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How risk influences the choice of governance mode in biopharmaceutical inter-firm relationships

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ABSTRACT

This paper proposes a new theoretical framework for assessing the influence of risk in shaping the governance form in biopharmaceutical inter-firm relationships. In particular, we propose a multidimensional operationalization of relational and performance risk and, by following Transaction Cost Economics (TCE) and Real Options (RO) theory constructs, we hypothesize a relation between the aforementioned risk components and the choice of governance form. Specifically, following TCE reasoning, we hypothesize that a high level of relational risk leads towards more hierarchical governance forms, while, following RO theory, we hypothesize that a high level of performance risk leads toward market-oriented governance forms; finally, we hypothesize a moderating effect of each risk component on the other. We empirically test our framework through the analysis of 353 inter-firm relationships signed worldwide between pharmaceutical and biotech companies from 2007 to 2010. The results show substantive support for our theoretical framework. Furthermore, we find a significant moderating effect of the performance risk on the TCE relation between relational risk and governance forms.

1. Introduction

Risk evaluation is a key factor in the decision-making process leading to the choice of governance form in inter-firm agreements (Sitkin & Pablo, 1992). Indeed, managers should select the governance form that enables them to maintain the risk related to a specific inter-firm agreement to an acceptable level. However, even though the scientific literature on alliances is very rich in terms of contributions examining the drivers influencing the choice of governance form of inter-firm agreements, risk evaluation is still underdeveloped. Indeed, by starting with Transaction Cost Economies (TCE) (Williamson, 1979, 1985, 1991), scholars have primarily focused on issues such as investment specificity and uncertainty. Both of these drivers increase transaction costs and, consequently, call for more hierarchical governance forms. However, while the influence of investment specificity has been largely acknowledged by empirical literature (David & Han, 2004), the influence of uncertainty on the choice of governance form is still quite controversial (Mahoney, 1992). Indeed, unlike TCE scholars, Real Options (RO) researchers (Myers, 1977; Kogut, 1991; Folta, 1998) argue that uncertainty leads firms to prefer more flexible and less hierarchical governance modes in order to avoid the opportunity cost of irreversible investments in shared ventures (Folta, 1998). Recently, Santoro and McGill (2005) and Van de Vrande, Vanhaverbeke, and Duysters (2009) investigated how these different views on transaction uncertainty influence the choice of governance forms between market and hierarchy. Both papers show controversial support for the two theoretical strands.

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Nevertheless, up to now, the debate between TCE and RO theories has concerned a different view of uncertainty. In this paper we want to move the discussion to the risk concept that, while in some way related to uncertainty, is quite different from it. Several scholars, starting from the seminal work of Knight (1921), have addressed the difference between risk and uncertainty. Furthermore, TCE scholars have always located the perception of opportunism risk as a key issue in defining the governance form (Williamson, 1979, 1985, 1991; Ring & Van de Ven, 1992, 1994). However, in spite of this, few works focus on how risk influences the governance of inter-firm agreements. Nooteboom (1996) developed a model explicating the determinants of opportunism risk and its influence on the governance structure. Some recent contributions concern the influence of risk on the stability of alliances (Jiang, Li, & Gao, 2008) and on the choice between contractual mechanisms (control) and non-contractual mechanisms (such as trust) in alliances (de Man & Roijakkers, 2009). However, the most significant contribution concerning how risk influences governance structure certainly comes from work conducted by Das and Teng (1996, 1998, 2001).

Das and Teng (2001) explain that risk is central in the inter-organizational governance decision-making process. Indeed, one mechanism to control risk is actually the choice of alliance structure, which may either mitigate or add to the risk level. Thus, the rational choice of an alliance structure should keep the total risk level of the alliance from being inordinately high. Starting from these considerations, Das and Teng (2001) develop a theoretical framework linking two risk dimensions, i.e. relational and performance risk, with four types of governance forms.

Although the framework proposed by Das and Teng (2001) is original in defining a relationship between risk dimensions (performance and relational) and governance structures, it has several limitations. First, from a theoretical point of view, it does not provide a theoretical construct linking risk with the most acknowledged theoretical strands such as TCE and RO; thus, the question of how risk is related to inter-firm literature has yet not been fully addressed from a theoretical point of view. Secondly, the framework, which is still not exhaustive, remains basically a theoretical one, since it has never been operationalized or, overall, empirically tested. Indeed, very few empirical papers deal with risk appraisal in governance form choice. Delerue (2004) develops a framework linking managers' perceptions of relational risk in alliances with three situational factors: the degree of relational capital, the structure of the relationship and the degree of asymmetries between partners. Afterwards, she tests the framework using a survey dataset on partnerships of European biotechnology firms. Delerue and Simon (2009) empirically analyse the influence of cultural differences in relational risk perception in biopharmaceutical alliances. Through a multiple-case-study investigation, de Man and Roijakkers (2009) study how relational and performance risk determine the mix between control and trust in inter-firm agreements. Thus, it is notable that no empirical contributions to date have investigated how to operationalize relational and performance risk, or how these risk components influence the choice of governance structure.

In this paper we contribute to the inter-firm relationship literature by filling the two aforementioned gaps. First, we propose a framework that provides a theoretical construct linking relational and performance risk with the choice of inter-firm governance forms by applying TCE and RO theory strands in a discriminating fashion. In this way, we also contribute to the literature on TCE and RO theory by opening a discussion on the relation between theories and risk. Secondly, we operationalize our theoretical framework and empirically test it within the biopharmaceutical context. Thus, we also contribute to understanding of the risk concept by providing an operationalization of relational and performance risk within a high-tech industry such as biopharmaceuticals.

The remainder of the paper is organized as follows: Section 2 describes the theoretical framework; Section 3 explains why we have chosen to use the biopharmaceutical industry for our empirical analysis and how we operationalize our framework in such an industrial context; Section 4 presents the dataset and the model used for the empirical analysis, while Section 5 discusses the results of the analysis; finally, Section 6 presents implications and conclusions.

2. Theory and hypotheses

Several authors have stressed that risk is quite different from uncertainty (Knight, 1921; Nooteboom, Berger, & Noorderhaven, 1997; Das & Teng, 2001; Delerue, 2004). The most interesting distinction between risk and uncertainty is certainly that proposed by Knight (1921). In the Knightian sense, risk is different from uncertainty because the former applies to situations in which we do not know the outcome of a given situation, though we can estimate the odds, while the latter applies to situations in which we cannot know all the information we need in order to make an odds estimation in the first place. TCE- and RO-theory scholars also refer to the concept of "Knightian risk". RO-theory scholars (Adner & Levinthal, 2004; Rese & Roemer, 2004) agree that RO uncertainty refers to Knightian risk because an uncertain realization of future environmental states can be derived from an ex-ante specified probability distribution. On the other hand, TCE, focusing on bounded rationality, seems to be agnostic when marking a difference between risk and uncertainty (Leiblein, 2003). However, TCE defines a means by which to measure opportunism risk through transaction cost estimation. Indeed, David and Han (2004) find that out of over 238 TCE empirical papers concerning transaction cost estimation, 19% measure asset specificity (specialized assets and skills), 15% measure technology, demand and price volatility, and 9% measure interaction among the above items. Thus, transaction cost measurement represents a means by which to estimate the risk associated with an inter-firm transaction. Moreover, both theories highlight the importance of risk when dealing with inter-firm agreements. TCE claims opportunism risk as the main source of inter-firm agreement failure, while RO theory emphasizes

the role of risk in its attempt to value the underlying distribution of future returns and follow-on opportunities associated with a particular investment. However, while both theories emphasize the role of risk in shaping governance form choice, neither TCE nor RO scholars have developed a theoretical framework linking risk and governance form choice according to the two theoretical strands.

On the other hand, in our opinion, Das and Teng (1998, 2001) provide sufficient explanation for why risk is central in the inter-firm governance decision-making process. Indeed, alliances are seen as a means by which to face the (exogenous) risk of uncertain investments, technologies, marketing decisions and so forth. However, inter-firm agreements themselves are sources of possible (endogenous) risk; therefore, the choice of governance form has to balance exogenous and endogenous components so as to minimize the overall risk. In inter-firm agreements, it is possible to distinguish between two components of risk (Das & Teng, 2001): *relational risk* and *performance risk*. *Relational risk* is the probability and consequence of a lack of cooperation between partner firms. It is linked to endogenous factors, which, being embedded in the specific relationship, can be controlled by partners' actions (Lo Nigro & Abbate, 2011). Thus, this risk comes from the possibility that partners will behave opportunistically. On the other hand, *performance risk* refers to the factors that may jeopardize the success of an alliance, even when the partners fully cooperate. Thus, it is related to exogenous factors inherent in the activity that is taking place, regardless of whether partners behave as agreed or not. Thus, by arguing on each governance structure, Das and Teng (2001) hypothesize a relation between risk components and governance forms: joint ventures (JVs) fit a situation of low relational and performance risk; minority equity alliances/bilateral contract-based alliances are related to low/high performance risk and high/low relational risk; and finally, unilateral contract-based alliances are suitable when both risk typologies are high.

However, while we do agree with Das and Teng (2001) that the critical role of relational and performance risk are critical drivers for governance choice, we think that the relation between the two risk components and the governance mode is to be found in the TCE and RO constructs. Thus, in the following we deeply investigate the concept of relational and performance risk and, afterwards, formulate our theoretical framework.

2.1. Relational risk

Relational risk exists because the inter-firm relationship does. Indeed, it depends on the probability that a partner firm will not commit itself in the desired manner, and on the consequences of this (Das & Teng, 1996). This risk arises from the possibility of opportunistic behaviour from one or both firms (Williamson, 1975). Examples of opportunistic behaviour are shirking or cheating the partner, distorting or hiding information, illegitimately obtaining assets from the other firm, and so on. This kind of behaviour is very common; thus, firms tend to try and prevent it by controlling partners' behaviours and detailing explicit deterrents within contracts.

Several factors may enhance the perception of relational risk, for example expected inequities regarding payoffs of the alliance (Alchian & Demsetz, 1973; Hart & More, 1990), differences in terms of bargaining power of the partner firms (Williamson, 1993), lack of trust in the partner's competences and skills (Kale, Singh, & Perlmutter, 2000), lack of confidence in the good faith of the partner (Gulati, 1995; de Man & Roijakkers, 2009), and also factors relating to different cultural background (Oxley, 1997; Oxley & Sampson, 2004; Delerue & Simon, 2009). All of these elements lead to a higher perception of relational risk.

2.2. Performance risk

Performance risk depends on several factors that might prevent the strategic objectives of an alliance to be achieved, despite firms' full cooperation (Das & Teng, 1996). These factors include changes in the competitive environment, such as intensified competition and new entrants; changes in the general environment, for example in regulations and government policies; and changes in the internal environment, such as the lack of a particular competence due to the advent of a new technology. Of course, performance risk strongly depends on the objectives of the partnership; namely, if they are cooperating in technology development in R&D-intensive industries, the performance risk embedded in this kind of activity is high in itself. Thus, according to the alliance objectives and types, there are different sources of performance risk in inter-firm relationships. For example, R&D risk is the most important risk component in R&D alliances, while commercial risk is the most important in marketing and commercialization alliances, and international risk is an important factor when partner firms belong to different countries. Thus, no matter what the level of cooperation among the alliance partners, performance risk is always present.

2.3. Theoretical framework

When designing the governance form of an inter-firm relationship, managers have to choose between different organizational modes. As highlighted in the previous section, this choice is strongly related to their perception of performance and relational risk. The literature has traditionally used different theoretical perspectives in order to explain why managers choose, for instance, a licensing agreement rather than an equity alliance.

In this paper we focus on TCE and RO in order to examine how and in which way risk perception influences the choice of a particular governance mode.

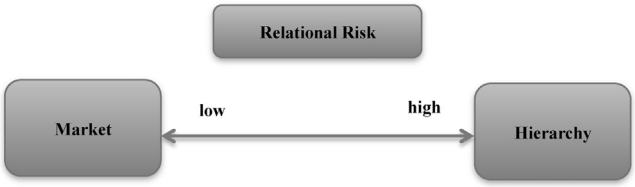

Fig. 1. The influence of relational risk on governance form.

2.3.1. TCE and relational risk

As is well known, TCE aims to select the governance form that minimizes the sum of total production and transaction costs. However, because, on the one hand, the marketplace is characterized by scale and specialization economies, efficient adaptation, flexibility and residual claimant advantage, while, on the other, hierarchies are characterized by administrative and incentive limits, TCE generally assumes that simple market contracts provide a more efficient, or lower-cost, mechanism for managing economic exchanges, compared to hierarchical organizations. Nevertheless, given that, because of bounded rationality, contracts are often incomplete, the theory holds that in certain situations the costs of market exchange may increase substantially and surpass the technical efficiencies provided by the market; in such cases, firms should internalize transactions. TCE scholars associate high transaction costs with opportunistic behaviour (Williamson, 1975, 1985), hold-up problems (Klein, Crawford, & Alchian, 1978), residual appropriation (Alchian & Demsetz, 1973), asset rent seize (Grossman & Hart, 1986) and appropriation concern (Oxley, 1997). As previously highlighted, all the above-mentioned sources of transaction costs arise from the relation between the parties involved in the agreements. Thus, for our purpose, TCE focuses on relational risk and assumes transaction costs to be a Knightian measure of such a risk. Furthermore, it is well known that the TCE approach to the choice of transaction governance forms is a kind of "discriminating alignment" decision (Williamson, 2000). This implies the need to match simple market exchanges with simple modes of governance, and more complex exchanges with more complex forms of organization. Indeed, when the relational risk is low, market-oriented agreements, such as contractual or equity alliances, should be preferred in order to exploit the marketplace's potential; on the contrary, when relational risk is high, more complex and hierarchical governance forms, such as merger and acquisitions (M&A), help to reduce transaction costs. Thus, in accordance to the above reasoning, we formulate our first hypothesis (Fig. 1).

H1. When relational risk is high, firms prefer hierarchical governance forms such as M&As to market-oriented agreements such as contractual and equity alliances; conversely, when it is low, firms prefer contractual alliances or equity alliances to M&A.

2.3.2. Real options and performance risk

RO are investment opportunities that confer the right, but not the obligation, to take some specific operating actions in the future. Thus, under the RO perspective, certain types of investment might be considered as the creation of an option, which can be exercised at a later point in time using a more integrated solution (Kogut, 1991; Hagedoorn & Sadowski, 1999; Vanhaverbeke, Duysters, & Noorderhaven, 2002). This approach implies recognition of the existence of opportunity costs associated with irreversible investments under a risky context. In this scenario, the ability to defer a commitment of resources under uncertainty can raise the investment value by adding the options value; furthermore, many investments can create valuable follow-on opportunities, or growth options, that are still valuable. By merging these two perspectives, deferring today and growing tomorrow, RO theory evaluates the flexibility of small, risky investments by reducing irreversible investments today while delaying them to the point at which the firm receives new information regarding market demand, competitive conditions, the viability of new processes technologies, and so forth. In RO theory, individuals are rational and risk-adverse decision-makers who are able to forecast a set of future states of the world, to choose among known sets of alternatives, and to maximize their expected values. This also implies that RO theory recognizes the value of flexibility embedded in investments with exogenous sources of risk, such as that involved in price and demand volatility or technological newness, etc. Indeed, these types of risk have an impact on the value of the underlying asset through its volatility. Thus, unlike TCE, RO theory focuses on performance risk. It is quite evident that the reasoning of RO theory fits well into inter-organizational decision-making, so that RO have been applied in JV investment evaluation (Kogut, 1991; Folta, 1998; Folta & Leiblein, 1994; Reuer & Leiblein, 2000), R&D alliances (Pisano, 1990) and inter-organizational governance (Leiblein & Miller, 2003).

In inter-organizational governance decisions, deferring means postponing irreversible investments, such as acquisitions or mergers, in order to acquire further information that allows for a reduction in the performance risk. On the other hand, less irreversible investments, such as contractual alliances or equity ones, allows an option to be built that can be exercised in the future. Following this reasoning, we formulate the following hypothesis (Fig. 2):

H2. When performance risk is high, firms prefer market-oriented governance modes such as contractual and equity alliances to hierarchical governance forms such as M&A; conversely, when it is low, firms prefer M&A to contractual or equity alliances.

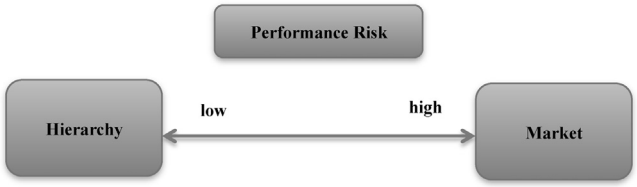

Fig. 2. The influence of performance risk on governance form.

2.3.3. The moderating effect

It should be noted that TCE and RO theories, looking at different components of risk, are opposite in terms of suggesting the most suitable governance form. However, as also highlighted by previous contributions (Das & Teng, 2001; de Man & Roijakkers, 2009), both types of risk can be present in an inter-firm agreement, and thus the elements put forward by the two theories impact in an opposite way on the decision-making process underlying the choice of the most suitable inter-organizational governance form. Indeed, let's consider the case of a contemporarily presence of high relational and performance risk. How firms should select the governance form in this case?

From one hand, according to the TCE perspective explicated in H1, in order to reduce the relational risk, firms would select a hierarchical governance form, i.e. an acquisition. However, acquisitions are quite ineffective in reducing the performance risk; furthermore, they are irreversible investments that increase organizational costs. Thus, in presence of high performance risk, an acquisition increases the magnitude of the firm's losses in case of failure. Therefore, the high level of performance risk weakens the TCE-based preference of managers towards acquisitions in case of high relational risk.

On the other hand, according to an RO-theory perspective, in order to control the performance risk, firms would prefer a delay option, by doing a flexible reversible investment, such as a contractual or equity alliance, postponing the irreversible one, i.e. the acquisition, further on. However, contractual alliances are ineffective in reducing relational risk because they do not provide the necessary instruments to lower transaction costs. Equity alliances provide more safeguards concerning the control of the opportunism risk, but they are still less effective than M&A since do not provide an internalization of the transaction. Therefore, the high level of relational risk weakens the RO-based preference of managers towards contractual or equity alliances in case of high performance risk.

According to the above reasoning, we formulate the following hypothesis (Fig. 3):

H3. A significant level of performance risk moderates (reduces) the TCE-based relation between high relational risk and merger and acquisitions. Conversely, a significant level of relational risk moderates (reduces) the RO-theory-based relation between high performance risk and contractual or equity alliances.

A corollary of hypothesis 3 is that in case of a contemporarily presence of high relational and performance risk, equity alliances should be preferred to both contractual alliances and acquisitions. Indeed, from one side, by choosing an equity alliance managers would gain more control and monitoring of the activities thanks to their presence in the board of the subsidiary and to the hierarchical structure of the subsidiary itself, thus reducing the relational risk; on the other hand, they create a more flexible and less costly organizational structure (if compared with acquisition) reducing the potential loss in case of failure.

3. Industry motivation and framework operationalization

3.1. Industry motivation

Biotechnology has represented a competence-destroying technology for the R&D activities of the pharmaceutical industry, because it requires technical skills and knowledge that are fundamentally different from those pharmaceutical companies had developed until the biotech age advent (Tushman & Anderson, 1986). Indeed, Rothaermel (2001) estimated

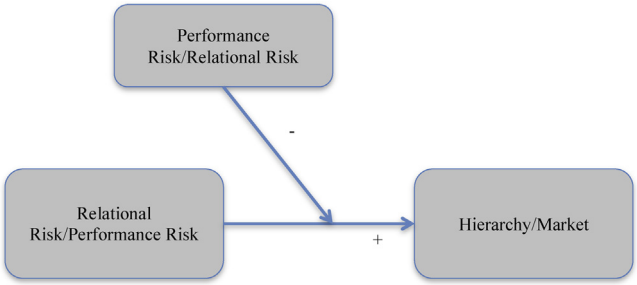

Fig. 3. The moderating effect.

that the skill loss for a scientist making the transition from the traditional chemical-based framework to the new biotechnology one is between 80% and 100%. However, unlike other industries, the effect of this radical change has not been disruptive for traditional pharmaceutical firms. Indeed, despite the considerable technological advantage of new entrants, incumbents still own important strategic assets in developing such new biopharmaceutical products (Rothaermel, 2001), and furthermore in marketing and distribution.

This situation has created positive opportunities for collaborations between the new sources of technical expertise and established firms (Pisano, 1990, 2006; Powell, Koput, & Smith-Doerr, 1996). For such reason, since the mid 1970s the biopharmaceutical industry has been characterized by an increasing recourse to inter-firm agreements between big pharmaceutical firms and small new biotechnology firms (Hagedoorn, 1993; Higgins & Rodriguez, 2006). The basic explanation for the increasing number of inter-firm relationships in the industry is related to the extent of strong asset complementarities between the two types of firms. On the one hand, a pharmaceutical firm wishing to commercialize a biotechnology-based drug needs to acquire the necessary competencies by developing the required R&D capabilities in-house or sourcing them from outside, i.e. from a biotechnology firm (Chiesa & Toletti, 2004). On the other hand, a biotech company that has developed a new compound or a technological platform and wants to bring it into the market often lacks critical functions or capabilities, such as those relating to drug manufacturing and marketing. According to McCutchen and Swamidass (2004), biotechnology firms are, in fact, "functionally incomplete".

Furthermore, pharmaceutical firms have been facing threats such as increased R&D costs and a decline in R&D productivity (DiMasi, Hansen, & Grabowski, 2003; Bradfield & El-Sayed, 2009), the expiration of numerous patents, exhaustion of old technologies and increasing competition from generic pharmaceutical firms. Conversely, biotechnology firms have technological assets that make it possible to face such threats (Danzon, Epstein, & Nicholson, 2007).

Finally, a very important source of complementarities is on the financial side. Indeed, the drug development process is long, costly and highly uncertain: it requires 10–15 years from research to market, and costs vary from US$ 800 million (DiMasi et al., 2003; Goozner, 2004) to US$ 1.2 billion for a biopharmaceutical drug (DiMasi & Grabowski, 2007). Furthermore, out of 100 drug candidates, only one or two are launched into the market. Thus, it is easy to understand that financing is extraordinarily important for high-tech industries in general, and for the biotech industry in particular, so that young biotech start-ups usually obtain financial capital by entering into strategic deals with other firms (Pisano, 2006; Gopalakrishnan, Scillitoe, & Santoro, 2008). In the other respect, more mature companies can rely on the commercialization of products and technologies, as well as intellectual assets (i.e. patents) and service sales. However, Pisano (2006) highlights how, despite the commercial success of companies such as Amgen and Genentech, most biotechnology firms earn no profit. Finally, beyond the lack of financial capital of biotech firms, which is absolutely essential for carrying out their activities, biotech firms also use alliances as a signalling mechanism of their value in order to improve their market evaluation (Janney & Folta, 2003). On the other hand, established pharmaceutical firms have large amounts of financial resources, due to their blockbusters and their long presence in the market. Thus, entering into agreements with pharmaceutical firms represents an extremely important strategic tool for biotech companies (Pisano, 2006).

All the aforementioned complementarities provide reasons for pharmaceutical and biotech companies to cooperate. This is the reason why, starting from the seminal work of Pisano (Pisano, 1990), several scholars (Folta, 1998; Steensma & Fairbank, 1999; Santoro & McGill, 2005; Rothaermel & Deeds, 2006; Higgins & Rodriguez, 2006; Rosiello, 2007; Dunne, Gopalakrishnan, &, Scillitoe, 2009; de Man & Roijakkers, 2009; Van de Vrande et al., 2009) have used this industry as test-bed for investigating governance form choices in inter-firm relationships.

3.2. Framework operationalization

3.2.1. Relational risk operationalization

According to Das and Teng (2001), relational risk reflects decision-makers' concerns about the level of cooperation between partners. According to TCE scholars, partners' cooperation levels are threatened by opportunistic behaviour (Williamson, 1975, 1985), hold-up problems (Klein et al., 1978), residual appropriation (Alchian & Demsetz, 1973), asset rent seize (Grossman & Hart, 1986) and appropriation concern (Oxley, 1997). On the other hand, partners' levels of cooperation are improved by trust (Gulati, 1995) and firms' familiarity with inter-firm relationships. Thus, in line with these considerations, we detect the following factors as main drivers of relational risk perception: *investment specificity*, *partners' asymmetry*, *lack of trust*, *lack of inter-firm relationship experience*.

3.2.1.1. Investment specificity. TCE emphasizes the role of transaction-specific investments in determining high levels of opportunistic behaviour. As defined by Williamson (1975), asset specificity is the extent to which investments made to support a particular transaction have a higher value within the transaction than they would have if they were redeployed for any other purpose. According to TCE, the more an investment is relation-specific, the higher will be the sunk costs associated with the relationship. The more such costs are not equally balanced between the partners, the higher the probability that one partner will act in an opportunistic way in terms of trying to seize the other partner's rent. Thus, highly relation-specific investments might increase the expected inequities of payoff in a relationship, and therefore, according to Das and Teng (2000), they are related to relationship risk. David and Han (2004) provide strong empirical support that asset specificity influences transaction costs; indeed, the extent of asset specificity increases transaction costs and creates greater opportunism risk, and thus higher relational risk. In this case, TCE suggests that the transaction should be internalized in

order to reduce this risk. Santoro and McGill (2005) find strong empirical evidence that confirms the importance of asset co-specialization in influencing governance form in the biopharmaceutical industry.

3.2.1.2. Partners' asymmetry. The presence of asymmetry between alliance partners in terms of relative size, different resources and bargaining power determines an increase in the perception of the relational risk. Several authors (Harrigan, 1985, 1988; Oliver, 1990; Parkhe, 1991; Bleeke & Ernst, 1995; Das & Teng, 2001) observe that inequality between parties, which allows the stronger firm to exercise power and control over its partner, leads the weaker party to perceive high relational risk. Aghion and Tirole (1994) suggest that bargaining power is a determinant in the governance negotiation outcome, so that the most powerful firm has the possibility to negotiate the transaction in its favour by improving asset and transaction rents. Thus, according to the TCE framework, the stronger the partners' asymmetry, the higher the risk of possible opportunistic behaviour, such as asset rent seizure and/or residual appropriation, from the stronger party. Finally, Delerue (2004) finds partners' asymmetry to be one of the main sources of relational risk in the biopharmaceutical industry.

3.2.1.3. Lack of trust. Trust in inter-firm agreements has received a huge amount of contributions as a key driver influencing governance form choice (Ring & Van de Ven, 1992). Relational and TCE scholars suggest that successful alliances result from characteristics such as trust, reputation, commitment, cooperation and communication (Williamson, 1971; Dyer & Singh, 1998; Gulati, Nohria, & Zaheer, 2000). In particular, trust and reputation establish norms and expectations about appropriate behaviour, lowering the perception of relational risk. Authors such as Parkhe (1993) and Gulati (1995) suggest that trust can be a substitute for hierarchical contracts in many exchanges, and serves as an extra-contractual control mechanism by reducing the perception of relational risk. Indeed, the familiarity established among partners mitigates the hold-up risk and, therefore, reduces relational risk. Gulati (1995) finds empirical evidence to support this view. In addition, Ring and Van de Ven (1994) show that trust is an essential condition for market transactions. In the same way, the lack of trust among partners determines higher behavioural uncertainty, namely relational risk perception, thereby increasing the need for costly monitoring and control of hierarchical governance (Santoro & McGill, 2005). Finally, trust has been deeply investigated as a driver influencing governance form choice in the biopharmaceutical industry (Santoro & McGill, 2005; Delerue, 2004; Van de Vrande et al., 2009).

3.2.1.4. Lack of inter-firm relationship experience. The collaboration propensity of a firm might influence the relational risk perception. Indeed, having a successful partnership history should determine a higher level of confidence about the success of the new relation, and the experience of past alliances enables partner firms to accumulate valuable knowledge about alliance management (Hagedoorn & Duysters, 2002). Kale and Singh (2007) find that alliances offer great learning opportunities for firms to develop their capabilities. Other studies have found evidence that firms learn to manage alliances more effectively over time (Anand & Khanna, 2000; Barkema & Vermeulen, 1997). We argue that inter-firm agreement experience has a double effect in reducing relational risk. The first effect, based on dynamic capability theory, looks at the point of view of a company that has experienced several inter-firm relationships, and suggests that such experience increases its confidence about its capabilities in managing such relationships (Wang & Zajac, 2007). For instance, Villalonga and McGahan (2005) show how former alliance and acquisition experience increases the number of the same typology of inter-firm agreements. The second effect, based on TCE argumentations, is from the partner's point of view, stating that the higher the number of relationships the counterpart has been involved in, the higher its reputation in terms of being a good partner for a relationship. From this perspective, Teng and Das (2008) argue that inter-firm experience helps to build trust among the partners. Indeed, the more inter-firm relationships a partner is involved in, the higher the possibility they will behave correctly in relating with other subjects; thus, this kind of trust reduces the need for contractual safeguards and therefore lowers transaction costs, pushing toward less integrated solutions. At the same time, the lack of inter-firm experience determines a higher perceived relational risk, leading to more structured and integrated governance forms. Finally, both Van de Vrande et al. (2009) and Santoro and McGill (2005) use firm's experience in previous relationships as a control variable in studying the choice of governance mode in the biopharmaceutical industry. However, up to now, former inter-firm agreement experience has not been related to relational risk in any empirical study involving the biopharmaceutical industry.

3.2.2. Performance risk operationalization

According to Das and Teng (2001), performance risk in strategic alliances is the probability and consequences of a firm's failure to achieve its strategic objectives, despite full cooperation, i.e. when the relational risk is assumed to be non-existent. Performance risk arises from drivers such as market demand and prices, commercial and technological risk, R&D risk, international risk, corporate risk and strategic risk. Coherently, we operationalize performance risk as follows.

3.2.2.1. Technology/product newness. Technology/product newness is one of the main sources of performance risk. The newer the technology involved in the agreement, no matter what the level of cooperation among the partners, the higher the risk of not gaining the expected results. Indeed, Ahuja and Lampert (2001) note that when technology is in an early stage of development, its basic concepts stem from practice, thereby raising the uncertainties associated with it. This is particularly true in the biopharmaceutical industry, where specific applications from chemistry, functional genomics and bioinformatics are combined to target and test new molecules, making applications in therapeutics more uncertain than those in

diagnostics, as indicated by systematic financial market variances among therapeutic, diagnostic and other biotechnology sub-fields. According to this, Lambe and Spekman (1997) find that the presence of biotech compounds in early stages of development makes performance risk particularly high. Higgins and Rodriguez (2006) suggest that pharmaceutical firms seeking early-stage research may incur high performance risk. Also, RO-theory scholars point out technology newness as a significant form of performance risk, especially in the biopharmaceutical industry (Van de Vrande et al., 2009). Folta (1998) highlights that technology newness is one of the main reasons why a technology investment might turn out to have little value. Leiblein (2003) evidences how technology newness also increases the risk of obtaining the desired performance because of the weak, or still unknown, appropriability regimes and significant inter-generational knowledge spillovers. Janney and Dess (2004) show that the uncertainty surrounding new radical technologies should be addressed by the investing firm through small initial investments – so-called "learning investments" – in order to gradually acquire the knowledge and the information needed to reduce the performance risk.

3.2.2.2. Technological distance. Dissimilarities between the knowledge bases of two partners might have significant implications on performance risk. Indeed, large dissimilarities lead to limited capabilities to detect, assimilate and integrate technology that is quite different from firms' core technologies. This type of problem is typically related to the absorptive capacity of firms (Cohen & Levinthal, 1990), i.e. the more dissimilar the knowledge base of the two partners, the larger the probability that the absorptive capacity of the investing firm will fall short, thereby affecting the extent to which a firm can recognize and absorb its partner's technological capabilities. This, of course, increases the performance risk. Also, TCE scholars note that a greater technological distance makes unintended spill-over of knowledge less likely to happen, thereby decreasing the threat of opportunistic behaviour; thus, the greater the knowledge base dissimilarities, the less attractive the integration solution. Furthermore, Oxley and Sampson (2004) argue that high technological dissimilarities, while increasing the performance risk, reduce the broadness of an alliance's scope. Conversely, Villalonga and McGahan (2005) argue that a greater technology relatedness between the two parties implies a lower-cost of integration, due to economies of scale within the organization, and therefore reduces performance risk. RO-theory authors, such as Folta (1998), find empirical evidence for the relation between technology distance, performance risk and governance form choice in the biopharmaceutical industry; indeed, he shows that when the knowledge bases of the firms are dissimilar, companies are more likely to use less integrated governance forms in order to delay part of the investment until further information is available. In addition, Pisano (1990) finds that uncertainty coming from technological distance plays a critical role in pharmaceutical firms' decisions to acquire biotechnology R&D from outside. He observes that a firm that is not yet familiar with the technological know-how of its partner will manage the performance risk by first learning from the partner through arm's-length transactions, before being able to accumulate knowledge.

3.2.2.3. Nationality. International alliances are exposed to an additional risk called international risk, which has its roots in national differences in terms of distance, cultures, regulations, technological standards, and business practices (Parkhe, 1991; Brouthers, 1995). Several authors, such as McCutchen, Swamidass, and Teng (2008), analyse alliance risk in both domestic and international alliances, and highlight the main managerial difficulties linked to the so-called "international risk" (Miller, 1992). International risk depends on several factors: (i) distance increases coordination costs; (ii) partners in international alliances have different needs and offer different resources and capabilities (Hitt, Dacin, Levitas, Arregle, & Borza, 2000); (iii) different legal, institutional, historical and language environments (Lane & Beamish, 1990) make communication more difficult and increase the chance of misunderstandings between partners; (iv) different managerial cultures create difficulties and lead to alliance failure (Delerue & Simon, 2009); (v) different economies in which partners operate entail different risks associated with politics, foreign exchange rates and local laws and regulations (Kogut & Singh, 1988) and finally, (vi) international differences in intellectual property rights protection make it more difficult to manage R&D collaborations and gain common results such as patents (Oxley, 1999; Hagedoorn, Cloodt, & van Kranenburg, 2005). It is notable that different nationalities of the partners lead to an increasing level of risk no matter how the partners behave, and thus different nationalities increase performance risk.

Table 1 summarizes the relational and performance risk drivers discussed so far, by evidencing their influence on the two risk components.

4. Empirical analysis

4.1. Governance forms in the market-hierarchy continuum

In Table 2, we review the governance forms used by the most significant empirical literature on the issue. In this paper we follow the consolidated empirical literature on governance form, and consider three different governance modes. According to a TCE perspective (Oxley, 1997; Sampson, 2004; Santoro & McGill, 2005; Villalonga & McGahan, 2005), the governance form closest to the market is a *contractual alliance*. This, in our case includes, both unilateral contractual alliances such as licensing, subcontracting and distribution agreements, and bilateral contractual alliances such as joint production, joint marketing and promotion and joint R&D agreements.

Then, we consider *equity alliances*, namely those alliances involving equity exchange in one or both partners. In this group we consider both minority equity alliances and equity JVs (Oxley, 1997, 1999; Pangarkar & Klein, 2001; Oxley & Sampson,

Table 1
Operationalization of relational and performance risk.

Risk component	Drivers increasing risk component
Relational risk	Investment specificity Partners' asymmetry Lack of trust Lack of inter-firm relationship experience
Performance risk	Technology/product newness Technology distance Nationality

Table 2
Review of governance forms and their coding.

Author(s) and year	Governance form codes
Folta (1998)	Minority investment (0), JV (1), acquisition (2)
Gulati and Singh (1998)	Contractual alliances (0), minority equity (1), JV (2)
Gulati (1995)	Non-equity alliances (0), equity alliances (1)
Hagedoorn et al. (2005)	Contractual partnership (0), equity JV (1)
Leiblein and Miller (2003)	Alliances (any type) (0), acquisition (1)
Oxley (1997)	Unilateral contractual agreements (0), bilateral contractual agreements (1), JV (2)
Oxley (1999)	Contractual alliances (0), equity (1)
Pangarkar and Klein (2001)	Alliance involving purchase of equity stakes (1), otherwise (0)
Sampson (2004)	Alliance organized by bilateral contract (1), equity JV (2)
Santoro and McGill (2005)	One-way licensing (non-equity) (1), bilateral cross-licensing (non-equity) (2), bilateral non-licensing (non-equity) (3), minority equity (4), and equity JV (5)
Teng and Das (2008)	Contractual alliances (1), minority equity alliances (2), JV (3)
Van de Vrande et al. (2009)	Non-equity technology alliances (1), CVC investments (2), minority holdings (3), joint ventures (4), M&A (5)
Villalonga and McGahan (2005)	M&A (1), minority acquisitions (2), JV (3), non-equity alliances in technology R&D or manufacturing (4), non-equity alliances in marketing (5), licensing arrangements (6), divestitures (7)
Wang and Zajac (2007)	No relationships (0), alliances (any type) (1), acquisition (2)

2004; Villalonga & McGahan, 2005; Hagedoorn et al., 2005). Because shared ownership provides the right to participate/influence board decision-making, these kinds of arrangements imply a higher level of interdependence, shared resources and risk and more formal monitoring and control. Thus, they are also less flexible and difficult to restructure, modify or terminate. Finally, we consider totally integrated governance forms such as *mergers and acquisitions* (M&A).

Indeed, as also reported in Table 2, the rationality of considering acquisition in the biotechnology context is quite significant, because in such an industry, pharmaceutical firms might have an interest in integrating (acquiring) biotechnology platforms in order to have the possibility to develop new products later on.

4.2. Data and sample

In order to test the proposed framework, we built our data set by using the "Biotech & Pharma Collaboration" section of the BioWorld Industry Snapshot database. This data source was used for identifying worldwide inter-firm relationships among biotech and pharmaceutical companies during the period January 2007–December 2010. We selected the BioWorld database because it is a new and reliable source of records specific to the biotechnology industry, and contains information about partners' business names, deal type/objective, product area and financial terms. In the period examined, 1781 deals were included in the BioWorld database. However, our dataset comprises 353 deals and was constructed in the following way. First, we collected data about all deals signed in the period 2007–2010. Next, we excluded from the analysis 982 agreements for which financial terms were not disclosed in BioWorld. Afterwards, we also excluded agreements involving more than two parent companies, and those involving public research entities, such as universities. Finally, to ensure that our dataset matched the hypotheses, we checked whether the deal had actually been signed between a pure biotech company and a pharmaceutical/biopharmaceutical one, since many deals had been signed between two biopharmaceutical companies.

In this way, we obtained our final dataset consisting of 353 agreements divided into 216 contractual alliances, 43 equity alliances (39 minority equity alliances and 4 joint ventures) and 94 mergers and acquisitions.

Once the main information about the agreements were collected from the BioWorld database, we completed our dataset by integrating information such as partners' nationality, number of employees, age and main NACE codes from the Orbis Database, which is a global database containing profiles and financial information of over 80 million companies.

As far as the international dimension of our dataset is concerned, Table 3 reports the nationality of firms in our sample, which are divided into pharmaceutical and biotech companies, and the international dimension of the agreements. Our

Table 3
International dimension of the dataset.

Firms' nationality			
Pharma	353	Bio	353
USA	110	USA	240
UK	50	UK	22
Japan	42	Canada	21
Germany	41	France	13
Swiss	36	Germany	9
France	21	Belgium	7
Italy	7	Swiss	6
Belgium	7	Australia	6
Denmark	6	Denmark	6
Netherlands	5	Sweden	4
Canada	3	Austria	4
Australia	3	Netherlands	3
Ireland	3	Israel	3
Sweden	3	India	3
Israel	3	Italy	1
Korea	2	Ireland	1
India	1	Korea	1
Austria	0	Japan	0
Other	10	Other	3
International dimension of the agreements			
Within the same country			30%
Different country but same continent			14%
Different continent			56%

sample covers firms worldwide, and the percentage of agreements involving firms belonging to the same country is just 30% of the whole sample.

4.3. Variables coding

4.3.1. Dependent variable

The governance form is indicated using *G*. Following the main literature on inter-organizational governance forms (see Table 2), we code *G* as follows: contractual alliances = "1"; equity alliances = "2" and M&A = "3".

4.3.2. Control variables

In this study we include four control variables. First, we control for the effects of firms' size. Thus, we use two variables, i.e. *pharma size* and *biotech size*, to measure the number of employees in each firm. Since these two variables present a high range of variability, we applied a log transformation. Controlling for firms' size is quite common in research studies with a similar purpose to ours (Santoro & McGill, 2005; Van de Vrande et al., 2009).

Secondly, we control for *biotech patents*, that is the number of patents registered by the biotech firm in the period covered by BioWorld database from 2000 onward. We collected patent data both from the publicly available NBER Patent data (Trajtenberg, Jaffe, & Hall, 2001), for US companies, and from the Espacenet Database for European companies. This provided us with a continuous variable, to which we applied the log transformation. The influence of such a variable on governance form is already well documented. Indeed, patenting is often assumed as a measure of the knowledge accumulated by the biotech firm (Van de Vrande et al., 2009; Bosse & Alvarez, 2010) and, also, as a measure of the capacity to finance its own activities (Bosse & Alvarez, 2010; Lo Nigro, Perrone, & Chiapparone, 2012). Both these characteristics increase the bargaining power of the biotech firm, thereby allowing it to resist possible acquisition. On the other hand, they make the biotech company an even more interesting subject for acquisitions. Furthermore, in the biopharmaceutical industry many patents are related to technological practices, such as in the case of biotech technology platform. In such cases, in order to develop products, the pure biotech still needs the pharma's expertise in product developing and clinical trials. Thus, according to the main authors dealing with the topic, we recognise the possibility of the biotech's patents to influence governance form, but do not locate it as an investigation variable.

Finally, we control for the habit of the pharmaceutical company to acquire or to merge, i.e. *Pharma's M&A propensity*. Indeed, dynamic capability scholars such as Wang and Zajac (2007) argue that prior experience of acquisitions familiarizes firms with the issues that could arise during the integration process, and helps them to develop routines to solve the problems arising during such processes. This learned capability makes firms more prone to be involved in repeated acquisitions. Supporting this reasoning, Wang and Zajac (2007) find that the combined acquisition capabilities of two firms have a stronger positive relationship with the likelihood of an acquisition occurrence than the likelihood of an alliance. In the biopharmaceutical industry, the number of previous M&As signed by a pharmaceutical company identifies its propensity

towards making acquisitions through which to source external technologies, thus influencing the governance form choice. It should be stressed that we deal with this control variable differently from the *lack of inter-firm experience*, which we consider as an investigation variable. Indeed, the *pharma's M&A propensity* could increase the relational risk perception of the biotech company, however this perception concerns only one side of the relationship, therefore it cannot be related to a relational risk that, by definition, should concern both of the parties interested in the agreement. As a measure of the *M&A propensity* of the pharma, we consider the number of M&A agreements signed by the pharmaceutical firm with any other partner in the period covered by BioWorld, i.e. from 2000 onward.

4.3.3. Independent variables

Independent variables are all related to factors influencing the two typologies of risk discussed in Section 3.2 and summarized in Table 1. Concerning relational risk, we identify the following variables.

As a proxy of *investment specificity* we consider the log value of the up-front payment the pharmaceutical company pays to the biotech in all types of alliances. We assume that the higher the value of such payments, the higher the investment specificity. It should be said that other studies, such as Santoro and McGill (2005), use asset co-specialization to measure investment specificity. Asset co-specialization includes the typology of asset involved in the agreement – thus, for instance, authors classify R&D agreements as more specific than marketing agreements. However, we find that this methodology is affected by a high degree of subjectivity, and is very difficult to apply to biopharmaceutical agreements where several assets (commercial, development and research) are often involved at once. Therefore, we decided to use up-front payments. Such payments are undoubtedly relation-specific investments. Indeed, we consider investments having operational (commercial licensing of a drug; co-marketing; co-manufacturing) or R&D purposes (co-development; co-research). Such payments are non-refundable, so that when the agreement does not work as planned, firms cannot recover their investments (in all or in a great part). This is particularly true in biopharmaceutical agreements, where failed agreements have often incurred legal actions whose main aim has been the attempt to reduce, through renegotiation or partial reimbursement, such sunk cost (Newswire, 1996; Krishnan, 2011; Jones, 2009; CHPR, 2011). Thus, according to TCE, up-front payments are a suitable and an objective measure of transaction costs and, according to our framework, of the relational risk. Having clarified this issue, we also need to explain what we measure under up-front or irreversible payment. In case of contractual ($G = 1$) agreements, we include the up-front payment. In the case of equity agreements ($G = 2$), we compute the up-front payment plus the part of equity that is paid in cash when the agreement is signed. Finally, in case of M&A ($G = 3$) we also consider the part of equity that is paid in cash when the agreement is signed which, in several cases, is different from the equity as a whole; indeed, in biopharmaceutical acquisitions, it is quite common for equity acquisition to be done at different times, where a certain amount is acquired when the agreement is signed, and the remainder at predetermined milestones as certain results are gained. A good example of this is the 2010 acquisition of Novexel from AstraZeneca, where AstraZeneca agreed to acquire 100% of Novexel's shares for $350 million in cash payable at the agreement signing stage, and an additional $75 million to Novexel shareholders if specified development milestones were reached.

As a proxy of *partners' asymmetry*, we develop a measure of the different sizes of the firms involved in the agreement. Arinõ, Ragozzino, and Reuer (2008) suggest capturing firms' bargaining power by counting employees. Thus, we first group firms into five different groups depending on their size and industry[1]: "1" for micro firms (i.e. from 1 to 10 employees), "2" for small firms (from 11 to 50), "3" for medium firms (from 51 to 250), "4" for big firms (pharmaceutical firms from 251 to 750 employees and biotech firms from 251 to 500 employees), and "5" for big enterprises (more than 500 employees for biotech firms and more than 750 for pharmaceutical firms). Afterwards, we calculate the difference between the size of the pharma and the biotech.

As commonly encountered in literature, we assess the *lack of trust* between the same partners through the absence of previous ties. Based on BioWorld data, we count prior relationships between the two firms in a 7-year period prior to the agreement date. Thus, the variable "lack of trust" assumes a value of "0" if the partners reported previous relations; vice versa it assumes value of "1". So, when the variable increases the relational risk increases too.

As far as the measure of *lack of inter-firm relationship experience* (IFRE) is concerned, the variable is computed as: $[\mathrm{Max}_i(\ln(\mathrm{IFRE}_i)) - \ln(\mathrm{IFRE}_i)]/(\ln(\mathrm{IFRE}_i))$, where $\mathrm{Max}_i(\ln(\mathrm{IFRE}_i))$ is the maximum of the log transformation of the number of alliances (any kind) signed by the generic i-th pharmaceutical firm in a 7-year period, prior to the agreement in the whole data set. Hence, when $\ln(\mathrm{IFRE}_i)$ reaches the maximum value, *lack of inter-firm relationship experience* is "0"; therefore, the relational risk increases with the *lack of inter-firm relationship experience*.

Regarding performance risk, we identify the following measures. As a proxy for *technology newness*, we identify the development stage of the product/technology involved in the agreement. As is well known, the drug development process is composed of four macro phases prior to commercialization: the drug discovery phase, the preclinical development, the clinical trials (composed of three stages, i.e. phase I, phase II and phase III) and the approval phase. Each of these steps is complex and uncertain, so that the more advanced the development stage, the more likely the drug would be to reach the market. It should be considered that even when a drug has completed phase II-A of clinical studies, the expected probability of success does not even reach 50% (DiMasi, 2001). Thus, the development stage is a good measure of technology newness in biopharmaceutical agreements. Using both BioWorld data and hand-collected data from public announcements of alliances

[1] According to the US Small Business Administration Classification.

and M&As available on the companies' websites, we develop the following ordinal measure for the development stage: "1" if the product/technology is in the discovery phase or preclinical development; "2" if it is in phase I of clinical trials; "3" if it is in phase II; "4" if it is in phase III; "5" if it is in the approval stage or phase IV; and "6" if already approved or commercialized. Thus, as a measure of technology newness we assume the value: "*6 – development stage*". In this way, *technology newness* varies from 0 to 5, so that the higher its value, the higher its performance risk.

As a measure of the *technological distance* we use a dichotomy variable assuming the value "0" if the pharmaceutical is a biopharmaceutical company, i.e. a company already integrated in the biotech field; in this case the technological distance is low. On the other hand, the variable assumes "1" where it is a "pure pharma", i.e. a pharmaceutical company that has never experienced integration in the biotech field; in this case we assume a higher technological distance.

Finally, the variable *nationality* is an ordinal variable that is coded "0" if the partners have their headquarters in the same country, "1" if they are in the same continent, but in different countries, and "2" otherwise. Thus, the greater the variable value, the more significant the international risk and thus the performance risk.

4.3.4. Methods

Our dataset is a cross-sectional one, where each unit of analysis represents an inter-firm relationship between a pharmaceutical and a biotech company. In this kind of analysis, where the dependent variable can be ordered along a continuum from market-oriented governance forms to hierarchical ones, some researchers have used an ordinal logit model in order to preserve the ordered nature of the dependent variable (Santoro & McGill, 2005).

However, according to the main literature strand, we do not assume a continuum behaviour of the dependent variable; thus, we use multinomial logistic regression. Unlike ordinal logistic regression, multinomial allows pairwise comparisons of each level of the dependent variable versus the baseline (in our case, the baseline is M&A). Hence, since multinomial regression does not assume a predetermined ordering, the results can provide a more detailed insight when particular governance modes are preferred over others, depending on the circumstances.

5. Results

Table 4 provides descriptive statistics and correlations for all variables. Collinearity does not seem a problem with our data (all VIFs are far below 10).

Table 5 shows the regression results, and contains two models. Model 1 aims to test H1 and H2, so it contains only relational and performance risk variables (main effects). All variables are standardized, so that the coefficients reported in Table 5 are immediately comparable to one another; furthermore, differences among the coefficients are all significant.

Starting with control variables, we find that both *pharma size* and *biotech size* are significant at certain values (respectively $G = 1$ for *pharma size* and $G = 2$ for *biotech size*) of the dependent variable, and that they both show positive coefficients, meaning that contractual and equity alliances are more likely than M&A when the size of the company increases. *Biotech patents* is, on the other hand, not significant for any levels of the dependent variable. The variable *number of M&A* is significant at all values of G, and is negative; thus, as argued, the higher the propensity of the pharmaceutical firm to sign M&A, the more likely this governance form adoption in biopharmaceutical agreements.

Let us now analyse the results for the relational risk drives (Model 1).

The variable *investment specificity* is significant for any value of the dependent variable, and its coefficients are negative and fairly constant across the values of G; thus, according to H1's formulation, when relational risk increases due to higher investment specificity, M&A are more likely than any other governance form.

Table 4
Descriptive statistics and correlations.

Variable	Min	Max	Mean	Std. Dev.	VIF	1	2	3	4	5	6	7	8	9	10
Dependent variable															
G (governance form)	1	3													
Control variables															
1. Pharma size	0.69	11.7	9.1	2.4	3.22										
2. Biotech size	0.69	9.8	4.4	1.6	3.67	0.23									
3. Biotech patents	0	7.4	1.9	1.8	1.38	0.09	0.48								
4. M&A propensity	0	17	2.8	2.9	1.50	0.39	0.00	−0.07							
Relational risk variables															
5. Investment specificity	0	4.2	1.6	0.8	1.14	0.15	0.09	−0.03	0.03						
6. Partners' asymmetry	−2	4	1.8	1.2	3.87	0.37	−0.67	−0.37	0.17	0.02					
7. Lack of inter-firm experience	0	1	0.7	0.3	2.00	−0.57	−0.12	−0.06	−0.55	0.02	−0.14				
8. Lack of trust	0	1	0.8	0.4	1.07	−0.17	−0.11	−0.17	−0.08	0.00	0.01	0.12			
Performance risk variables															
9. Technology newness	0	5	2.8	1.6	1.23	0.25	−0.14	−0.05	0.08	−0.22	0.25	−0.25	−0.01		
10. Nationality	0	2	1.3	0.9	1.12	0.11	0.08	0.06	0.10	−0.14	0.04	−0.15	0.06	0.06	
11. Technology distance	0	1	0.5	0.5	1.09	−0.06	0.08	0.13	−0.02	−0.07	−0.06	0.05	−0.04	−0.08	0.20

Table 5
Multinomial regression results.

	Model 1		Model 2	
	$G=1$	$G=2$	$G=1$	$G=2$
Const.	−2.06	−1.807	−4.385***	−4.732***
	(1.518)	(2.602)	(0.218)	(1.548)
Control variables				
Pharma size	0.494***	0.173	0.559*** *1.75*	0.241 *1.27*
	(0.137)	(0.160)	(0.145)	(0.182)
Biotech size	0.239	0.665*	0.420 *1.52*	0.877** *2.40*
	(0.281)	(0.348)	(0.302)	(0.358)
Biotech patents	0.087	−0.164	0.094 *1.10*	−0.137 *0.87*
	(0.137)	(0.169)	(0.169)	(0.203)
M&A propensity	−0.239**	−0.380***	−0.271*** *0.76*	−0.460*** *0.63*
	(0.096)	(0.111)	(0.092)	(0.116)
Relational risk variables				
Investment specificity	−1.985***	−1.921***	−1.695*** *0.18*	−1.687*** *0.18*
	(0.252)	(0.341)	(0.225)	(0.292)
Partner's asymmetry	0.030	0.807*	0.041 *1.04*	1.121** *3.07*
	(0.302)	(0.433)	(0.359)	(0.499)
Lack of inter-firm experience	−0.697	−3.313***	−0.134 *0.87*	−0.761* *0.47*
	(0.302)	(1.167)	(0.355)	(0.436)
Lack of trust	0.132	0.916	−0.013 *0.99*	0.339 *1.40*
	(0.400)	(0.666)	(0.193)	(0.302)
Performance risk variables				
Tech newness	0.376***	0.402**	0.611*** *1.84*	0.592** *1.81*
	(0.134)	(0.185)	(0.258)	(0.293)
Nationality	0.570***	0.407*	0.370* *1.44*	0.186 *1.20*
	(0.188)	(0.185)	(0.202)	(0.238)
Tech distance	0.875**	0.077	0.342 *1.41*	0.057 *1.06*
	(0.353)	(0.473)	(0.243)	(0.318)
Interactions				
Inv. specificity × Tech newness			0.501*** *1.65*	0.497* *1.64*
			(0.191)	(0.270)
Inv. specificity × Nationality			0.427** *1.53*	0.186 *1.28*
			(0.192)	(0.238)
Asymmetry × Tech newness			−0.306* *0.74*	−0.142 *0.87*
			(0.200)	(0.266)
Asymmetry × Tech dist.			−0.131 *0.88*	−0.357 *0.70*
			(0.197)	(0.277)
Lack of inter-firm exp. × Tech dist.			0.662** *1.94*	1.005*** *2.73*
			(0.308)	(0.364)
Lack of trust × Tech newness			0.107 *1.11*	0.632** *1.88*
			(0.243)	(0.290)
Lack of trust × Nationality			−0.268 *0.76*	−0.178 *0.84*
			(0.230)	(0.267)
Pseudo R^2	0.333		0.397	
Log likelihood	−213.13		−192.65	
Chi-squared test	0.00		0.00	

Number of obs: 353. Reference category: 3.
Relational risk-ratios (RRR) are in italics; robust standard errors are in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Partners' asymmetry is significant only at $G = 2$, and its coefficient is positive, meaning that equity alliances are more likely than M&A when partner asymmetry increases; this is in contrast with our H1 prediction.

Lack of trust is not significant for any value of *G*.

Lack of inter-firm experience is significant at $G = 2$, and its coefficient is negative, as expected in H1, meaning that equity alliances are less likely than M&A when the relational risk associated with the scarce familiarity of the pharmaceutical firm with inter-firm relations increases.

In summary, the empirical results slightly support the predictions of H1; indeed, two out of four relational risk drivers, i.e. *investment specificity* and *lack of inter-firm experience*, behave as expected in H1; on the other hand, *partners' asymmetry* does not meet the H1 predictions, and *lack of trust* is not significant.

With respect to the estimates of performance risk drivers (see Model 1), the variable *technology newness* is significant at all values of the dependent variable and, according to the H2 prediction, with positive coefficients. Thus, when performance risk arises, due to higher levels of technology newness, M&A are less likely than market-oriented governance structures.

Also, the variable *nationality* is significant at all the values of *G* with positive coefficients. This result confirms H2's expectation that when performance risk increases as a consequence of a different nationality, market-oriented governance forms are more likely than M&A.

Finally, the variable *technology distance* is significant at $G = 1$ with positive coefficients. Again, according to H2's formulation, the greater the performance risk related to the technology distance, the more likely contractual alliances are in comparison to M&A.

In summary, H2 predictions are satisfied in all three drivers characterizing the performance risk.

Model 2 is designed to test H3 (Table 5), and thus it contains interaction effect variables (a moderation effect). In order to avoid multicollinearity problems in Model 2, investigation variables have been standardized before performing products. Afterwards, a stepwise procedure has been applied for optimising the model; thus, Table 5 reports only those interaction variables remaining after the stepwise procedure. In order to allow a comparison of coefficients in Model 2, we report, in italics, the Relational Risk Ratios (RRR), and we have verified that all the differences among RRRs are significant. The results for the control variables and for relational and performance risk drivers are substantially the same as in Model 1, so we go straight to commenting on interaction effects.

The interaction between *investment specificity* and *technology newness* is significant for all values of *G*. In particular, the RRR coefficients (1.65 and 1.64) are both much greater than those of *investment specificity* (0.18 and 0.18), and are lower than those of *technology newness* (1.84 and 1.81). The reader can notice how the presence of a high level of *technology newness* (a performance risk component) increases the likelihood of contractual and equity alliances over M&A, moderating the effect of a high *investment specificity* (a relational risk component) towards M&A. Conversely, a high level of *investment specificity* decreases the likelihood of contractual and equity alliances over M&A, moderating the effect of a high *technology newness* towards market-oriented governance forms. Thus, for these two variables the moderating effects predicted in H3 are confirmed for all values of *G*.

The interaction between *investment specificity* and *nationality* is significant at $G = 1$. In particular, the RRR coefficient (1.53) is much greater than that of *investment specificity* (0.18), but it is also greater than that of *nationality* (1.44). Thus, for these variables, while the moderating effect of the performance risk variable on relational risk is confirmed, the inverse moderating effect is not confirmed.

The interaction between *partners' asymmetry* and *technology newness* is significant at $G = 2$. The RRR coefficient (0.74) is not comparable with that of *partners' asymmetry*, because not significant. However, it is lower than that of *technology newness* (1.84) confirming in this way the moderating effect of the relational risk component (*partner's asymmetry*) on the performance risk one (*technology newness*). It should be noticed, however, that *partner's asymmetry* in Model 1 behaves differently from what hypothesized in H1.

The interaction between *lack of inter-firm experience* and *technology distance* is significant for all values of *G*. At $G = 1$ the RRR coefficient is not comparable with those of the main variables (*lack of inter-firm experience* and *technology distance*) because neither are significant. However, at $G = 2$, while the RRR coefficient (2.73) is still not comparable with that of *technology distance*, it is much greater than the coefficient of *lack of inter-firm experience* (0.47), confirming in this way the moderating effect of the performance risk variable on the relational risk one.

Finally, the interaction between *lack of trust* and *technology newness* is significant at $G = 2$. The RRR coefficient (1.88) is not comparable with that of *lack of trust* because not significant, while it is slightly greater that the one of *technology newness* (1.81) not confirming, in this case, the moderating effect of the relational risk component on the performance risk one.

In Table 6 we report a summary of the results discussed above. Specifically, in the H3 section, the first comment (confirmed or not confirmed) refers to the moderating effect of the performance risk driver on the TCE-based relation between relational risk and governance form; and vice versa for the second. Furthermore, NS stands for a "not significant" moderating effect, and NC for "not comparable", meaning that while the interaction is significant, the correspondent main effect is not.

Finally, it is remarkably to notice how only two interactions are significant for both the *G* values, that is: *investment specificity* and *technology newness* and *lack of inter-firm experience* and *technology distance*. While for the first couple of variables contractual and equity alliances are equally more likely than M&A, for the second couple of variables equity alliances are much more likely than contractual ones.

Table 6
Summary of the empirical results.

			Performance risk drivers		
			Tech. newness	Tech. distance	Nationality
		H2	Confirmed	Confirmed	Confirmed
		H1	H3		
Relational risk drivers	Investment specificity	Confirmed	Confirmed; Confirmed	NS	Confirmed; Not confirmed
	Partners' asymmetry	Not confirmed	NC; Confirmed	NS	NS
	Lack of trust	NS	NC; Not confirmed	NS	NS
	Lack of inter-firm experience	Confirmed	NS	Confirmed; NC	NS

6. Discussion and conclusion

The research presented in this paper provides interesting contributions both from a scientific and a managerial point of view. Our study contributes to the literature on governance form choice in three different ways.

First, in line with other scholars, such as Das and Teng (2001), we consider risk, relational and performance components as key drivers for shaping governance form; however, unlike Das and Teng (2001), we build a conceptual framework in which risk shapes governance forms under a TCE- and RO-theory reasoning used in a discriminating fashion. Thus, we build a theoretical framework that links risk with two of the most important theories used to understand the choice of governance form in inter-firm agreements. Furthermore, despite the importance risk has assumed in the governance form choice literature (Das & Teng, 2001; Delerue, 2004; Delerue & Simon, 2009; de Man & Roijakkers, 2009), no scholars to date have empirically tested the influences of both relational and performance risk on governance form choice.

Hence, the second contribution of this paper comes from the fact that we operationalize our theoretical framework and test it within an international biopharmaceutical environment. Finally, we also contribute to the controversial debate on how TCE and RO theories influence governance form choice, by providing new, interesting knowledge about the reciprocal contribution of the two theories.

Our theoretical framework operationalizes relational risk through four drivers: *investment specificity*, *lack of inter-firm relationship experience*, *partners' asymmetry* and *lack of trust*. All of the above components increase relational risk. According to TCE, we hypothesize that the higher the relational risk, the more likely the recourse to hierarchical governance forms (H1). By looking at the results summarized in Table 6, H1 receives slight support. Indeed, two out four of the relational risk components, specifically *investment specificity* and *lack of inter-firm experience*, behave as expected, at least when comparing M&A with other, less hierarchical, governance forms. Thus, according to our TCE reasoning, when relational risk arises as a consequence of the above components, M&A are preferable over other governance forms. It should be noted that this result is quite interesting from a theoretical point of view; indeed, while it was expected for *investment specificity*, since its influence on governance forms is widely recognized in TCE literature (David & Han, 2004), the same cannot be said for the other relational risk drivers. Certainly, several scholars (Villalonga & McGahan, 2005; Santoro & McGill, 2005; Wang & Zajac, 2007; Van de Vrande et al., 2009) recognize a role of *inter-firm relationship experience* in shaping the governance form because of an organizational learning perspective. Teng and Das (2008), by ascribing to this experience-based component the ability to influence partners' trust, also predict an influence on governance form. However, no scholars to date have associated this driver with relational risk and, consequently, highlighted its ability to shape governance form on the base of a TCE construct. Nevertheless, *partners' asymmetry* has not confirmed our prediction. In particular, contrary to our expectation, when *partners' asymmetry* increases, equity alliances are more likely than M&A. *Partners' asymmetry* has specifically been indicated as a form of relational risk by different scholars (Das & Teng, 2001; Delerue, 2004); however, Das and Teng (2001) highlight that firms' bargaining power cannot be easily captured only by firm size, since it depends also on resources and market power. Indeed, Arinõ et al. (2008), by measuring relative partners' asymmetry through the difference between the number of employees, do not obtain a significant effect on alliance governance form negotiation. On the other hand, Bosse and Alvarez (2010), by measuring *partners' asymmetry* through a combination of the amount of resources employed in the agreement and the market access provided by the partner, find that the larger the firm's bargaining power, the more likely the recourse to equity alliances over non-equity alliances. Furthermore, Billitteri, Lo Nigro, and Perrone (2013) argue how the number of products already commercialized by the biotech company influences the asymmetry among partners and it can also influence the choice of the governance form. Therefore, our results could have been affected by the size-based measure we used. However, there is another interpretation of our empirical results; indeed, while higher bargaining power surely increases the relational risk, it could also provide the stronger partner with the necessary safeguard for reducing transaction costs. In the case of biopharmaceutical agreements, where the pharmaceutical partner is usually the strongest one, this could lead to a preference for equity-based alliances over more risky acquisition forms. If this interpretative key is correct, partners' asymmetry, while still increasing relational risk, could lead to a less integrated governance form; thus, this point needs to be

thoroughly understood. Finally, *lack of trust* is not significant across all *G* levels and models, providing neither support nor negation for H1. There is a huge body of literature, starting from Gulati (1995), which acknowledges trust as a way in which to reduce relational risk (Judge & Dooley, 2006). However, while some scholars, like Santoro and McGill (2005), by posing TCE argumentations, like we do in our paper, conclude that the relational risk reduction, due to trust, makes less integrated governance forms more likely, other scholars, such as Van de Vrande et al. (2009), argue that higher trust, due to prior cooperation, can push toward either less integrated solutions or more integrated ones.

In this last case, the reason is that better knowledge due to prior cooperation makes acquisition less risky. Our empirical results seem to confirm the presence of this double effect that, in the end, makes lack of trust non-significant in shaping governance forms. Therefore, with regards to H1, our empirical results confirm the TCE view on relational risk and governance forms, but, at the same time, provide a different perspective, with respect to TCE, on relational risk drivers such as *partners' asymmetry* and *lack of trust*.

H2, by using an RO-theory perspective, predicts that a higher performance risk pushes toward less integrated governance form. Our theoretical framework operationalizes performance risk through three drivers: *technology newness, technology distance* and *nationality*. From Table 6, it can be seen that H2 is strongly supported by our empirical findings, since all the performance risk components behave as expected. In this case, we would like to highlight our contribution concerning the *nationality* driver. Indeed, while *technology newness* and *distance* have been widely indicated as forms of performance risk (Das & Teng, 2001), and their impact on governance form choice has been tested by RO-theory scholars (Santoro & McGill, 2005; Van de Vrande et al., 2009), *nationality*, while still associated with performance risk (Das & Teng, 2001), has not been tested under an RO-theory perspective to date. Indeed, some scholars (Oxley, 1997; Teng & Das, 2008) have pointed out that the international risk of alliances increases the appropriation concern and, according to TCE reasoning, leads to a more integrated solution. However, the empirical results of such an approach are quite controversial; indeed, while Teng and Das (2008) find empirical support for their TCE approach, Oxley (1997) finds opposite results that are in line with the evidence we have obtained in our research. Also, while Teng and Das's (2008) dataset comprises several kinds of industries, with low evidence of high-tech industries, Oxley's (1997) and our dataset are largely centred on high-tech industries. Thus, our results seem to confirm that in high-tech industries, where different nationality contributes to a higher performance risk due to different appropriability regimes, the RO-theory approach is more consistent that the TCE approach in explaining the choice of governance form.

Now we come to the H3 results, which, we believe, provide also a significant scientific contribution of our work. Indeed, H3 states a moderating effect of performance risk on the TCE-based relationship between relational risk and governance form, and, conversely, the moderating effect of relational risk on the RO-theory-based relationship between performance risk and governance form choice. By looking at the results summarized in Table 6, the moderating effect of performance risk on relational risk is confirmed each time we find a significant interaction (three times), and always with a consistent variation of the RRR coefficients. On the other hand, the moderating effect of the relational risk on the performance risk is significant only four times with controversial support to H3. Indeed, in two cases the moderating effect matches the expectation of H3, however in other two cases it does not; furthermore, also in those cases in which the moderating effect behaves as hypothesized in H3, coefficients variation, while still significant, is quite limited. Thus, the moderating effect of the performance risk on the TCE-based relationship between relational risk and governance form receives strong empirical support from our data. On the other hand, the symmetrical effect does not.

This result provides two important contributions to the debate between TCE and RO theory in governance form choice. First, TCE and RO theory are not in contrast to one another, as recent scholars have pointed out (Santoro & McGill, 2005; Van de Vrande et al., 2009); instead, they identify two different types of risk involved in an inter-firm relationship. Thus, when the relational risk is much higher than the performance risk, governance form choice is mostly driven by TCE; on the other hand, when the performance risk is prevalent, RO theory more accurately informs the choice of governance form. This perspective is new in the literature on governance form choice, and certainly constitutes an important contribution of our work. Indeed, although some scholars (Leiblein, 2003; Roemer, 2004) have pointed out that both TCE and RO theory deals with the concept of risk, no scholars to date have built a theoretical framework linking two risk components, relational and performance, with the aforementioned theories. Moreover, our findings provide a sound answer to David and Han's (2004) evidence on uncertainty; indeed, the two scholars do not find support for the TCE-based construct on uncertainty, since they find almost as much evidence that increasing uncertainty leads to results in the opposite direction to that predicted by TCE. However, they have measured uncertainty as a mixture of market (price and demand), technology and relational uncertainty. According to our framework, market and technology uncertainty, by increasing performance risk, lead to less hierarchical governance forms.

Secondly, the performance risk has a moderating effect on the relational risk, while the moderating effect of the latter risk dimension cannot be confirmed by our analysis. Indeed, when both the risk dimensions are high, since a hierarchical governance form does not help to reduce the performance risk, while it increases investment, rigidity and organizational costs, firms prefer to adopt an RO perspective. Thus, they prefer to delay binding investments in favour of small learning investments that reduce the performance risk over time and, at the same time, allow the development of trust among the parties, which helps to reduce relational risk. This result provides a new perspective about the "learning investment" concept that has been widely observed in the biopharmaceutical industry (Janney & Dess, 2004; Pisano, 2006).

Finally, it should be also stressed that our research provides a controversial support to the framework conceptualized by Das and Teng (2001) in their theoretical paper. Das and Teng (2001) predict the use of bilateral contractual alliances when

the performance risk is high and the relational risk is low. Our results is quite in line with this prediction since contractual alliances are always more likely when performance risk components are high and relational risk are low. Conversely, they predict the use of minority equity alliances in the case of high relational risk and low performance risk. Our results suggest that, in such case, more integrated solutions, such as acquisition, are preferred over other kinds of alliances (contractual and equity alliances), and that no significant preference exists among other forms of alliances (see, for instance, the results for *investment specificity*). Finally, Das and Teng (2001) predict the use of unilateral contract-based alliances in case both performance and relational risk are high. In this case, as already discussed, our results indicate that equity alliances are never less likely than contractual ones, and in one case they are even more likely. This seems in line with our expectation that equity alliances, from one side, offer the necessary safeguards to reduce transaction costs in presence of high relational risk and, on the other hand, allow reducing the failure risk being more flexible than M&A.

Our research shows several managerial implications. First, it contributes to stressing the importance of risk evaluation for making governance form decisions. Furthermore, it provides an interpretative key for making governance form decisions, that is: managers should look at two different risk components and try to reduce them by using TCE and RO theory constructs in a discriminating fashion. Of course, we are not providing normative suggestions to select the best governance form depending on the risk levels because we are not analysing performances; however, we undoubtedly provide a new perspective to approaching governance form decisions. Finally, our analysis does not confirm the moderating effect of the relational risk on the performance risk. This has important managerial implications, because when the performance risk is higher in a transaction, no matter what the level of relational risk, the RO-theory approach seems to prevail, leading to less integrated solutions. This evidence also seems to suggest a higher level of managerial sensibility toward the performance risk that, being unequivocally characterized by exogenous factors, is less controllable by managerial practices.

Finally, our work has some limitations. We have already discussed the operationalization of the *partners' asymmetry* variable, and a more structured measurement of such a variable, as also suggested by Bosse and Alvarez (2010), would certainly help to provide a better understanding of the role of this variable in our constructs. Furthermore, as far as the methodology is concerned, we have used a very simple measure of operationalization for the variable *technology distance*, while some other, more sophisticated, measure (Van de Vrande et al., 2009) could be used and, perhaps, would improve the significance of this variable, especially in Model 2. Furthermore, we used multinomial logistic regression in our attempt to obtain more discriminating results among the several governance forms considered in this paper. However, the empirical results do not provide a clear discrimination, especially among contractual and equity agreements. Finally, our results are confined to the industry we have examined in this paper.

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