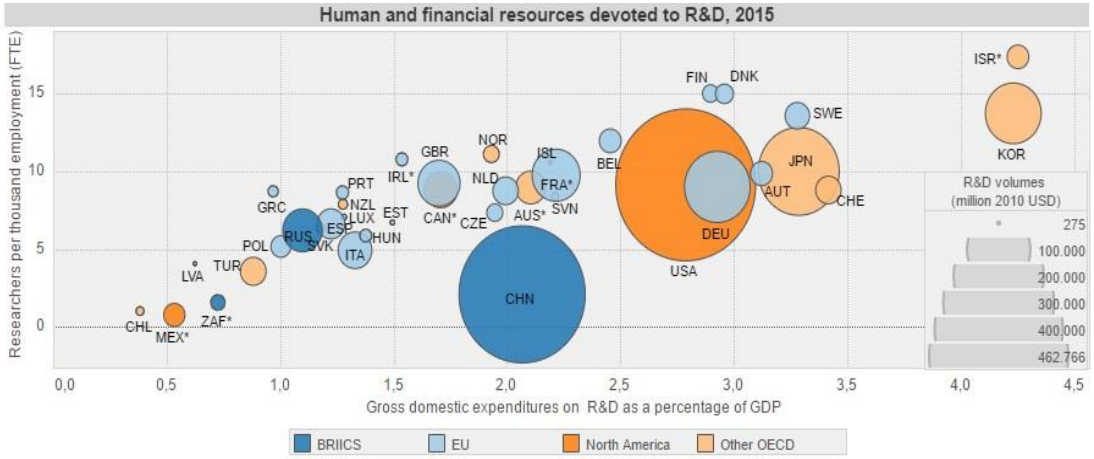
According to the Small Business Administration Office of Advocacy web site[4], reporting data from U.S. Census Bureau, SUSB, CPS, International Trade Administration, Bureau of Labor Statistics, BED and the Advocacy founded research (update to 2010), since the latest recession, from mid-2009 to 2011, small firms led by the large ones in the category (20-499) accounted for 67% of the new net job. The spread of both spin off and spin out, small enterprises, and, more generally, small entrepreneurial organizations shows us how remarkably evident be the fact that small business is engaged in diffusion of innovation. This is due to a critical economic and financial framework on the one hand, and a strong competition among firms on the other one, in addition to some other problems such as to the difficulties of small firms not only to enter the market, but also their capability to compete and to resist the market laws.

This spread of technological innovation has been documented also by the R&D Magazine. Recently the journal published the 2016 Global R&D Funding Forecast, i.e. the analysis of the R&D World Investment. The ranking[5] drown up for individual countries shows that the top 40 countries investing in R&D are characterized by different behaviour. In particular, if we look at the USA and China, while in 2015 USA invested almost five hundred billion dollars in R&D (the 2.4 % more than 2014), China in 2015 grew up by 8.4%, three time higher than USA. This is confirmed also by the OECD chart contained in the figure 5:

[4] www.sba.gov

[5] Every data is computed in the light of the PPP.

Figure 5 – Human and financial resources devoted to R&D

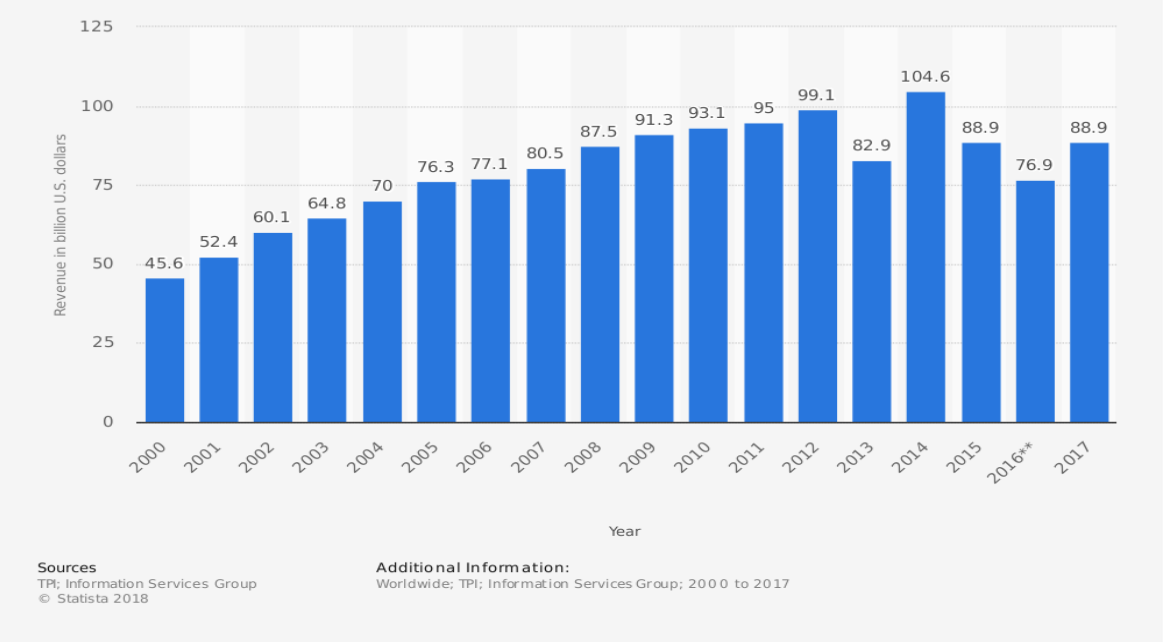


Source: OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The digital transformation*, OECD Publishing, Paris.

According to R&D Magazine, the increasing exploitation of outsourcing strategy can be observed nowadays in the field of the R&D management (Greuber, 2009, www.R&Dmagazine.come). The 83% of the North America firms implemented outsourcing activities "to perform part of their R&D functions" (Greuber, 2009, www.R&Dmagazine.come). In so doing, firms have made R&D connections and innovations as a commonplace occurrence (Greuber, 2009, www.R&Dmagazine.come). From a result of a survey that R&D Magazine has conducted in 2009, it appears, indeed, that outsourcing is believed to increase continuously. What emerged from this research is the fact that outsourcing strategy is seen differently from the past: outsourcing is an activity that continuously changes its own nature, and it has become a core practice of firms (Greuber, 2009, www.R&Dmagazine.come).

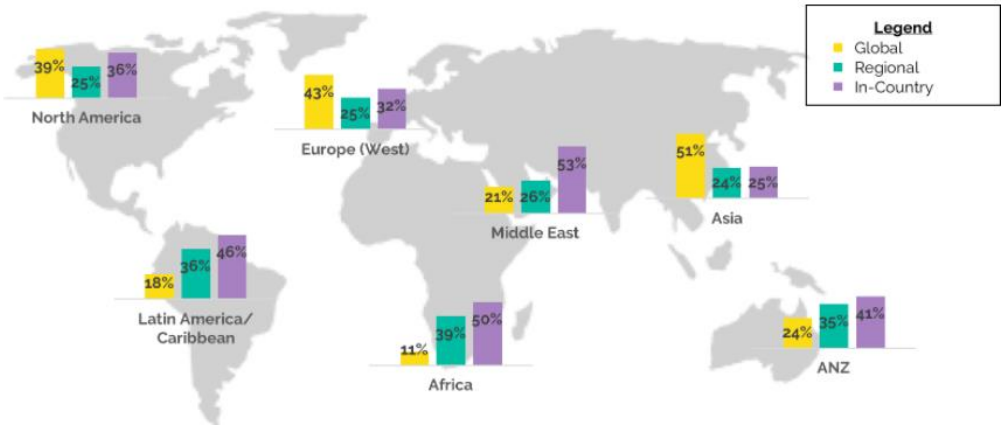
From 2000 to 2017 the trend of exploitation of outsourcing strategy has been positive and continually increasing. The Information Services Group estimated this positive trend which has been illustrated by the following figure 6:

Figure 6 – Global trend of R&D



This graph shows the global market size of outsourcing from 2000 to 2017. To give a geographical trend to describe areas where it has been operationalized, India was the best country where offshoring outsourcing has been implemented. In Europe and in the Middle East, business process outsourcing, and information technology outsourcing generated 88.9 billion U.S. dollars about. Latin America and South Africa got high proportion as well. As Zimmerman reported in his paper, "globally, the outsourcing market amounted to $104.6 billion in 2014, with Europe, the Middle East and Africa leading the charge, followed by the Americas and Asia.[3] To help put that number in perspective, $104 billion would be enough to build New York's One World Trade Centre, twenty-seven times. Some estimates, including one by market information provider IBISWorld, put the global number even higher, at $136 billion, funding over 900,000 jobs at 162,000 businesses" (Zimmerman, 2018, www.smartceo.com). The following figure 7 describes how outsourcing was globally spread in 2017:

Figure 7 – Geographical global trend of R&D



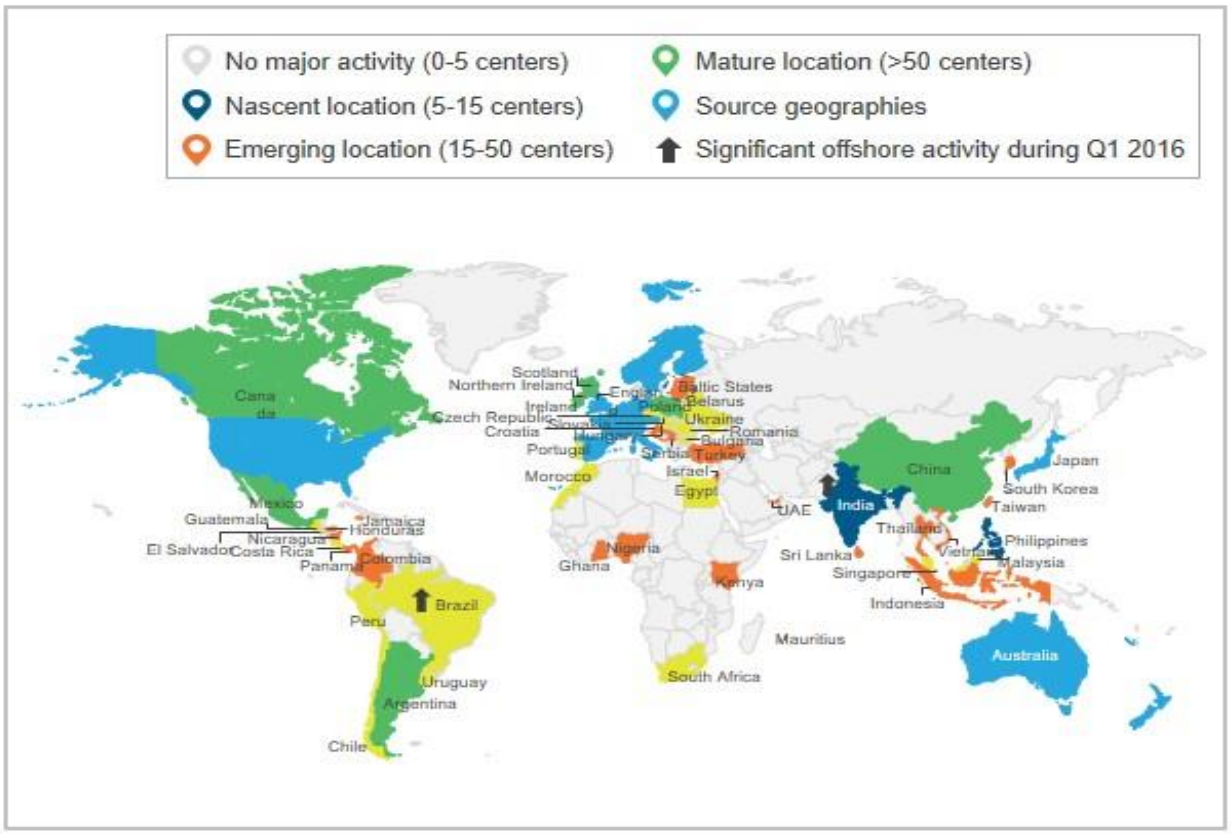
Compared with the global sourcing industry outsourcing trend of the 2017 Report, the 2018 global sourcing Report experienced an increasing trend in outsourcing demand, setups of global in-house centers (GICs) and service provider revenues (The Sourcing Market is on the Up and Up: Everest Group Reports Rise in Global Outsourcing Demand, GIC Activity and Service Provider Revenues in Q2 2018 | Press Release, in www.everestgrp.com). This comparison is represented in the following figure 8:

Figure 8 – Comparison between the 2017 trend and the 2018 trend

Source: Everest Group

In the following figure 9, reported by the Everest Group, we can observe the geographical expansion of the outsourcing activities in 2018 globally:

Figure 9 – Geographical expansion of the outsourcing activities in 2018



Everest Group®

According to Zimmermann, "outsourcing will continue to grow, and its growth will be exponential. But the work itself will change radically" (Zimmerman, 2018, www.smartceo.com).

However, this is not confirmed by Everest Group forecasting previsions: "Sourcing activity in 2016 was marked by increased location activity that was concentrated in the top-10 locations in offshore/nearshore countries. Another prominent trend in 2016 was the growth of digital services; the share of digital services in outsourcing deals as compared to traditional services rose to 35 percent in 2016, with cloud, analytics and mobility services leading the way" (www.everestgroup.com). It produces "a continued decline in the outsourcing growth rate1 over the next one to three years, falling to as little as 1.9 percent by late 2019, as a result of macro uncertainties, technological disruptions and competition" (www.everestgroup.com). This is due to the fact that "The sourcing industry is also facing substantial technology-led disruption. The increasing adoption of automation and DevOps; the growing utilization of IoT, machine learning and analytics; and the need for higher-skilled talent with digital expertise will be key

drivers, causing enterprises to re-evaluate their location portfolios to address changing service delivery models" (www.everestgroup.com).
Overall, Everest Group expects the preference for the in-house delivery model to increase, as it offers the potential for better risk management and control over IP, increased productivity, the ability to deliver more specialized or complex work, and other value benefits beyond labour arbitrage" (www.everestgroup.com).

4. The global trend of R&D outsourcing in pharma and biotech sectors

In order to give a tangible awareness of the sourcing market reality in the context of contractual relationships and partnerships, in the following sections we want to report a description of pharma and biotech R&D outsourcing.

As far as the market for technology and the R&D outsourcing are concerned, "the pharmaceutical industry has also undergone major change in terms of its industrial ecology with the rise of new research-based biotechnology and biopharmaceutical firms that have entered the drug market since the late 1970s" (Lockwood Howells, Gagliardi, Malik, 2012, p. 10).

Academic literature classifies pharmaceutical industry as a "high value, research-intensive sector" (Lockwood Howells, Gagliardi, Malik, 2012, p.10). Pharmaceuticals, indeed, compete in terms of quality, efficacy and technologically advanced innovation on the horizon of the its science-based structure (Lockwood Howells, Gagliardi, Malik, 2012).

Innovation and research represent the core key of success in the commercialization of innovative product aimed to the health care system and the R&D activities represent the core competency of the sector itself (Lockwood Howells, Gagliardi, Malik, 2012). For this reason, it is a matter of fact that pharmaceutical is a sector that intensively uses the market for technology when working with the biotech companies, and also intensively relies on licensing, intellectual property and property rights when performing in-house R&D activities (Lockwood Howells, Gagliardi, Malik, 2012).

However, the continuously rising cost of R&D activities (Lockwood Howells, Gagliardi, Malik, 2012) are pressing pharmaceutical and biotechnological sectors (Lockwood Howells, Gagliardi, Malik, 2012). Considering their nature, these two sectors necessarily

need external sourcing of R&D. The way in which they source R&D is through technological cooperation alliances (Lockwood Howells, Gagliardi, Malik, 2012).

Thanks to this openness in looking for external sources of R&D (that created the market for technology), "the research and knowledge boundaries of the firm are becoming more open, porous and indistinct. Above all, the increasingly distributed nature of innovation within the pharmaceutical industry should be seen in an increasingly international context" (Lockwood Howells, Gagliardi, Malik, 2012, p. 10). These networks among biotech and pharma sectors generated new knowledge. New knowledge generated new sectors of research. Thus, new sectors of Knowledge have been deeply studied, such as "cell and molecular biology, pharmacology and physiology, in the pharmaceutical industry where large, established pharmaceutical firms, based on traditional chemistry, lacked experience" (Lockwood Howells, Gagliardi, Malik, 2012, p. 10).

In these new fields of research emerged new firms that have been defined by Orsenigo and colleagues (Orsenigo et a., 2001, p. 501) as 'specialist' firms, because they are dealing with "clinical trial companies and small biotechnology firms specialising in, for example, genomic research, and computational biology" (Lockwood Howells, Gagliardi, Malik, 2012, p.555). This block of new knowledge permitted the discovery of new horizon for those firms dealing with innovation in several sectors and moreover new frontiers for the production itself. This produced the emergence in the market of new firms (small sized firms), that started to represent a new factor of competitiveness for large pharmaceutical and biotech companies.

The difference between the two classes of firm size refers to the way in which they acquire knowledge. The traditional idea that large companies were more likely to outsource R&D has been reversed (Lockwood Howells, Gagliardi, Malik, 2012). Nowadays, small firms are continuously exploiting external sources of R&D. Moreover, this is true for the small biotech firms. Small biotech firms are "catching up 'big pharma' in their levels of outsourcing because of cost pressures (associated with their high cash 'burn rates') and the development of a wider R&D outsourcing ecology. this provides a greater selection of R&D providers to choose from with tasks becoming ever more specialised with the increasing division of labour and expertise" (Lockwood Howells, Gagliardi, Malik, 2012, p. 555). On the contrary, large firms are quite behaving to maintain their position as big companies within the market. Instead of concentrating their

work as suppliers of knowledge, on the contrary they prefer to maintain their contractual power in a certain sense, exploiting their dominant position.

Even though big pharma industries tried to adapt the market, by developing a more flexible behaviour and approach with respect to the new entrant, nonetheless they rest less likely to acquire external R&D. While on the one hand this is understandable, on the other one this is a sort of missing the new possibilities and opportunities that open innovation in the market for technology can contribute "to give" in terms of advantages for the civil society as well as for the economy (Arora, Gambardella, Fosfuri, 2000)[6].

This new trend of the outsourcing behaviour of firms started during the last economic crises. Indeed, in 2007 R&D Magazine published the Nice Insight's report. Nice Insight Report has tracked outsourcing behaviours in the drug development industry in North America. Its purpose was that of capturing the most significant trends in the market of drugs, pharmaceuticals, and biotechnology to give new insights for launching innovative products in the field of drugs into the global pharmaceutical and biotechnology market at a lower cost and faster pace. What emerged from this research reveals the fact that firms that in the beginning were focused on in-house R&D activities, reversed their approach by focussing on strategic partnership According to Nice Insight Report, many pharmaceutical innovators were used to keep pharmaceutical R&D discovery in-house, in order to retain intellectual property started to outsource (R&D Magazine, 2007).

[6] Then, literature suggested interesting reasons that big pharma industry could take into consideration in favour of outsourcing behaviour: "firstly, it can be expected that there will be a size bias given the evolving structure of the industry with large traditional, chemistry-based pharmaceutical firms being dependent on smaller biotechnology and information and knowledge-based firms for R&D expertise. The larger the firm or business in the pharmaceutical industry, the more likely it is to be engaged in outsourcing. Thus, Gassmann and Reepmeyer (2005) and Gassmann et al. (2010) state that R&D expenditures are escalating as a result of high investments in new drug discovery and more complex clinical studies and, as a response, larger pharmaceutical firms have started to focus on balancing the right size and structure of their R&D activities which has led to a trend of more open innovation, including the outsourcing of R&D. Secondly, larger firms have more resources and are better able to scan their research horizon for opportunities to collaborate and outsource their R&D. Thirdly, larger firms or businesses are also more likely to have greater absorptive capacity than smaller firms making such potential collaborations more effective. A further factor playing in favour of such hypothesis is that smaller firms might find outsourcing challenging as the relatively smaller size of contracts do not provide enough contractual power in drawing up an advantageous outsourcing agreement (Hatonen and Eriksson, 2009)" (Lockwood Howells, Gagliardi, Malik, 2012, p 557)

After the 2009 economic crisis, within such a faltering economy, competition was increased, generating unsustainable R&D expenditures. In the drug sector, pharmaceutical companies were looking for new strategies aimed to reduce costs and develop new drug. As a result, pharmaceutical companies started to accelerate their R&D outsourcing activities (R&D Magazine, 2009).

According to R&D Magazine, outsourcing was supposed to be considered by R&D managers as an answer for pharmaceutical and biotech sectors (R&D Magazine, 2007). According to the Cutting-Edge Information study (Uniting R&D and Marketing for Integrated Early-Stage Market Preparation Report), reported by R&D Magazine (R&D Magazine, 2007), pharmaceutical and biotech companies in that period started to outsource. Pharma and biotech industry considered, in fact, outsourcing as a tool that would allow them to "free up cash for more early-stage marketing" (R&D Magazine, 2007). According to the Cutting-Edge Information study, "early-stage development and commercialization resources can be hard to come by" (R&D Magazine, 2007). Indeed, by exploiting R&D outsourcing, firms could commercialize better their product in the market for technology. According to the report, "pharmaceutical companies [were] looking towards the biotech sector to outsource development of new drugs. In doing so, the company [could] free up resources to market drugs currently in their pipelines […]. The idea [was] based on the biotech industry's capability to develop innovative products more quickly than slow-moving […]. The company [invested] almost as much in early-stage research as it would for an in-house compound, but it [outsourced] the work to smaller, faster-moving biotech, which [assumed] some of the risk that the company would otherwise retain" (R&D Magazine, 2007).

This novelty in the strategy for firms operating in the market for technology, was followed between 2011 and 2016, by the practices of open innovation and CRO[7], as a way to operationalize the strategy of outsourcing.

As far as the open innovation is concerned, the necessity of pharma and biotech companies to acquire innovation is a matter of fact. One way to acquire, trough the practices of outsourcing, is the open innovation. Open innovation "moves outside the proverbial box" (R&D Magazine, 2011) of the firm the R&D, but while the traditional way to acquire outsourcing was that of spending internal capabilities to produce R&D at

[7] Contracts of research outsourcing

a higher cost, open innovation allows firm to obtain external knowledge as a resource for the internal advantage at a lower cost. In this sense, the exploitation of outsourcing for innovation encourages companies to use external sources of new knowledge "as a means to advance technology" (R&D Magazine, 2011). Open innovation allows companies to buy or to license innovation "from other organizations anywhere in the world, instead of relying entirely on their own research efforts. Likewise, inventions developed internally that are not being used or marketed by an organization can find new life through licensing, joint ventures, or collaborative efforts with other companies […]. In open innovation, by contrast, a company reaches out to innovation resources that expand internal capabilities and become an asset for the company" (R&D Magazine, 2011).

As far as CRO is concerned, this is another model of exploiting R&D outsourcing in the market for technology. This models would provide a "strategic partnerships to streamline costs, better manage capacity, improve efficiencies and decrease time to market" (Industry standard research, R&D Magazine, 2016, www.R&DMagazine.com). In 2016, the situation was completely reversed. Indeed, R&D Magazine published the "Contract Development and Manufacturing Outsourcing Models" report made by Industry Standard Research. According to its results, R&D Magazine declared that two-third of the North America manufacturing of the pharmaceutical sector is just outsourced. What this report underline refers the motivations and strategies that move pharmaceuticals to outsource innovation and how managers of this sector select their suppliers. In addition to this, it describes that tactical or transactional outsourcing models are exploited by pharmaceutical. According to this report, "two-third of Pharma Manufacturing is outsourced" (www.outsourcing-pharma.com, 2016), while only one-third in-house. This is an important change ad challenge for the practice of outsourcing. According to Outsourcing-pharma, "this report digs into how the internal resources and know-how at sponsor organizations impact both the decision to outsource and which outsourcing model to use in order to gain the stability in supply appropriate to one's needs" (ww.outsourcing-pharma.com, 2016). In another 2016 survey of Nice Insight, it has been confirmed the fact that the CRO is used because it guarantees "better quality, increased efficiency, greater competitive advantage, and added operational and technical expertise as top reasons for clinical trial outsourcing" (www.outsourcing-pharma.com, 2016).

Nowadays pharmaceutical and biotech companies exploit outsourcing because of the risk of performing R&D activities in-house. According to news-medical, "the average cost

of drug development can reach into the billions of dollars, and it takes an average of 10 years to bring a new drug to market. In addition, many drugs fail to be clinical effective and subsequently never see the light of day" (www.news-medical.net, 2018). In the light of this, the outsourcing strategy used as a costs-saving measure, in pharmaceuticals helps companies to reduce operational and manufacturing cost and allows them to lower financial risks. According to Biopharma Trend, pharmaceutical companies have intensively and exponentially increased the exploitation of outsourcing. Both Biofarma Trend and New-medicines affirm that CRO strategy is the most used outsourcing strategy by pharmaceuticals and biotech. According to News-medicines, "private contract research organizations (CROs) and other academic organizations represent the primary outsourcing locations for pharmaceutical companies, and many of these companies provide everything from drug discovery and structural analysis to phase 4 clinical trials" (www.news-medical.net, 2018). This is due to the fact that CRO is "a strategy to stay competitive and flexible in a world of exponentially growing knowledge, increasingly sophisticated technologies and an unstable economic environment" (Biopharma Trend, 2018)

5. The Italian Trend and the Transfer of Innovation

After looking at the global situation of the market for technology within which the pharma and biotech sectors exploit outsourcing, we want to describe a closer reality of this phenomena. According to the availability of data, and according to the weight that the tech outsourcing is going to continuously acquiring, Italian case can be an important example, which is in line with the existing literature, on the one hand, and with the current facts that globally are happening in the market for technology.

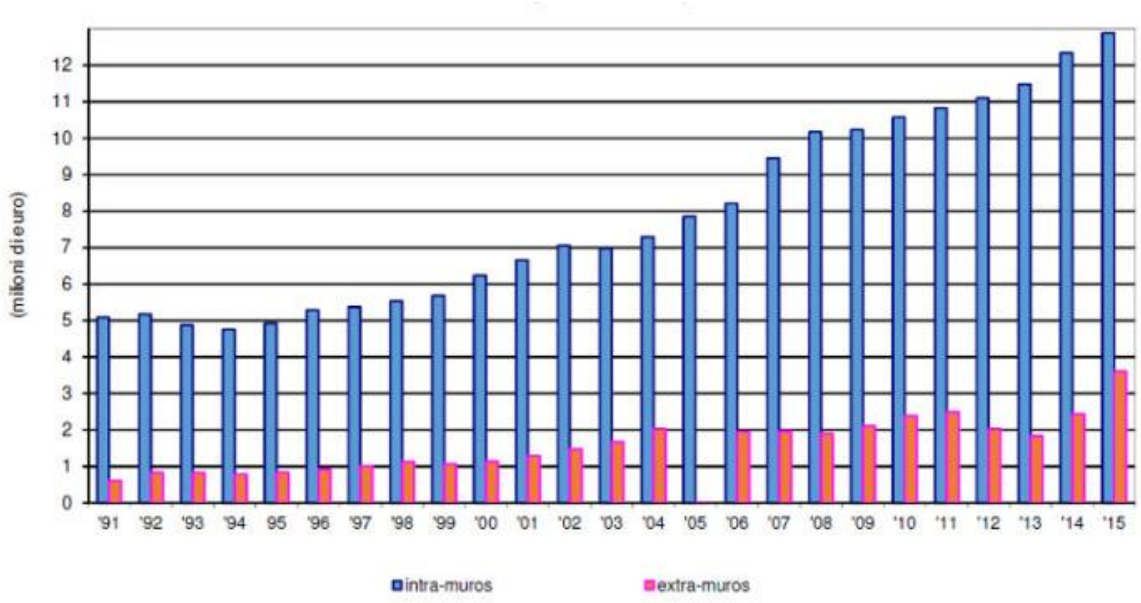
According to the 2015 Istat Report (Istat Report, 2015), on the competitiveness of production sectors with respect of R&D, firms dealing with the biotech sector recur to outsourcing of R&D (Airi, 2018). According to this Report, between 2012 and 2014 Italian firms used to outsource about 16% of R&D activity, showing a decreasing trend with respect to the past negative trend in exploiting outsourcing R&D (-14.5%) (Airi, 2018). In addition, manufacturing and service companies intensively recourse to outsourcing as well. However, according to the Report, this finding does not reflect necessarily the expression of a vertical integration management, because it is not excluded the possibility that some functions are performed internally within the company (Istat report, 2015, p. 48).

Manufacturing and services industries purchased mainly legal, accounting and financial services (respectively by 63 and 55.3 per cent of the companies). In addition, the manufacturing companies declare that they have a significant impact (for almost 54 percent of the units of the sector) on the outsourcing of transport, distribution and storage services, and for about 41 percent to that of ICT services, together with some minor activities of outsourcing, such as the sectors of design, research and development and marketing and after-sales services (only declared by 20% of companies in the first case, since 16 percent in the second, from less than 15 percent in the third case). However, the exploitation of outsourcing is a continuously increasing phenomenon that has grown over the past two years, both between manufacturing and service companies.

As far as the manufacturing sector is concerned, while the percentage of companies that claims to have maintained the degree of recourse to external sources for the performance of the aforementioned functions is more than 60 percent, on the other hand the percentage of companies that declare to have intensified the outsourcing of these services is always higher than that of the units which claim to have recourse less than before. This occurs, in particular, for those functions that were less frequently performed in outsourcing, such as research and development. Indeed, according to Airi, during the 2016, outsourcing exploitation reached the 28% more than the previous years with respect to the in-house R&D expenses (Airi, 2015). According to Airi, R&D expenditure represents a record because over 3.6 billion euros of R&D activities has been invested from external companies in 2015.

According to ISTAT data, 33% of external companies bought Italian R&D activities through outsourcing contracts in the market for technologies. In addition, the increment of research and development that Italian firms negotiated with university is particularly significant (from 2.50% in 2014 to 7.50% in 2015). Moreover, the 76% of R&D outsourcing expenses is largely invested within Italy and the 60% of those expenses are addressed to other Italian companies and other public and private organization. The weight of the contract of transfer of innovation and outsourcing contract to buy and sell R&D among firms in Italy is represented by the following figure 10 :

Figure 10 – R&D Intra-muros and extra-muros expenditures in Italian enterprise



Source: Istat, 2018

As far as biotech Italian firms are concerned, according to Airi and the 2018 BionItaly Report (produced by Assobiotec, made up of Federchimica, and ENEA, both Airi Members), the Italian biotechnological industry is characterized by a step of highly intensive phase of research and growth. According to this report, in Italy there are 571 companies working in the sector of biotechnology. The 90% of these companies is composed of micro and small firms, dealing with the production of R&D to be sold in the market for technology. The 38% of this group of biotech companies deals with the commercialization of their R&D product within foreign market for technologies, more than manufacturing sector (23%) and more than the Italian industry as a whole (5%). The distribution of Italian biotech exports is concentrated as follows: the 90% of the totals concentrated in Lombardy, Piedmont, Tuscany and Lazio. The investments in R&D biotech represent 35% of the total R&D investments for the total of the companies analysed, this figure rises to 90% for companies dedicated to Italian biotech R&D. The amount of biotech R&D expenditure is 764 million euros around, that is more the 22% compared with the 2014. The 34% of the total biotech expenditures in research activities are outsourced (extra-muros biotech investments), while the 67% of research activities are carried out in-house (intra-muros biotech investments).

As far as the BioinItaly analysis is concerned, it collects, computes and studies about biotech Italian companies up-dated to 2017. On the base of its estimations, biotech firms working in Italy represent an important and remarkable segment of this sector within the

Italian scenario, reaching an international excellence thanks to the application of the research in pharmaceuticals, medicines, food farming, health-care and advanced therapies.

The report uses the OECD guide-lines and, in so doing, Italian biotech firms are split into two macro groups:

1) Biotech enterprises: firms implementing at least one biotechnological technique. This kind of firms produce good that are technologically advanced in order to develop research in the field of biotechnology.
2) R&D Biotech enterprises: firms dedicated to the biotech R&D, investing at least the 75% of their own internal budget in research and development. In other words, these firms are dealing with in-house biotech R&D to be sold within the market for technology, the national one and the foreign one.

Within these two macro groups, firms are sub-split again in micro sectors, according to the specific field they are dealing with: health care, food farming and zoo-technologies, and GPTA, that is firms dealing with the research about genomic and proteomic technologies.

The life of the Italian biotech industry is living a moment of stabilization; all the principal economic indicators of this economy estimate an increment and increasing trend in the rate of growing of this sector. The following figure 11 describes some statistical data about the biotech industry in Italy:

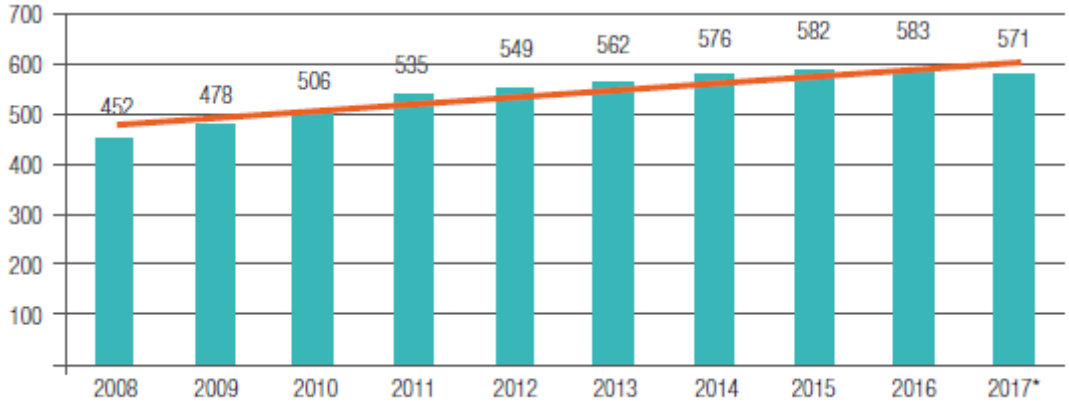
Figure 11 – Data on Biotech industry in Italy

	Total number of firms	Biotech R&D Firms	Biotech R&D Firms with Italian Capital
Number of firms	571	323	296
Biotech revenue	11.535.929	4.583.022	1.124.316
Total R&D Investments	2.148.985	549.843	300.474
Total Biotech R&D Investments	764.367	491.607	270.039
R&D Personnel	12.781	5.879	4.087
Biotech R&D Personnel	3.790	2875	1.868

Source: BioinItaly, 2018

As it can be observed in the table, in the end of 2017, it has been enumerated 571 biotech firms. 323 firms over the total amount of 571 (the 57%) is composed of firms that, in line with the OECD guide-lines, invest their own 75% of financial resources in biotech in-house R&D. These firms are small sized firms. The total biotech revenue is grater than11,5 billion of euros spent between 2014 and 2016. The increment is more than 12%, despite the negative economic conjuncture. In the following figure 12 we can observe the demographic trend of the number of biotech firms in Italy:

Figure 12 – Trend of Italian Biotech firms

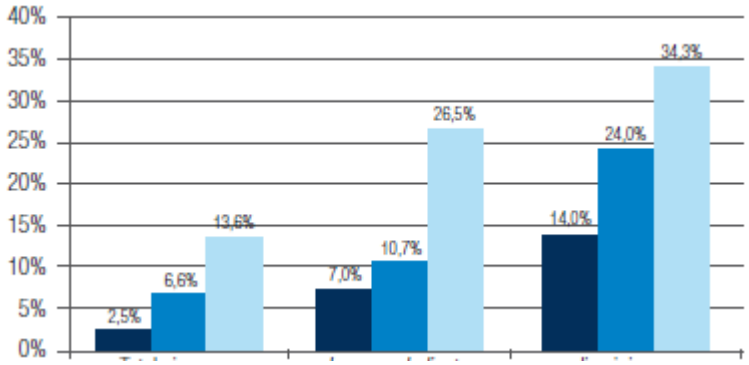


Source: BioinItaly, 2018

As it can be seen, the Italian biotech industry for R&D is continuously growing. The amount of biotech firms is rose by 57% in 2017. The overall investments in R&D rose by 760 billion euros as well as the growth that rose too by 22% between the 2014 and 2016.among the enterprises dedicated to biotech R&D, the amount of the small sized organizations represent the 89 %, rising 13 points with respect to the biotech industry as a whole.

As far as the biotech R&D intensity is concerned, BioinItly 2018 describes the trend trough this figure 13:

Figure 13 – Biotech R&D intensity



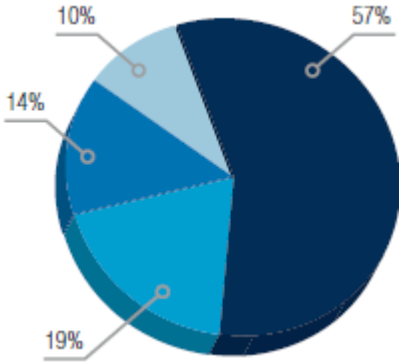
Source: BioinItaly 2028

The dark blue area describes the R&D intra-muros investment over the total amount of investments, the medium blue describes the biotech R&D intra-muros investment over the total amount of investments, the light blue the number of Personnel R&D over the total amount of the number of employees. the first histogram on the left describes the total amount of firms; the second histogram shows the firms dealing with biotech R&D According to these data, the 57 % of active companies, that is 323 companies, is composed of firms investing at least 75% of the intra-muros investments in R&D to biotech research activities. 296 firms have Italian capital as it is represented by the third histogram.

According to the report, the R&D intensity of the sector is confirmed to be high and the investment in sustained growth in biotechnological R&D. This is reflected in an increase in the share of companies specializing in biotechnology and even more so in those specializing in biotech R&D. As far as the firm size in concerned BioinItaly2018, produced this interesting figure 14[8]:

[8] As far as the firm size is concerned, the distribution of number of employees is concentrated as follow: micro = 1-9 employees; small 10-49 employees; medium= 50-249 employees; large = 250+ employees.

Figure 14 – Pie chart of the firm size in biotech sector



Source: BioinItaly 2018

According to this graph, the 57% of Italian biotech firms is composed of Micro sized firms; the 14% of Italian biotech firms is composed of small sized firms; the 19% of Italian biotech firms is composed of medium sized firms and just the 10% is represented by large companies. BioinItaly also describe the percentage during the time from 2014 to 2017 in this figure15 that we reported as follow:

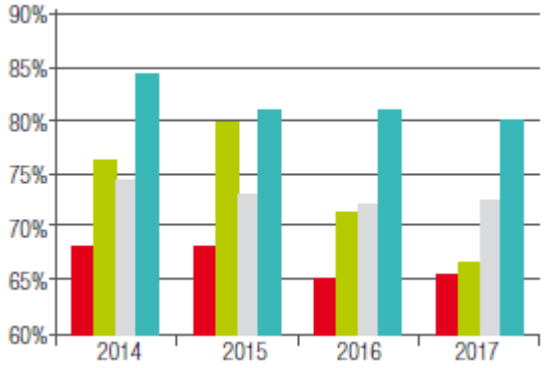
Figure 15 – Statistics of firm size in biotech sector

	2014	2015	2016	2017
Micro	60%	59%	58%	57%
Small	17%	18%	18%	19%
Medium	13%	13%	14%	13%
Large	10%	10%	10%	10%

Source : BioinItaly, 2018

According to these tables, we can observe that the 76% of Italian biotech firms is composed of small sized firms. Between the 2014 and the 2017 an increment of the number of small sized firms can be observed. Only the medium enterprises semm to be reduced. This reduction is due to the fact that since the biotech sector is continuously growing, a general reduction implies a single growth of a single firms in this sector.
According to the firm size, BioinItay report describes the field of application of the biotechnologies produced in Italy:

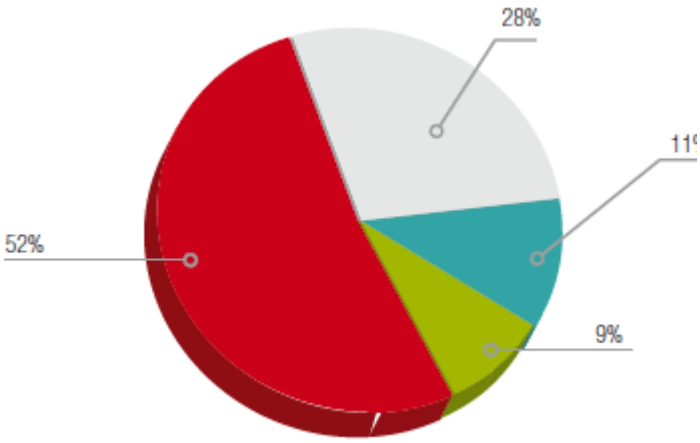
Figure 16 – Field of application of the biotechnologies produced in Italy



Source: BioinItaly 2018

According to the graph 16, the red histogram represents the health care sector; the green represents the food farming and zootechnology sectors; the grey area shows the environmental industry, and finally the light blue histogram describes the GPTA sector. Another pie chart in the figure 17 of Bioninitaly 2018 report describe the analysis of the application sector of the biotech R&D:

Figure 17 – Pie chart of the application sector of the biotech R&D



Source: BioinItaly 2018

This pie chart is a photography of the biotechnology companies in Italy, confirming, according to the BioinItaly Report, the Italian excellence the health care sector, which rose by the 52% of the overall amount of biotech firms as a whole.

6. Three case studies

An important example of the Italian reality in the sector of Biotech, Pharmaceuticals and Health care is represented by TTFactor.

TTFactor is a small sized company that deals with transfer of innovation activity at the Oncological European Institute and at the Institute of the Molecular Oncology Institute too. Both the Oncological European Institute and the Institute of Molecular Oncology are working to enhance R&D activities through TTFactor. TTFactor has been created in 2010 by both of the Institutes, in order to foster the development of drug discovery and to commercialize the research products. We obtained information about their history and their activities through their web site.

After its constitution, the organization signed more than 200 contracts with other firms and other Italian and foreign investors. Indeed, TTFactor is the exclusive licensor of the Intellectual Property produced by the two founders Institutes. Since the tech transfer in the medical field are supposed to be risky, in 2015 TTFactor signed a contract wtih Sidinnova.

Soffinnova is a strategic partnership, and in addition it is also an important venture capitalist in Europe. It is specialized in medical technologies and it has created a BiovelocITA, the first Italian accelerator dealing with the biotech sector. The contract is an R&D outsourcing partnership through the form of transfer of technology.

This contract allows the two parts to finance research activities such that of testing the effectiveness of technology on the experimental models they have discovered in clinical and medical fields. In addition, TTFactor announced another partnership on an anti-tumoral research project. If the test will be positive, they announced also the constitution of a new spin-off or a licence for further future drug discovery.

In addition to this Italian case, we want to report other two cases. Kamuriwo and Fuller (Kamuriwo, Fuller, 2016) conducted a research study on two case studies, Avertical and Ehub, in order to compare their approaches in the development of biotech products. They started their research by dividing what the firms were performing in-house, and what they were acquiring externally.

As far as Avertical is concerned, it is a company founded in 1998, performing anti-infective medicines. By 2003, Avertical started focussing its production in the sub-segment of antiviral and anti-bacterial drugs sector. This change moved the company to reorganize its own R&D management. It implied "downsizing R&D staff numbers from a peak of 70 in early 2004 to about 50 by late 2005, and adopting a flatter organizational structure by removing a whole layer of management […]. After this move, according to senior managers, Avertical's R&D capabilities were 'at the cutting edge of science' and targeted 'novel markets'" (Kamuriwo, Fuller, 2016, p.1038).

During that shift in rearranging the organization of its R&D structure, the company started to develop new high technology. In order to implement this activity, Avertical built a partnership with seven external suppliers (Kamuriwo, Fuller, 2016). This partnership was exploited to develop core in-house R&D skills (Kamuriwo, Fuller, 2016). The partnership was composed by "Inpharmatica (a specialist provider of bioinformatics data), Tripos (Avertical's supplier of chemistry in its early days) and Replizyme (a specialist assaying service provider); and four universities that provided specialist services, including chemistry and assaying" (Kamuriwo, Fuller, 2016, p.1038). This partnership of R&D outsourcing allowed Avertical to growth fastly and continuously during time, so that the company started to sell and exchange intellectual property and sharing the cost of R&D activities with the other partners through the collaboration that the company built with Virogen Inc., Triangle Pharmaceuticals and Acambis (Kamuriwo, Fuller, 2016, p.1038). This new collaboration allowed Avertical to reach the general goal to transfer knowledge, through its approach based on alliances with a selected outsourcing partnership.

The agreements that Avertical signed was based on the fact that "each firm would pledge to use their internal capabilities to incorporate the other's IPRs, and to choose – independently – promising technology that they would jointly fund going forward" (Kamuriwo, Fuller, 2016, p.1038).

As far as Ehub is concerned, it is a British company, founded in 1998 and engaged in anti-inflammation therapeutics. The structure and financing management of it R&D department depended on an important public research laboratory. (Kamuriwo, Fuller, 2016). The research that the company was developing involved "extracting tick saliva

molecules for use as potential anti-inflammatory drugs using emerging recombinant technology" (Kamuriwo, Fuller, 2016, p.1039).

The goal of the Ehub patent policy on this strategy: as its CEO expressed and Lockwood Howells, Gagliardi, and Malik reported, "[Essentially] the strategy is to try to patent the biology source, to patent the means of discovery of the agents and then to patent the agents themselves. And then when the activity in human beings is observed for the first time, to patent that mode of treatment again. So, you have actual substance of matter patents through to use patents. And the whole purpose of this was to try to get a reasonable lifetime for the overall patent" (Kamuriwo, Fuller, 2016, p.1039).

7. Conclusion

The difference between the two cases of Avertical and Ehub refers the opportunity to spread knowledge in an open system based on alliances versus a closed structure. While Avertical employed a large number of R&D personnel, Ehub decided to focus on a few expertise "who outsourced all of Ehub's R&D by working collaboratively with carefully selected partners to design studies and commission external development for each and every stage in the drug development value chain […]. The approach was knowledge access rather than knowledge transfer" (Kamuriwo, Fuller, 2016, p.1039) as Avertical has done by building and exploiting a consistent partnership. These two differences reflect in concrete the real difference between make and buy decision, the managers wondering on what to buy and to buy it, and what to perform internally and at a which cost.

Avertical's system was internally focused, founding its activities on the "core in-house multidisciplinary R&D knowledge" (Kamuriwo, Fuller, 2016, p. 1040). This structure has facilitated the flow of knowledge transactions. This flow of knowledge among several sectors of research has been crucial in terms of innovation (Kamuriwo, Fuller, 2016). The dense flow of external knowledge that Avertical could move has been also possible thanks to the alliances that the company could create (Kamuriwo, Fuller, 2016).

On the other hand, Ehub is characterized to be a closer reality, based on a few researchers working on innovation technology in a laboratory and focussing just on few target of research. The way in which this company could transfer knowledge was founded on the

“extensive co-authorships and citations in scientific publications and patents between the firm’s scientists and other organizations” (Kamuriwo, Fuller, 2016, p. 1040). This system “obviate the need for dense cross stage knowledge flows but still allow the integrator to access very specialized knowledge within each development stage” (Kamuriwo, Fuller, 2016, p. 1042).

With respect to Avertical, Ehub has no partnership a still remains in the laboratory. On the contrary Avertcal developed its own border thanks to alliances, even though Avertical was based on an internally focused system integrator, this system is in fact integrating external reality. Then while Avertical, through partnership is a buyer of R&D, Ehub is a seller of R&D.
In the case of Avertical the management behaviour is based on what to buy externally in order to complement and rich the internal production. In the case of Ehub the idea is that of what to produce in-house in accordance with the clients’ health care needs. As it has been claimed, “the internally focused product system integrator has few upstream or mid-stream external partners. In contrast, the network structure of the externally focused system integrator involves outsourcing product development stages to partners – a division of labor in which a product development stage is linked to a relevant network partner with the necessary knowledge” (Kamuriwo, Fuller, 2016, p. 1043).

The Avertical case study is an interesting model that shows us how it is important in the market for technology the complementarity between internal and external R&D and moreover it is a demonstration of the fact that insourcing and outsourcing R&D are not two polar alternatives, are not perfect substitutes, and do not represent a binary decision (Tierlink, 2015, Cassiman and Veugelers, 2006, Chesbrough, 2003, Lockwood Howells, Gagliardi, Malik, 2012, Kamuriwo, Baden-Fuller, 2016). The consequences of Ehub strategy is that of precluding and making closer the R&D activities no longer on the core activities, but on the non-core activities (Lockwood Howells, Gagliardi, Malik, 2012, Cassiman et al., 2005, Veugelers, 1997 Kamuriwo, Baden-Fuller, 2016).

Although the literature has emphasized the importance of core competences and the protection of innovative product as the necessary tool to get and to keep competitive advantage (Barney, 1990), nowadays it seems that a knowledge integration through alliances and networks among firms to transfer innovation based on an open system are the most available management practices that can operationalize the strategies of

outsourcing and insourcing within the market for technology (Arora and Gambardella, 2000; Chesbrough, 2003; Cassiman and Veugelers, 2006).

Considering the current variability of the market and, given the continuously increasing trend in the technology research, especially the research and innovation in the fields of biotech and pharmaceuticals, rethink of the make-or-buy dilemma can be nowadays conductive of new possibilities either for firms to improve, grow and develop, either for economy and society.

The Kamuriwo, Fuller's study (2016) has demonstrated that a strategy based on an external partnership for transferring technology, knowledge and innovation is more than a simple network among firms to get profit. "It should not be seen as risky and unwise […] but rather that the strategy is an exemplar of pushing the envelope of boundaries to accessible R&D outsourcing" (Kamuriwo, Fuller, 2016, p. 1044).

It has been demonstrated that the openness of Avertical's model can reach not only the implementation of R&D outsourcing within the market for technology, but also the fact that this particular kind of market can increase the possibility to spread innovation through this strategy successfully (Kamuriwo, Fuller, 2016). This can be successful moreover for small organizations. The traditional way of producing in-house R&D and that this R&D product could be produced only by large firms nowadays is going to be reversed. Kamuriwo and Fuller claimed that "though the knowledge base of the externally focused product system integrator is relatively smaller, its product system outcomes are not stunted by the greater on-going externalization of its R&D" (Kamuriwo, Fuller, 2016, p. 1044).

Literature then suggests the importance of outsourcing external R&D and create network, by claiming that "an externally focused product system integrator relies on external partners to access high value core R&D […].The core of the externally focused product system integrator does grow, not to substitute partner R&D expertise but to increase the focal firm's capacity to manage its network" (Kamuriwo, Fuller, 2016, p. 1043) as after all has been demonstrated also by the Italian TTFactor.

As with other research studies, ours paper suffers as well from limitations. The study we conducted focuses on three case studies, with particular attention to the Avertical and Ehub cases. They are two organizations whose work is based on innovative research in biotech and pharma sectors. However, they do not represent the solely cases that act within the market for technology, as well as biotech and pharmaceuticals are not the

solely sector dealing with technology R&D the which in turn point to opportunities for future research. This represents for us an opportunity to proceed our work in future research.

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Chapter 3

The moderation role of firm size in the market for technology

The moderation role of firm size in the market for technology

1. Introduction

In this his paper we focus on the impact of technology markets on firms' technological outsourcing/insourcing strategy. In addition, we discuss whether this relationship is moderated by the firm size. We hypothesize that, in line with the transaction costs approach, the cost of using the market (Coase, 1937, Williamson, 1985) together with the firm size (Cassiman, and Veugelers, 2006), could be considered a determinant of insourcing vs outsourcing strategy in the market for technology. Our theoretical assumptions are based on the Williamson one (Williamson, 1985; 1999). Indeed, when innovation is traded within the market for technology (Arora, Gambardella, Fosfuri, 2001; Arora and Gambardella, 2008), risks of technological outsourcing are higher (Arora and Gambardella, 2008).

Risks of technological outsourcing are higher because the costs of R&D are higher *per sè* (Binz et al., 2007), and the diffusion of new technology is not always a certain goal for firm that try to commercialize new ideas (Guns, and Stern, 2003). In addition to this, the market size conditions should be taken into consideration. It means that if the market for technology is characterized by a higher level of closeness, it would be difficult for new technology to be traded. It would be difficult because of competition (Guns and Stern, 2008; Cassiman and Veugelers, 2006). In such a framework, transaction costs will be higher and contractual relationships will be lower due to the high level of protectionism of companies.

It implies a lack of knowledge and innovation diffusion, a lack of the market for ideas and a loss in terms of development and growth for all the actor operating in innovation, in addition to a waste of efforts. This dramatic scenario would not be in line with the coasian approach, in particular with the idea that the nature of the firm is that of overcoming the market failures. When the market is inefficient because of its high market-price mechanism, there will be a failure in the market for technology (Williamson, 1985).

Due to this scenario, part of the literature affirms that economic contractual relationships are risky (Scherman et al., 2016; Alaghebandet al., 2011; Lacity et al, 2001). They are

risky because of information asymmetries, uncertainty, and moral hazard. Even though these risks strongly relate to the transaction costs theoretical assumptions (Williamson, 1985). The transaction costs approach is no longer a proper theory that can be applied in the relationship between technology outsourcing and market for technology (Scherman et al., 2016). According to this part of the literature, it is necessary to produce an endogenous theory of transaction costs (Alaghebandet al., 2011; Lacity et al, 2001).

But, what if this scenario is allocated within the market for technology? The traditional point of view (Porter, 1985) has always affirmed the dominant role of large organizations in exploiting, producing and selling technological innovation (Arora, Gambardella and Fosfuri, 2001). This approach was due to the fact that technological innovation has always been conceived as the prerogative of large firms because of their size.

However, literature has recently recognized the relevance of the market for technology in the commercialization of new ideas and innovation (Guns and Styern, 2003). Nowadays we can observe an increasing role of small firms and start-up dealing with technological R&D and innovation, more than large firms are still currently doing. Even though the Schumpeterian literature strongly discussed how firm size impacts on R&D intensity for a long time, only recently scholars discussing the complementarity between in-house R&D and the technology outsourcing, recognizing the need to furtherly study whether firm characteristics could impact the relationship between insourcing and outsourcing.

In line with this, we focused on the Veugelers and Cassiman' research (Veugelers and Cassiman, 2006). According to Cassiman and Veugeler (Cassiman, Veugeler, 2006), a lack of efforts alongside this stream of research need to be developed. Cassiman and Veugelers, indeed, claimed the necessity to develop research on the firm characteristics and how firm characteristics can affect complementarity between insourcing and outsourcing. Following this suggestion, the novelty of this paper refers to the role of firm size as a moderator within the relationship between the technology market and the firms' decision to outsource technology.

Then, according to this matter of facts, we also want to see whether the firm size can play a role within the market for technology with respect to the technological outsourcing. In other words, we want to understand whether the influence of the market

for technology on technological outsourcing is moderated by firm size (Badillo, Llorente, and Moreno, 2014/17).

The empirical analysis we carried out is based on 108 companies from US. Firstly, we assessed whether a positive technology market size incentivizes firms to adopt technology outsourcing strategy. Then, we assessed whether firm size could be a driver of this decision. Finally, we tested the hypothesis of the moderation effect of the firm size on the firms' decision to outsource innovation within a large market for technology.

Moreover, we tried to endogenize transaction costs by using the market size as an indicator to measure transaction costs. We obtained this endogenous measure by using the price that each buyer of technology paid to each suppliers of technology in the market for technology. Then by choosing specific technological sector we deducted that the cost of using the market that we identified by the market size indicator is nothing but the price of the logic demand supply and thus, the result of the price costs that each buyers of technology must pay to each technology seller. In the market. It is through this particular and specific framework that we have the technological market size.

This paper is composed of 5 sections. The second one is dedicated to the theoretical framework underpinning our research. This section is followed by the description and motivations of our hypotheses together with the methodological part. The estimation results and the conclusions end this second chapter.

2. Theoretical framework

The decision to insource and/or to outsource R&D is no longer conceived as a binary decision (Spithoven, Teirlinch, 2014). On the contrary, this strategic choice depends on the cost of using the market (Coase, 1937; Williamson, 1985, 1999; Cesaroni, 2004) and on the firm characteristics (Cassiman and Veugelers, 2006). Thus, given the cost of using the market, technological insourcing and technological outsourcing are two complementary strategies, and in both cases, the firm size is a moderator with respect the market for technology conditions. We conceive insourcing and outsourcing as complementary strategy that firms, both large and small sized, can implement within the technology market in order for the technology innovation to be traded among firms that behave as buyers and sellers. In this case, complementarity makes technology market

more efficient, and the problem for small sized firm to commercialize or to acquire technology innovation become less severe (Cesaroni, 2004). The technology outsourcing strategy become, then, a strategy that is applied in accordance with the technology market size (then, the cost of using the market), under the moderation effect of firm size.

2.1 The idea of complementarity and the cost of using the market

The choice between performing an activity in-house or purchasing (outsourcing) it externally from another independent firm is defined in the literature as the classical paradigmatic example of the make-or-buy dilemma (Walker and Weber, 1984, Aubert, Rivard, Patry, 1996, 2003, Holcomb, Hitt, 2006, Parmigiani, 2007, Lacity, Willcocks, Khan, 2014). This choice relates to the so-called vertical integration (Walker and Weberm 1984) and concerns contractual relationships between buyers and sellers.

According to Benoit, Aubert and Rivard, this kind of contractual relationship is a function of what firm decide to produce in-house or to outsource (Benoit Aubert, Suzanne Rivard, Michel Pstry, 1996, 2003). Then, this decision can be placed alongside a *continuum* whose polar alternatives are the make or the buy decision (Bensanko et al., 2012). Close to buy we can find the so-called long term contract method; close to make we can find all the goods and services that a firm need and that it produces internally (Bensanko et al., 2012). On the other side, R&D investment decision is based on the choice between internal and external sourcing (Veugelers, 1997).

From a theoretical point of view, the strategic decision whether to insource or outsource is related to the transaction cost approach. Then, the transaction costs approach represents the lens through which we want to conduct our analysis about the moderating role of the firm size in the relationship between the cost of using the technology market and technology outsourcing.

The nature of transaction costs is exogenous (Cesaroni, 2004; Alaghebandet al., 2011; Lacity et al, 2001), because they represent the cost of using the market (Coase, 1937; Williamson, 1985). Since contractual relationships are endogenous (Lacity et al, 2001), even if they have a transactional nature, they cannot be explained through an exogenous theoretical box. Conversely, since transaction costs theory well represent the relational nature in general of the economic relationship, and in particular of the contractual

relationships among economic agents, it is necessary to rethink the transaction costs approach through an endogenous horizon (Alaghebandet al., 2011).

Since the technological outsourcing strategy depends on the market fort technology conditions, if the cost of using the market is low, firms perform technological outsourcing. If the cost of using the market is high, firms perform R&D insourcing (Cesaroni, 2004, Arora, Fosuri, Gambardella, 2000, Gans, Hsu, Stern 2008). This moves us to use the lens of the transaction cost economizing towards R&D investment decision[9].

The literature dealing with the classical idea of the "make-or-buy" dilemma (Veugelers and Cassiman, 1999, 2006) fund that transaction costs became lower when technology innovation is highly transferred and traded. In addition, it has been shown also that an increase of transaction costs implies an increase of technology market as well. In this case the price of technology innovation increases, and it became more difficult to be commercialized (Teese, 1988; Guns and Stern, 2003). But if the technology innovation is traded within the market for technology, transaction costs became "less severe, and technology outsourcing becomes more attractive option for companies that decide to exploit. In relative terms, the advantage of in-house technology development reduce if markets for technology operate efficiently" (Cesaroni, 2004, p.4) for firms that, in so doing, can overcome "internal technology constraints" (Cesaroni, 2004, p. 4). The reverse works as well, also for those companies that want to sell technology within the market for technology.

Indeed, when transaction costs are high within the market for technology, large sized firms can decide to implement both simultaneously insourcing and outsourcing R&D. Even thought there were low cost of using the market or a high cost of using the market, large organizations can implement both activities. However, this is not true for small firms.

[9] In the transaction costs approach, the make-or-buy-decision logic can be applied to those firms that want to invest in R&D but, having some financial constraints, need to decide whether access to external resources or relying to their internal fund (Czarnitzki and Binz, 2008). In this case, when firms decide to rely on internal resources, that is when firm decide to insource, firms need that their internal resources match the market for technology conditions. Market for technology conditions are uncertainty, information asymmetries, opportunism and bounded rationality (Arora, and Gambardella, 2008).

2.2 The firm size and the outsourcing strategy

Shalit and Sankar, describe the firm size as a firm characteristic figured in several economic field such as, economies of scales, capital market, corporate governance, corporate finance, and strategic management. According to Tangen (2003), Berger and Di Patti (2006), Majdumdar and Chhibber (1999), and Shen and Rin (2012), corporate size is positively correlated to profitability and market value: the larger the size, the better their performances because, as Surajit and Saxen (2009) pointed out, thanks to the economies of scales firm size determines the firm success. This result has been shown in 2012 by Pervan and Visic too: firm size has a significant influence on firm profitability. In studying the impact of firm size on profitability, they found out that larger firms, thanks to their market power and their economies of scales, are able to charge higher prices and, hence, higher profit. In addition to this, larger firms, given their higher negotiating power, can obtain more favourable financing conditions than small firms could do.

The academic debate about the influence and the role of the size in explaining profitability and firm value started with Sheferd in 1972 and Sherer in 1973, by emphasizing the importance of the economies of scale. A positive relation between firm size and firm profitability has been shown by Hall and Weiss in 1967. According to Baumol (Baumol, 1967), the advantages of larger firms depends on their market power as well as their greater access to the capital market. According to Capon et all (Capon et al., 2011), size could be used as a proxy variable of resources. Indeed, in line with the neoclassical approach, larger firms are better equipped because they have more organizational resources. According to Lee (Lee, 2009), the absolute firm size is the key determinant in explaining firm profitability, in particular, firm size can act a driving role to explain variations of profitability" (Lee, 2009). According to Papadognas, firm profitability is positively influenced by firm size (Papadognas, 2007).

Firm size matters in terms of growth through the channel of innovation (Pagano and Schivardi, 2003), because by investing in R&D firms are allowed to grow up and hence to create job and to enhance competition by bringing new products within the markets (Pagano and Schivarsi, 2003). According to this part of the theoretical framework, large firms are associated with faster growth in terms of productivity, because faster growth produces larger firms and higher R&D activities produces faster growth. According to Shefar and Frenkel (2003), R&D investments spawn innovation. Innovation fosters

growth. In order to innovate, R&D investments (in-house or outsourcing) are required. It seems that there exists reverse causality. Nonetheless, Pagano and Schivardi demonstrated that this hypothesis is ruled out thanks to the influence of the size on growth. As a consequence, it seems that not only a full exploitation of innovation benefits from the presence of large firm, but also that R&D activities are influenced by the firm size. As it has been shown by Shefer and Frenkel (Shefer and Frenkel, 2003). Therefore, the positive relation between size and growth increases through the channel of R&D intensity.

According to Schumpeter (1950), large size enhances R&D investment. Indeed, size "has a significant but small positive effect on the R&D intensity" (Coen and Levin, 1984, p1), because a mature capitalistic economy characterized by large firm necessarily produces a disproportion spread of technological innovation (Coen and Levin, 1984, p.2). Coen and Levin, indeed, states that size "affect[s]" the probability of conducting R&D. According to Coen and Levin, the correlation between size and the availability and stability of internal funds depends on the magnitude of transaction costs (Coen and Levin, 1984 p. 2).

A way firms apply to match market conditions is research and development as a strategic to tool to improve their own performances in terms of production of innovative goods. This argument fosters a relationship between innovation and firm size, that varies across industries, depending on their level on innovation investment affordability and market conditions, technological opportunities and absorptive capacity from R&D investment (Coen and Levin, 1984).

The idea behind the relationship between firm size and R&D is that higher investment in R&D foster the firm growth thanks to the economies of scale. The major existing literature, indeed, is characterized by a consensus view according to which "firm size is associated with increasing R&D intensity. According to Coen and Levin, "a simple regression of R&D intensity on size measures alone suggests that the size of the firm is positively associated with business unit R&D intensity" (Coen and Levin, p. 15).

However, as we mentioned in the previous section, the context of the market for technology (Arora, Fosfuri, Gambardella, 2000) and according to the lens of the transaction cost economics, we must consider the firm size differently with respect to

the existing literature. Differently means that the firm size should be considered as characteristic describing the market power of firm (Cassiman, Veugelers, 2006). It is just through this element that the difference between small and large firms is fixed. Large sized firms have that market power that the small firms do not have (Cassiman and Veugelers, 2006).

Considered the market power of large organizations, small firms are in fact not indifferent with respect to the cost of using the market. Not indifferent means that small sized firms have to decide whether to insource or to outsource R&D according to the market condition, i.e. the cost of using the market, and their capability and possibility to face it, accordingly to their absorptive capacity too.

In the context of the transactional market for technology, a strategic behaviour of firms that take into account internal factors (absorptive capacities) and external factors (the cost of using the market), is moderated by the firm size. This is important when firms deal with technological innovation. This importance has been proved by literature. According to Cassiman and Veugelers (Cassiman, Veugelers, 2006), the Schumpeterian literature states that firm size is conductive of R&D and innovation, and in so doing the size is considered important not only because it can describe financial characteristics of firm. In so doing it can explain strategical and contractual reason to explain the fact that large sized firms invest more in R&D.

Given transactional contractual relationships, if we take into consideration the idea that there are not only firms, in particular small firms, that are buyer of R&D, we should also consider that there exist some other independent firms that behave like sellers of R&D. In such a dynamic framework, there exist interactions between large and small firms when the market for technology is efficient. It means that when the cost of using the market is low, small firm can compete strategically with the large one trough a transactional and dynamic logic of make and/or buy decision. The size then impacts as a driver for innovation. Thus, small sized firms innovate in the market for technology. However, when the cost of using the market is high, and when the market for technology is not efficient, only large sized firm will implement outsourcing. In this latter case, the smaller firm are incentivized to make R&D in-house. They behave in such a way due to their small conditions in terms of financial resources and skilled and specialized personnel their challenging is no longer faced.

An outsourcing strategy based on external partnership is based on the availability of external suppliers of innovation, R&D, and technology. These suppliers must be, and they in fact are, specialized firms. Typically, those specialized firms need a system of patents and licences in order to maintain the value that they create when commercializing new ideas (Guns and Stern, 2003). In establishing this partnership, buyers and specialized suppliers provide complementarity capabilities. This demonstrates that in-sourcing and outsourcing of R&D are complementary activities (Lockwood Howells, Gagliardi, Malik, 2012; Cassiman and Veugelers, 2005).

3. Hypotheses and motivation

The current academic debate about the technology outsourcing is controversial (Badillo, Llorente, Moreno, 2014/17), and part of the literature affirms that the firm size affects R&D activities not directly but through the firm technological capability of implementing these activities (Lee, Sung, 2005).

However, according to Cassiman and Veugeler (Cassiman, Veugeler, 2006), even though studies have focused their attention on the complementarity between insourcing and outsourcing, a lack of efforts alongside this stream of research need to be developed. Cassiman and Veugelers, indeed, pointed out the necessity to develop research on the firm characteristics and how firm characteristics can affect complementarity between insourcing and outsourcing.

The technological capabilities of firms can be incremented either by in-house R&D technology activities, either by external technological outsourcing (Badillo, Lorente, Moreno, 2014/17). When firms decide to outsource innovation, it means that there are seeking "to blend external sources of innovation with company-level competences and assets to incorporate new ideas" (Badillo, Lorente, Moreno, 2017, p. 4; Chesbrough, 2003, 2006). In doing so, firms acquire technological innovation by establishing a form of R&D cooperation (Badillo, Llorente, Moreno, 2017). By establish such an outsourcing strategy to acquire external innovation, firms allow knowledge sharing and diffusion across firms (Badillo, Lorente, Moreno, 2017). This, in its turn, improves the creation of R&D cooperation and, at the same time, an increment of competitive advantage (Badillo, Lorente, Moreno, 2017).

The creation of R&D cooperation is equal to the creation of a market for technology, because the networks that is going to be established among firms generates technological transactions among firms. These technological transactions make firms behaving as buyers and sellers of technology (Badillo, Llorente, Moreno, 2017; Arora Gambardella, Fosfuri, 2000; Gambardella and Fosfuri, 2008). Behaving in such a way generates complementarity between the two strategies of both performing R&D activities in-house and acquiring R&D externally. It is this flow that generates technological transactions and makes innovation tradeable (Badillo, Llorente, Moreno, 2017; Arora Gambardella, Fosfuri, 2000; Gambardella and Fosfuri, 2008).

When a market for technology is generated in such a way, it is clear that the firm size issue is going to be reversed. It is reversed because innovation is no longer a large organizations priority. Conversely, since innovation is traded, also small firms can have access to innovation through external technological outsourcing. According to Badillo, Llorente and Moreno, (Badillo, Llorente, Moreno, 2014/17), in the literature there is no consensus about the fact that firm size could influence external cooperation in R&D. They found that literature affirms that a sufficient amount of financial, technical and human resources are necessary to perform internal R&D (Robertson and Gatignon, 1998) and in addition, firms should be characterize by a remarkable absorptive capacity to acquire external knowledge (Cohen and Levinthal, 1989; Veugelers and Cassiman, 2005). This is the case of large firms (Rothwell and Dogson 1991; Narula, 2004).

In line with this theoretical horizon, it is also true that small firms are characterized by a lower management skill to create and maintain innovation, in addition to a scarce level of specialized stuff to conduct R&D (Narula, 2004; Chun and Mun, 2012). Moreover, Badillo, Llorente and Moreno claimed that when small firms establish R&D cooperation, they need to have a quick scanning of innovation and prefer to share with partners the risks of creating and developing innovation. On the other side, large firms benefit from R&D cooperation not only because of the risk sharing, but moreover because the access the psrtners' experience Badillo, Llorente, Moreno, 2017). Thus, "although with different motivations, both large and small firms have incentives to embark on cooperation agreements for carrying out innovation activities. And from that point of view, firm size should not influence the propensity of firms to establish cooperation agreements in innovation" (Badillo, Llorente, Moreno, 2017, p.6).

However, we disagree with this conclusion because we think that it is just the motivation that moves firms to choose between internal or external innovation to confirm that firm size affects the relation between technological outsourcing and market for technology. Indeed, there exists different type of strategy that are implemented, in accordance with the size of the firm and the relative needs.

Then, the novelty of this paper is aimed to explain how the interaction between the cost of using the market and the size of firms can affect the decision to make or buy R&D. Complementarity, can just be true for large firms, but not for small sized firms (Parmigiani, 2007). Indeed, if the firm is a small sized firm, it has necessarily to rely on private or bank credit to outsource R&D. But the problem for SMEs is that they cannot guarantee to face those debits. Then, it is just for this reason that it's hard for them to obtain external financial resources (Czarnitzki and Binz, 2008). On the contrary, as far as the large sized firms are concerned, they can do simultaneously in-house R&D and outsourcing R&D; it means that just in this case complementarity between internal and external R&D can exist (Cassiman, Veugeler, 2006).

Under the transaction cost economics approach and according to the Schumpeterian literature, firm size and transaction costs have been used as two drivers of innovation and, nonetheless, they have not been conceived as two element that, by interacting between them, could impact the outsourcing R&D decision in firm's strategy within the market for technology (Arora, Fosfuri, Gambardella, 2000).

However, other researches (Cassiman, Veugeler, 2006), pointed out the importance to deepen the lack of studies about these issues. What we are going to consider in this paper relates, indeed, the interaction between firm size and the cost of using the market make firms to decide whether to make and/or buy R&D. However, when the market for for technology is efficient, size is that moderstor that, interacting with the low level of the cost o using the market, permits, through the outsourcing R&D decision, the commercialization of innovation.

Then, having regard for the fact that the R&D outsourcing/insourcing firm's decision is affected by the cost of using the market, in particular by the fact that

1) lower transaction costs imply high level of technology outsourcing in the market for technology;
2) higher transaction costs imply lowe level of technological outsourcing in the market for technology;
3) given that the relationship between technological outsourcing and the market for technology is moderated by the firm size;
4)since in presence of high transaction costs small sized firms perform in-house R&D activities;
5) given the fact that in presence of low transaction costs small sized firms are incentivized to perform technological outsourcing;
6) being aware of the fact that in both cases large sized firms perform both insourcing and technological outsourcing;

we claim that:

H1) transaction costs affect positively the firms' decision to outsource technology
H2) Firm size moderates the relationship between transaction costs and R&D outsourcing

According to the wide range of academic literature, we want to test whether firm size moderate the relationship between the technology markets size and technology outsourcing. In what follows, we show two schemes that summarize the motivation of our hypotheses.

Table1 – Moderation Diagram

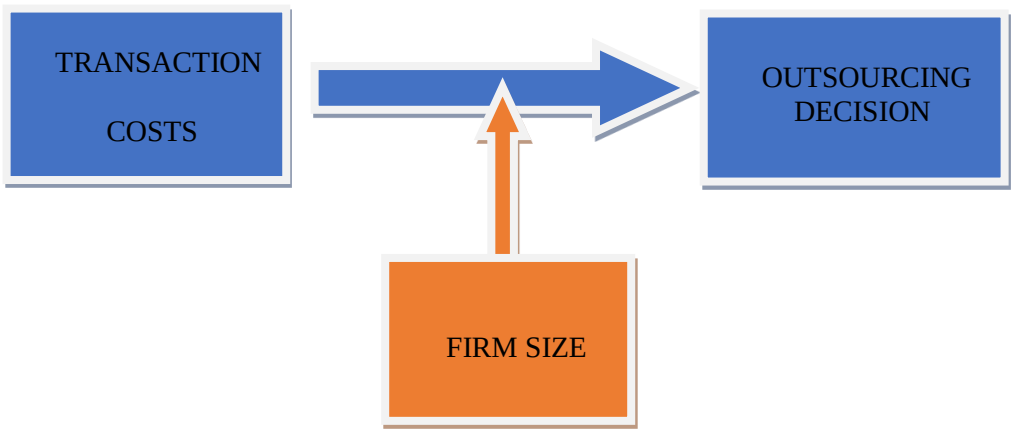

Table 2 – Technology market influence diagram

	HIGH POSITIVE TRANSACTION COSTS	LOW POSITIVE TRANSACTION COSTS
LARGE FIRMS	INSOURCING/ OUTSOURCING	INSOURCING/ OUTSOURCING
SMALL FIRMS	INSOURCING	OUTSOURCIN

These two schemes graphically represent the logic behind our research questions: *a)* whether technology outsourcing is driven by technology market size; *b)* whether firm size moderates the relationship between technology outsourcing and the technology market.

According to the literature dealing with the markets for ideas and the market for technology, scheme 2 graphically summarize what fallows. Technology market drives outsourcing decision. When the technology market is large, it means that the cost of using the market is low. If the technology market size is lower, firms are incentivized to perform R&D activities internally, because transaction costs are higher. When the technology market is negative, the cost of using the market is high. If the technology market size is higher, firms are incentivized to perform technology innovation externally, i.e. to outsource it.

According to the first scheme, the discrimen between in-house R&D and technology outsourcing is mediated by firm size. Large sized and small sized firms behave, in fact, differently in accordance with the technology market behaviour.

When the firm is large sized, if the market for technology is both positive or either negative, they will be indifferent in the choice between insourcing or outsourcing. Probably they will do both of activities thanks to their market power or thanks to their dominant position that gives them contractual power within contractual relationship. The same does not work with smaller firms. When the cost of using the market for technology is high, small sized firms that have no market power cannot negotiate the price at which they want to buy innovation. In addition, when the cost of using the market for technology is high most probably the level of property rights, copy rights and so on and so forth will be high as well. In presence of such an economic condition, large sized firms can decide, and they do, their conditions, i.e. they can negotiate the price at which they "will buy" the needed innovation technology. Most probably, firms producing, and then selling R&D, will be start up or SMEs. In this case, they necessarily produce in-house R&D, but the selling price will be fixed in the end by the market power imposed by larger firms. Since the market for technology is a competitive market, there will be a higher level of competition among small firms producing innovation. At this level, it is, then, intuitive how their size necessarily moderates the relationship between technology market size and technology outsourcing.

When small firms do not produce technology, but they need it to grow up, small firms have two different possibilities: insourcing R&D, or outsourcing. When the technology market size is negative, it implies that transaction costs are higher. Then they cannot buy innovation technology outside their borders. Conversely, when the technology market size is positive, it implies that transaction costs are lower. Then, outsourcing is a strategy that small firms can implement.

4. Dataset and variables

We performed our analysis by applying a sectorial distinction among firms in order to deconstruct the setting of the technology market. In so doing, the aim was that of understand the distinction between buyer and sellers. We performed this sectorial distinction according to the Pavitt-Consoli taxonomy. In its turn, this taxonomy we built allowed us to understand the behaviour of technology market size. In so doing, we obtained both our id observations and their context. Finally, we distinguished large sized firms from the smaller firms by creating a dummy variable for small firms: 1 when the firms were small, 0 otherwise. The criterion we applied to create a new dummy variable

consists in the application of the SBA, according to which under the number of 500 employees the firms is considered small. Over 500 employees the firm is considered larger. This path analysis allowed us to obtain a distinction in firms' behaviour according to their firm characteristics when buying innovation technology within the technology market.

As we have argued in the previous sections, the technology outsourcing firms' strategy depends on the technology markets size and on the interaction role of firm size. Therefore, before moving to the description of our empirical strategy, we shall show the list of variables we used for our empirical analysis in table 1 which provides a descriptive statistic of our variables.

Table 3 – List and description of variables

Variables	*Description*
Outsourcing	DV; Ratio between intangibles and total asset
Techmarksz	The sum of SB and SI sales across firms. This is a proxy for transaction costs, measuring the size of the market for technology
Smallsz	Dummy variable of the number of employees, measuring the firm size: 1 if the firm is a small sized firm, 0 otherwise.
Xrd	Internal R&D expemses
Profmargin	Ratio between net profit and revenues
Roe	Profitability
Sale	Sale per each SD firm
Interaction	Variable used for the interaction test: Techmarksz multiplied by smallsz

5. The empirical strategy and the Pavitt-Consoli Taxonomy

We implemented our research by using a Compustat Dataset from 1950 to 2015. Before running our research methodology and analysis, we just selected from this dataset observations during the time period between 2004 and 2013. After having selected the years, we selected our observations, i.e. North American firms, and according to Pavitt-Consoli's taxonomy (Pavitt, 1985; Consoli 2015), we kept those firms that could be identified by SS, SD, SI, and SB macro-sectors[10]. The Pavitt and Consoli taxonomy, that we applied to our dataset, allowed us not only to distinguish firms acting as buyers and firm acting as sellers, but also to deduct the size of technology market. Then, we got information about We developed our empirical analysis and data collection starting from the identification of macro-sectors because it was only starting from and according to this point that we could identify the variables we needed. We used 4 digit for our observation id.

Firstly, we started by considering the SB, SI, and SS macro-sectors. Then we changed our id by selecting as observations. The id we choose is characterized by SD. According to the logic of make-and-buy decision, and according to the logic of the relationship between buyers and sellers, we needed to identify also SB and SI in order to get a proxy variable for Transaction Costs paid by the SD firms. Indeed, we used the total annual sales of SB and SI, paid by SD. We got a sale across firms, in order to get variation of transaction costs at the firm level, and we got also annual variation of transaction costs. in order to understand the cost that SD, as buyers, should pay to SI and SB, we necessarily had to use the taxonomy. By using this taxonomy, and according to the Pavitt scheme of industrial logic within the logic of buyers and sellers' relationships, we built a correspondence among sectors. We can observe it in the tables 4 and 5 within the appendix.

The selection based on the taxonomy permitted us to distinguish among sales. Once we find macro-sectors, indeed, we could identify the correspondent sector sales. Then, we could get the SB and SI firms' sales. Their sales represent the cost of transactions paid by SD firms to buy outsourcing. We computed this proxy variable both across firm, and over time. In order to compute the proxy at the firm level we looked at each micro-sector

[10] SS= Specialized Suppliers; SD=Science Dominated; SI= Scale intensive; SB= Science based.

and its correspondent sale firm by firm and them we summed up. In the second case, we summed up the total annual sale per each macro-sector.

We adopted this methodology to create the proxy variables for transaction costs for fours orders of motivation: According to Coase (Coase, 1937) and according to Williamson (Williamson, 1985) transaction costs are an exogenous item, because they are an external measure used to indicate the cost of using the market. Then we could not use another kind of some other proxy variable to identify transaction costs present within the Compustat dataset, because each of its variable is an endogenous and financial indicator. On the contrary, and as we have mentioned before, transaction costs are nor endogenous or internal form of economic measure, neither a fiscal or financial indicator.

The availability of data and dataset, proper for our research had to face the lack of numerical variable versus a survey's analysis, and this is the classical problem that the literature on transaction costs keeps on facing. Considering the last three points, we tried to analyse an external measure starting from an internal indicator to find an item able to describe the relational and transactional nature of the market within which buyers and sellers behave reciprocally. The only measure that underline this characteristic is the sale per each firm, and the total annual sale per each sector. That is the reason we needed the taxonomy, otherwise it would not be possible this kind of operationalization in the field of transaction costs economizing.

In the same way we computed the expenses in research and development paid by SD per each micro-sector and per year, by using the variable xrd contained within the original dataset. In order to identify the variable used for firm size, we used the variable emp, already contained within the original dataset, and we got two dummy variables, one for small sized firms, the order one for large sized firms. In order to model the variable, we used the SBA criterion for the identification of firm size by using number of employees.

6. Estimation results.

The econometric estimation has been performed by applying the random effect model because we suggest that across firms and over time there exist some aspects of our research that are not fixed and that cannot be observed, according to the way in which we have constructed our dataset. Our model is the following one:

$$Y_{OUTSit} = \beta_0 + \beta_1 X_{TMSit} + \beta_2 X_{FSit} + \beta_3 X_{INTERACTIONit} + \beta_4 X_{PROFMARGit} + \beta_5 X_{ROEit} + \beta_6 X_{XRDit} + \beta_7 X_{dummies\ sectorit}\ \beta_8 X_{SALESit} + \beta_9 X_{DUMMIESSECTORSit} + v_{it}$$

As far as the first hypothesis is concerned, we assess whether technology market size affect negatively the firm's technology outsourcing decision. We run the regression before without the variable of the firm size ($\beta_2 X_{FSit}$), then by including it. In so doing, we wanted to verify whether the technology market alone, without the presence of the dummy variable for small sized firms, could impact the firms' decision to outsource innovation. Then we run the Hausman test. The result we got is 0.0000. We can interpret this result as no correlation between the regressors and the error term. However, we applied also the Breusch and Pagan Lagrangian multiplier to test furtherly for random effects. The result we got is 0.0000. then in this case we cannot reject the null hypothesis of the test itself. Then, we can accept the result we got by running the random effect model.

As far as the second hypothesis is concerned, we claim the role of firm size as mediator within the relationship between the outsourcing decision and the market for technology. In this second case we run the previous second regression by including also the interaction term.

	(1)	(2)
VARIABLES	Random Effects	Random Effects
techmarksz	0.00796**	0.657***
	(0.00359)	(0.0578)
smallsz		9.110***
		(1.651)
interaction		-0.165***
		(0.0146)
xrd	-0.00315	-0.000818
	(0.00195)	(0.00174)
profmrgin	0.00126	0.00201***
	(0.000930)	(0.000778)
roe	-0.000154	-0.000271

	(0.000719)	(0.000582)
sale	-0.000352	0.000158
	(0.000878)	(0.000740)
utility	-0.447	-24.72***
	(4.573)	(4.377)
hway	3.233	-21.02***
	(5.159)	(4.814)
civileng	3.098	-21.22***
	(5.213)	(4.866)
buildequip	-1.488	-25.66***
	(5.204)	(4.887)
o.tradecontr	-	-
o.fiber	-	-
fabricmills	-0.550	-25.33***
	(4.370)	(4.185)
textile	-0.00327	-24.37***
	(4.357)	(4.170)
appknitmil	-0.669	-24.35***
	(4.856)	(4.496)
footwear	-0.324	-25.28***
	(4.287)	(4.149)
leather	0.377	-25.05***
	(4.398)	(4.236)
sawmills	-0.223	-25.29***
	(4.728)	(4.432)
veneer	0.310	-24.13***
	(4.409)	(4.214)
paper	-0.274	-24.48***
	(4.256)	(4.091)
printing	-0.152	-24.39***
	(4.264)	(4.094)
optical	1.271	-23.44***
	(4.521)	(4.293)

electrequip	1.032	-23.74***
	(4.259)	(4.118)
newspap	0.575	-23.74***
	(4.319)	(4.124)
soundrec	-0.527	-24.98***
	(5.952)	(5.365)
o.waste	-	-
Constant	0.747	-11.49
	(4.386)	(7.158)
Observations	442	442
Number of id	153	153
Country FE	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Theses result allow us to distinguish between internal factors affecting the firms' decision to outsource, as well as external factors. Firm size is an internal factor that impact this strategy. External factors are represented by the market for technology behaviour. In addition, these results suggest that it is moreover the interaction between internal and external factors that induces small firms to outsource innovation when the market for technology is efficient, because the transaction costs are low.

According to the results, the positive sign of technology market size is in line with our first hypothesis. It confirms that when the market for technology is positive the transaction costs are lower, then small sized firm can decide to implement the technology outsourcing strategy instead of performing in-house R&D. As far as the moderation term is concerned, we obtained a negative but highly significant coefficient.

7. Discussion and Conclusion

The high significance of the interaction term in our model confirms our second hypothesis. However, what is not clear is the negative sign of the interaction term itself, considering the positive sign and the high statistically significance of the proxy we used for small firm. The result we got is confirmed by the literature. According to Koufteros

(Koufteros et al, 2007) it seems that the impact of the firm size as moderator "had a statistically significant negative effect" (Koufteros et al, 2007, p. 863).

In both the models we run the technology market size variable we used for the identification of transaction costs is positive too, confirming not only that the efficiency of the market for technology holds for small sized firms, but also for the large firms as well. This result is confirmed too in the literature. Indeed, ss far as the moderation effect of firm size is concerned, "firm size does affect the levels of behaviour based management techniques" (Koufteros et al, 2007, p.857) when firms are strategically choosing whether insourcing or outsourcing. We interpret the negative sign of the interaction term as an indicator of the fact that if for large firms, given their size, can exploit both outsourcing and insourcing simultaneously, they can exploit, in so doing the meaning itself of the idea of complementarity we expressed in the previous chapter. It appears to be different for small firms, for which is always valid the fact that outsourcing and insourcing are complementary strategy, but for small sized firm the technology market size matters in terms of impact on their decision more than for large firms.

Indeed, if for large firms the inefficiency of the market for technology is not a factor risk because large firms have more resources than the small firms, the reverse for small firms does not work.
If we recall the table 2, we have said that large sized firms are somehow "indifferent" to the market condition. With the term indifferent we want to say that "larger firms have more flexibility to devote resources to strategic supply chain activities, while smaller firms may not share the same level of flexibility" (Koufteros et al, 2007, p.856) with respect to market conditions. In addition larger firms have the market power that they can exploit against small firms. It implies that "a small firm may be unable to convince suppliers to adopt a more collaborative posture and it may lack the skills and resources to develop collaborative exchanges" (Koufteros et al, 2007, p.856).

In addition to this, "a small firm may also be practicing single sourcing due to necessity, not choice. There might be situations where very few suppliers may be willing to do business with a relatively small customer. This is especially true in situations where significant specific assets have to be in place for the supplier to be able to transact with

a prospective small customer. Small firms may also have difficulty in attracting first-class suppliers" (Koufteros et al, 2007, p.857).

As far as the interaction term is concerned, (i.e. which is the variable we used for identifying the technology market size multiplied by the small firm dummy variable) we obtained a higly significant but negative result. The idea behind the relationship between firm size and R&D is that higher investment in R&D foster the firm growth thanks to the economies of scale. The major existing literature, indeed, is characterized by a consensus view according to which firm size is linked to an increasing level of R&D (Levinthal, 1985). This result is in line with the literature. According to Koufteros and Cheng, not only the firm size has a positive and significant effect (as we fund in our results), but also its moderating "effect for small firms [is] statistically significant, but negative" (Koufteros and Cheng, 2007, p864).

8. Limitations and future research

As far as limitations and future research are concerned, our approach to the empirical analysis is not free of criticism. Further efforts in testing our results need to be implemented. We tried to find a measure for transaction costs by using a proxy variable we fund as the size of the market for technology. We measured technology market size by exploiting the Pavitt-Consoli taxonomy and, to find the relationships between buyers and suppliers we combined the correspondent sales. However major efforts need to be done in order to better understand the statistical results for what concern the result of the interaction term. We know that our model can fit better the analysis both on large as well as small firms, considering the lack of studies referring to the role of moderator of the firm size on the relationship between the technology outsourcing and the market for technology. In addition, we have assessed our interaction model using a proxy variable for small firms, to make a distinction between large and small firms. In order to grouped firms into these two groups we used the number of employees, by considering the U.S. Small business administration (SBA) guideline, according to which small firms as those firms with less than 500 employees. Perhaps it would be preferable to include also medium enterprises in our analysis. We are aware of the fact that this paper contains other limitations to this study that must be corrected and overcame, moreover when interpreting our results, so we leave this last point to future research.

Appendix

Table 4 – Macro-sectors and taxonomy

naics 4	**naics4 description**	**Pavitt-Consoli_Taxonomy**
3254	Pharmaceutical and Medicine Manufacturing	SB
3341	Computer and Peripheral Equipment Manufacturing	SB
3342	Communications Equipment Manufacturing	SB
3343	Audio and Video Equipment Manufacturing	SB
3344	Semiconductor and Other Electronic Component Manufacturing	SB
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	SB
1133	Logging	SD
2361	Residential Building Construction	SD
2362	Nonresidential Building Construction	SD
2371	Utility System Construction	SD
2372	Land Subdivision	SD
2373	Highway, Street, and Bridge ConstructionT	SD
2379	Other Heavy and Civil Engineering Construction	SD
2382	Building Equipment Contractors	SD
2389	Other Specialty Trade Contractors	SD
3131	Fiber, Yarn, and Thread Mills	SD
3132	Fabric Mills	SD
3141	Textile Furnishings Mills	SD
3151	Apparel Knitting Mills	SD
3152	Cut and Sew Apparel Manufacturing	SD
3159	Apparel Accessories and Other Apparel Manufacturing	SD
3162	Footwear Manufacturing	SD
3169	Other Leather and Allied Product Manufacturing	SD
3211	Sawmills and Wood Preservation	SD

3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	SD

3219	Other Wood Product Manufacturing	SD
3221	Pulp, Paper, and Paperboard Mills	SD
3222	Converted Paper Product Manufacturing	SD
3231	Printing and Related Support Activities	SD
3346	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	SD
3359	Other Electrical Equipment and Component Manufacturing	SD
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	SD
3372	Office Furniture (including Fixtures) Manufacturing	SD
3379	Other Furniture Related Product Manufacturing	SD
3399	Other Miscellaneous ManufacturingT	SD
5111	Newspaper, Periodical, Book, and Directory Publishers	SD
5122	Sound Recording Industries	SD
5629	Remediation and other waste services	SD
2111	Oil and Gas Extraction	SI
2121	Coal Mining	SI
2122	Metal Ore Mining	SI
2123	Nonmetallic Mineral Mining and Quarrying	SI
2131	Support Activities for Mining	SI
3111	Animal Food Manufacturing	SI
3112	Grain and Oilseed Milling	SI
3113	Sugar and Confectionery Product Manufacturing	SI
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	SI
3115	Dairy Product Manufacturing	SI
3116	Animal Slaughtering and Processing	SI
3118	Bakeries and Tortilla Manufacturing	SI
3119	Other Food Manufacturing	SI

3121	Beverage Manufacturing	SI
3122	Tobacco Manufacturing	SI
3241	Petroleum and Coal Products Manufacturing	SI
3251	Basic Chemical Manufacturing	SI
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	SI
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	SI
3255	Paint, Coating, and Adhesive Manufacturing	SI
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	SI
3259	Other Chemical Product and Preparation Manufacturing	SI
3261	Plastics Product Manufacturing	SI
3262	Rubber Product Manufacturing	SI
3271	Clay Product and Refractory Manufacturing	SI
3272	Glass and Glass Product Manufacturing	SI
3273	Cement and Concrete Product Manufacturing	SI
3274	Lime and Gypsum Product Manufacturing	SI
3279	Other Nonmetallic Mineral Product Manufacturing	SI
3311	Iron and Steel Mills and Ferroalloy Manufacturing	SI
3312	Steel Product Manufacturing from Purchased Steel	SI
3313	Alumina and Aluminum Production and Processing	SI
3314	Nonferrous Metal (except Aluminum) Production and Processing	SI
3321	Forging and Stamping	SI
3322	Cutlery and Handtool Manufacturing	SI
3323	Architectural and Structural Metals Manufacturing	SI
3324	Boiler, Tank, and Shipping Container Manufacturing	SI
3325	Hardware Manufacturing	SI
3326	Spring and Wire Product Manufacturing	SI
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	SI
3328	Coating, Engraving, Heat Treating, and Allied Activities	SI

3361	Motor Vehicle Manufacturing	SI
3362	Motor Vehicle Body and Trailer Manufacturing	SI
3363	Motor Vehicle Parts Manufacturing	SI
3364	Aerospace Product and Parts Manufacturing	SI
3365	Railroad Rolling Stock Manufacturing	SI
3366	Ship and Boat Building	SI
3369	Other Transportation Equipment Manufacturing	SI
4412	Other Motor Vehicle Dealers	SI
5622	Waste treatment and disposal	SI

Table 5 – Buyers and Makers correspondence microsectors

MAKERS (SB+SI)		**BUYERS(SD)**	
Naics code	Naics description	NAICS code	NAICS description
3341 **SB**	Computer and Peripheral Equipment Manufacturing	3346	Optical
		5122	Sound Recording Industries
3342 **SB**	Communications Equipment Manufacturing	5111	Newspaper, Periodical, Book, and Directory Publishers
3343 **SB**	Audio and Video Equipment Manufacturing	5122	Sound Recording Industries
3344 **SB**	Semiconductor and Other Electronic Component Manufacturing	3346	

		3359	
		5122	Sound Recording Industries
3345 **SB**	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing		Utility System Construction
			Other Heavy and Civil Engineering Construction
		3346	Optical
		3359	
		5122	Sound Recording Industries
2121	Coal Mining	2373	Highway, Street, and Bridge Construction
			Other Heavy and Civil Engineering Construction
3112	Grain and Oilseed Milling	3131	Fiber, Yarn, and Thread Mills
		3132	Fabric Mills
		3141	Textile

			Furnishings Mills
		3151	Apparel Knitting Mills
		3221	Pulp, Paper, and Paperboard Mills
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	3131	Fiber, Yarn, and Thread Mills
		3132	Fabric Mills
3115	Dairy Product Manufacturing	3131	Fiber, Yarn, and Thread Mills
		3132	Fabric Mills
3116	Animal Slaughtering and Processing	3169	Other Leather and Allied Product Manufacturing
3241	Petroleum and Coal Products Manufacturing	2373	Highway, Street, and Bridge Construction
		2379	Other Heavy and Civil Engineering Construction
3251		3141	Textile

	Basic Chemical Manufacturing		Furnishings Mills
		3151	Apparel Knitting Mills
		3131	Fiber, Yarn, and Thread Mills
		3132	Fabric Mills
		3211	Sawmills and Wood Preservation
		3222	Converted Paper Product Manufacturing
		3231	Printing and Related Support Activities
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	3131	Fiber, Yarn, and Thread Mills
		2371	Utility System Construction
		3231	Printing and Related Support Activities
			footware
3253	Pesticide, Fertilizer, and Other Agricultural	3231	Printing and Related Support Activities

	Chemical Manufacturing	3211	Sawmills and Wood Preservation
		3151	Apparel Knitting Mills
		3131	Fiber, Yarn, and Thread MillS
		3132	Fabric Mills
		3221	Pulp, Paper, and Paperboard Mills
3255	Paint, Coating, and Adhesive Manufacturing	3231	Printing and Related Support Activities
		3221	Pulp, Paper, and Paperboard Mills
		5111	Newspaper, Periodical, Book, and Directory Publishers

		3212	Veneer, Plywood, and Engineered Wood Product Manufacturing

3259	Other Chemical Product and Preparation Manufacturing	3131	Fiber, Yarn, and Thread Mills
		3132	Fabric Mills
		3211	Sawmills and Wood Preservation
		3222	Converted Paper Product Manufacturing
		3231	Printing and Related Support Activities
3261	Plastics Product Manufacturing	5111	Newspaper, Periodical, Book, and Directory Publishers
		3162	Footwear Manufacturing
5622	Waste treatment and disposal	All sectors	All sectors
3369	Other Transportation Equipment Manufacturing	2389	Other Specialty Trade Contractors
3273	Cement and Concrete Product	2361	Residential Building Construction

	Manufacturing	2362	Nonresidential Building Construction
		2371	Utility System Construction
		2379	Other Heavy and Civil Engineering Construction
		2382	Building Equipment Contractors
		2373	Highway, Street, and Bridge ConstructionT
3272	Glass and Glass Product Manufacturing	3346	Optical

3325	Hardware Manufacturing	3346	Optical
3323	Architectural and Structural Metals Manufacturing	2361	Residential Building Construction
		2362	Nonresidential Building Construction
		2371	Utility System Construction
		2379	Other Heavy and

			Civil Engineering Construction
		2382	Building Equipment Contractors
		2373	Highway, Street, and Bridge Construction
3311	Iron and Steel Mills and Ferroalloy Manufacturing	2373	Highway, Street, and Bridge Construction
			Other Heavy and Civil Engineering Construction
			Buildings construction
3312	Steel Product Manufacturing from Purchased Steel	2373	Highway, Street, and Bridge Construction
			Other Heavy and Civil Engineering Construction
3313	Alumina and Aluminum Production and	2373	Highway, Street, and Bridge Construction

	Processing		Other Heavy and Civil Engineering Construction
		3346	Optical
3365	Railroad Rolling Stock Manufacturing	2373	Highway, Street, and Bridge Construction
3366	Ship and Boat Building	3346	Optical
3364	Aerospace Product and Parts Manufacturing	3346	Optical
3363	Motor Vehicle Parts Manufacturing	2389	Other Specialty Trade Contractors
3362	Motor Vehicle Body and Trailer Manufacturing	2389	Other Specialty Trade Contractors
4412	Other Motor Vehicle Dealers	2389	Other Specialty Trade Contractors

Table 6

Pavitt Taxonomy scheme

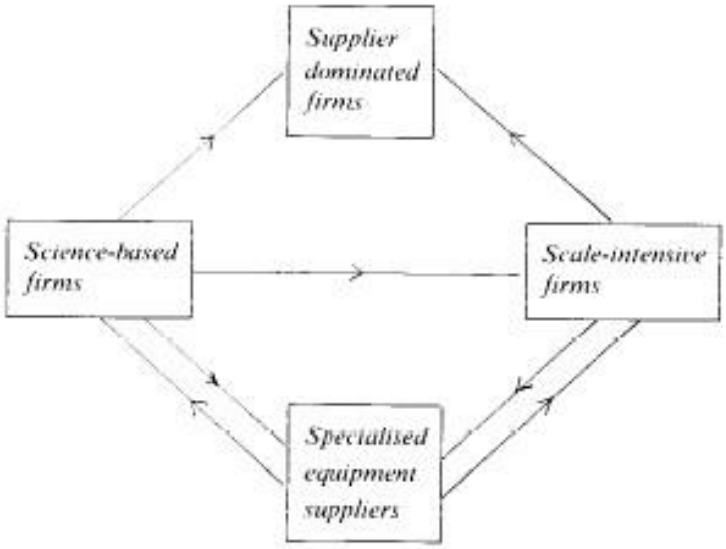

Fig. 1. The main technological linkages amongst different categories of firm.

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W.C. Benton Jr. b		opportunism in outsourcing RELATIONSHIPS	

Conclusions

The choice between technological insourcing and/or technological outsourcing is defined in the literature as the classical and paradigmatic example of the make-or-buy dilemma (Walker and Weber, 1984, Aubert, Rivard, Patry, 1996, 2003; Cesaroni, 2004; Holcomb, Hitt, 2006; Parmigiani, 2007; Lacity, Willcocks; Khan, 2014). This choice relates the so-called vertical integration (Walker and Weberm 1984) and concerns contractual relationships between buyers and sellers (Arora, Gambardella, Fosfuri, 2001).

The decision to insource and/or to outsource technological innovation is no longer a binary decision (Spithoven, Teirlinch, 2014) between what to produce in-house and what to buy externally (Aubert, Rivard, Patry, 1996, 2003). Nowadays, literature has demonstrated that it also depends on the cost of using the market (Cesaroni, 2004; Cosae, 1937, Williamson, 1985; Arora, Gambardella and Fosfuri, 2001) with the interaction of the firm size (Cassoman and Veugelers, 2006; Hermossilla and Wu, 2018; Berchicci, 2013)

The idea behind this dependence is based on the fact that if the cost of using the market is low, firms perform technological outsourcing. If the cost of using the market is high, firms perform R&D insourcing (Cesaroni, 2004, Arora, Fosuri, Gambardella, 2000, Gans, Hsu, Stern 2008). This moves us to use the lens of the transaction cost economizing towards R&D investment decision.

According to Benoit, Aubert and Rivard, this kind of contractual relationship is a function of what firm decide to produce in-house or to outsource (Benoit Aubert, Suzanne Rivard, Michel Pstry, 1996). Then, this decision can be placed alongside a continuum whose extremes are, in fact make and buy. Close to buy we can find the so-called long term contract method; close to make we can find all the goods and services that a firm need and that it produces internally (Bensanko et al, 2012).

When transaction costs are high within the market for technology, large sized firms can decide to implement both simultaneously insourcing and outsourcing R&D. Even thought there were low cost of using the market or a high cost of using the market, they can implement both activities.

This is not true for small firms. Conversely, they are in fact not indifferent with respect to the cost of using the market. Small sized firms have to decide whether to insource or to outsource R&D according to the market condition, i.e. the cost of using the market, and their capability and possibility to face it. As it has been mentioned before, this behaviour is moderating by the firm size.

According to Cassiman and Veugelers (B. Cassiman, R. Veugelers, 2006), the Schumpeterian literature states that firm size is conductive of R&D and innovation, and in so doing the size is considered important not only because it can describe financial characteristics of firm. In so doing it can explain strategical and contractual reason to explain the fact that large sized firms invest more in R&D. In the context of the market for technology (Arora, Fosfuri, Gambardella, 2000) and according to the lens of the transaction cost economics, the size of the firm is, indeed, a characteristic describing the market power of firm (Cassiman, Veugelers, 2006). It is just through this element that the difference between SMEs and large firms is fixed. Large sized firms have that market power that the small firms do not have.

Indeed, under a transacting rationale, that is under an exchange contractual relationship logic, if we take into consideration the idea that there are not only firms, in particular small firms, that are buyer of R&D, we should also consider that there exist some other independent firms that behave like sellers of R&D. In such a dynamic framework, there exist interaction between large and small firms when the market for technology is efficient, that is when the cost of using the market is low and small firm can compete with the large one trough a transacting and dynamic logic of make and/or buy decision and strategy. The small sized then impact on the drivers for innovation because when the cost of using the market is high and when the market for technology is not efficient, only large sized firm will implement outsourcing.

The smaller firm are incentivized to make R&D in-house, but giving their small condition in terms of financial resources and skilled and specialized personnel their challenging is no longer faced. It implyies a lack of knowledge and innovation diffusion, a leak of market for ideas and a loss in terms of development and growth for all the actor operating in innovation, in addition to a waste of efforts.
This dramatic scenario would not be in line with the coasian approach, in particular with the idea that the nature of the firm is that of overcoming the market failures. When the

market is inefficent because of its high market-price mechanism, there will be a failure in the market for technology.

What we tried to describe in the previous section concerns on the one the fact that a traditional literature , dealing with the make-or-buy decision, stated that the transfer of technology increase transaction costs (Cesaroni, 2004) because more transfers means more transaction, then an increasing level of the price of transaction costs that firm have to pay if they increase their transactions.

However, this is no longer true in the market for technology when dealing with technology outsourcing. Cesaroni claimed, in fact, that transaction costs could become less constraining when emerging technology markets (Cesaroni, 2004). In this case, outsourcing is more attractive. This is due to the fact that transaction costs are exogenous, i.e. they represent the cost of using the market which can be reduced

According to the literature on innovation and outsourcing technolgoy, in order to match the cost of using the market, and then in order to overcome external costs, firm can rely on their internal sources and at the same time overcome their constraints problem by exploiting outsourcing. Then, transaction costs become less sever producing, in so doing, an increment of the R&D investment propensity. In addition to this, outsourcing is not anymore, a binary solution because firms have to decide not only what to produce in-house and what to buy externally, but also that there exist external and internal factors that impact on this strategic decision. In particular the technology market efficiency and the capability of the firm to exploit conveniently the cost of using the market, together with the awareness of their size.

Considering that outsourcing and insourcing innovative technology are two complementary strategy, when the market for technology is efficient small sized firms, as well as the large sized firms, can enter the market for technology, match competition and behave as buyers or sellers of technology.

An important consequence of this framework is that at list a network of companies that share information increase the level of innovation not only beyond the traditional R&D contracting, but also beyond the traditional Transaction costs-based approach. As it has been discussed by Dyer, transaction costs can be minimized through the trust. If we apply

the transaction costs minimizing revisited by Dyer to the R&D investment, we can see how outsourcing networking can enforce not only trust or network (in a more general way), among firms and a zero cost the can spread innovation increasing its level. Moreover, this kind of relationship, in fact, information asymmetries and the consequent uncertainty due to the bounded rationality, hat favour the opportunistic behaviour could be diminished. The effect is well described by Veugelers:"in their strive for access to external know-how, the exploitation of complementarities between partners and sharing of risks and costs, while internalizing spill-over effects, firms revert to cooperative modes ranging from R&D consortia, joint ventures, implicit coordination, mutual exchange or "informal" know-how […], and this despite the possible higher transaction costs associated with external sourcing" (Veugelers, 1996, pp 12) .

This theoretical result could be conceived as a contribution and a sort of innovation for the traditional Schumpeterian theory, according to which R&D activities are run just by large firm thanks to the monopolistic framework of the market governance and imperfect competition. The way of interpreting and also exploiting outsourcing in terms of sharing of information allows the interaction between knowledge producers and knowledge user enhances technological progress.

This new theoretical viewpoint moves to the idea of complementarity between insourcing and outsourcing. if the traditional approach described outsourcing as a binary decision, nowadays this is no longer true. It is no longer true because the interaction between internal factors and external factors impact on the decision firm to decide whether insourcing or outsourcing technology or innovation.

The reason why external and internal factors impact on this firm decision depends on the market for technology efficiency. As we have said before, if firms know how to get the opportunity to exploit the cost of using the market for technology, they can understand whether it is more convenient to outsource or, conversely more convenient to produce innovation in-house. In addition to these external factors, internal factors such as the firm size intervene: the capability of a firm to understand when outsourcing is convenient to be implemented does not depends only on the dimension and efficiency of the market for technology. It will depend also on the firm size.

As we mentioned d before the size of a firm describe several aspects and characteristics of a firm. Then the conceptual idea of the complementarity between internal and external R&D cane conceived as a natural progression or combination of internal and external factors that, together will incentive firms to implement different outsourcing strategies. If the cost of using the market is high, those barriers to entry are higher too. In this case, there is no longer competitiveness, and the exploitation of dominant position and opportunism, those behavioural strategies that observed before, can be observed. So, when barriers are high, large firms can implement both insourcing and outsourcing R&D; while small firms can implement just insourcing. When barriers are lower, large firms will keep being indifferent between insourcing and outsourcing R&D. Probably they will implement both of them simultaneously. But, in this latter case, small firm can participate to the market for technology and they can take their place in by implementing outsourcing R&D.

In conclusion what we have learned and where we go from here? Contrarily to the traditional mindset, technological outsourcing is a complementary strategy when firms deal with innovation. Innovation is no longer a large companies' prerogative. Small technological firms can get a high level of innovation with lower transaction costs in the market for technology, where technology is traded and when the market is efficient. When the market for technology is efficient, then transaction costs are lower if transaction cost are lower, thus, transaction drive the outsourcing strategy. In this relationship, firm size play the role of moderator, implying that firms' role has changed. Behaving as buyer and sellers of technology, they foster the idea that the size as a moderator matters. Nonetheless, we have to learn more about our topic. We are aware of our limitations, both under the theoretical point of view and under the quantitative one. We are aware also of the fact that corrections are required. We give this tasks to future research projects.