Knowledge misappropriation risks and contractual complexity in entrepreneurial ventures' non-equity alliances

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Abstract This paper explores the role of anticipated knowledge misappropriation risks in contract design in non-equity alliances involving high-tech entrepreneurial ventures. We argue that these ventures anticipate higher knowledge misappropriation risks, and are, thus, inclined to negotiate more complex contracts, when partner firms have greater ability and incentives to appropriate the ventures' technological knowledge, and knowledge misappropriation is more detrimental to the ventures. In the empirical sections of the paper, we consider 211 dyadic non-equity alliances involving Italian high-tech entrepreneurial ventures, and we examine the relationship between contractual complexity and a series of characteristics of partner firms associated to either higher ability/incentives to appropriate ventures' knowledge or more negative consequences of misappropriation.

Keywords Alliances · Contractual complexity · Entrepreneurial ventures · Knowledge misappropriation risks

JEL classification L15 · L26

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1 Introduction

Interfirm alliances (hereafter, simply referred to as alliances) are a crucial value creation mechanism for high-tech entrepreneurial ventures[1] (e.g., Deeds and Hill 1996; Eisenhardt and Schoonhoven 1996; Shan et al. 1994). These firms generally lack the internal resources and capabilities to transform their innovative technological knowledge into successful new products and services. Alliances allow high-tech entrepreneurial ventures (hereafter, referred to as entrepreneurial ventures) to access and leverage the valuable technological and commercial resources and capabilities of the partner firms (hereafter, partners), thereby generating value for both the ventures and their partners (Colombo et al. 2006; Deeds and Hill 1996; Segers 1993; Teece 1986).

Despite these benefits, alliances are a double-edged sword and may result in substantial hazards for entrepreneurial ventures and their partners by exposing them to the other party's opportunism (Williamson 1991; Oxley 1997). Previous studies inspired by transaction cost economics argue that forming equity alliances allows firms to effectively alleviate the hazards generated by partners' opportunism (e.g., Kogut 1988; Williamson 1991; Oxley 1997, 1999). However, for most entrepreneurial ventures, the shield provided by this governance mode is out of reach, because equity alliances involve

[1] We define a "high-tech entrepreneurial venture" as a small or medium-sized enterprise (SME), not controlled by other companies, that is established to commercially exploit innovative technological knowledge in a high-tech industry.

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high administrative and set-up costs that entrepreneurial ventures cannot bear (Folta 1998). Previous studies support the view that entrepreneurial ventures are generally not inclined to use equity alliances.[2] A more viable, even if still costly, option to mitigate the hazards arising from partners' opportunism is to form a non-equity alliance and negotiate a *complex contract*, i.e., a contract including provisions that "define remedies for foreseeable contingencies or specify processes for resolving unforeseeable outcomes" (Poppo and Zenger 2002: 707). In accordance with the view that entrepreneurial ventures use complex contracts to safeguard against partners' opportunism, Reuer et al. (2006) show that entrepreneurial ventures tend to resort to more complex contracts when they have more at stake in the focal alliance because of its strategic importance. They point to the risk that entrepreneurial ventures' valuable resources fall in the hands of alliance partners as an important determinant of contractual complexity.[3]

In this paper, we build on this insight and examine the use of contracts to alleviate *knowledge misappropriation risks*, i.e., the risks that the cutting-edge technological knowledge possessed by entrepreneurial ventures is unintentionally leaked to and misappropriated by partners, which then exploit this knowledge in a private manner to the detriment of the focal ventures (Alvarez and Barney 2001). Proprietary technological knowledge generally is the most valuable, if not the unique resource of entrepreneurial ventures. Alliances often entail high risks that this knowledge is misappropriated by entrepreneurial ventures' partners (Alvarez and Barney 2001; Katila et al. 2008). Unintended leakage of knowledge to partners and partners' subsequent misuse of the appropriated knowledge may considerably damage the ventures' competitive position, and even threaten their survival (Colombo et al. 2006: 1172–1173). Hence, entrepreneurial ventures should avoid selecting partners that pose severe knowledge misappropriation risks, even though these partners can contribute valuable resources, as indicated by the so-called "swimming with sharks" literature (Dushnitsky and Shaver 2009; Diestre and Rajagopalan 2012). However, when the set of prospective partners is limited, entrepreneurial ventures may be induced to form alliances with valuable but dangerous partners (Colombo and Shafi 2016) if the (potentially high) knowledge misappropriation risks inherent in these collaborations can be mitigated through a careful design of alliance contracts. Extant studies on alliance contracts indeed suggest that specific contractual provisions may help in alleviating knowledge misappropriation risks (e.g., Lerner and Malmendier 2010).[4] Nonetheless, to the best of our knowledge, no studies explore in depth the role of these risks in contract design.

In this paper, we address this gap by arguing that the anticipation of higher knowledge misappropriation risks induces entrepreneurial ventures to resort to more complex contracts. The (owner-)managers of an entrepreneurial venture assess these risks according to the *probability of their occurrence* and the *severity of the harm* they would generate for the focal venture. In other words, the venture's (owner-)managers will anticipate higher misappropriation risks when the probability that the partner misappropriates the venture's knowledge is greater and when knowledge misappropriation is more detrimental for the venture. We also argue that the probability that the partner misappropriates venture's knowledge increases with partner's *ability* to appropriate this knowledge and its *incentives* to misuse the appropriated knowledge. These theoretical mechanisms allow us to formulate a series of hypotheses about the impact on contrac-tual complexity, defined as the comprehensiveness and heterogeneity of the provisions included in alli-ance contracts (Reuer and Ariño 2007), of a series of partners' attributes that are associated with their ability and incentives to misappropriate venture's

[2] Of the sample of 66 alliances involving entrepreneurial ventures in telecommunication services considered by Reuer et al. (2006), only 9 were equity alliances (i.e., 14%). In their study of US small biotech firms' alliances, Yang et al. (2014) find that the overwhelming majority of alliances are non-equity alliances. As shown later in this paper, of our sample of 237 alliances, only 26 (less than 11%) are equity alliances.

[3] Conversely, they do not find any evidence that greater exposure to the hold-up hazards associated with relation-specific investments leads to use more complex contracts, as Reuer and Ariño (2007) documented in a different context.

[4] Lerner and Malmendier (2010) examine research alliances between biotech start-ups, the research firms, and large pharmaceutical compa-nies, the financing firms. To avoid that biotech researchers use the funds provided by the financing firms for other research projects, pharmaceutical firms negotiate the inclusion in alliance contracts of termination provisions that give them the unconditional right to termi-nate the collaborations and obtain broad property rights to the termi-nated projects. To prevent the financing firms from exercising the termination option to misappropriate biotech firms' knowledge, the termination provisions associate termination with payments to the research firm, thus providing incentives for pharmaceutical companies not to behave opportunistically.

knowledge, and with the detrimental consequences of knowledge misappropriation for the focal venture. In the empirical sections of the paper, we use fine-grained data on 211 dyadic non-equity alliances formed by Italian entrepreneurial ventures to test our hypotheses.

Our study provides a twofold contribution to alliance literature. First, as abovementioned, we contribute to studies on the design of alliance contracts by exploring the under-investigated role of knowledge misappropriation risks and identifying antecedents of contractual complexity that have gone unnoticed so far. Second, we add to the "swimming with sharks" literature by showing that anticipated knowledge misappropriation risks do not influence only partner selection but also the design of alliance contracts once the partner has been selected. In particular, we suggest that if an entrepre-neurial venture is forced to ally with dangerous partners because it needs the valuable resources that these latter possess and no other, less dangerous, partners are available, the venture can suitably design the alliance contracts so as to alleviate knowledge misappropriation risks.

The paper proceeds as follows. In the following section, we review the literature on the antecedents of contractual complexity and develop our hypotheses. Then, we provide a description of the data collection process, validity checks, and sample, and subsequently we illustrate the econometric methodology. The presentation of the econometric results follows. In the last section, we discuss the paper's key results and contribution to the literature, point out limitations, and high-light future research opportunities.

2 Background and theoretical hypotheses

2.1 Antecedents of contractual complexity

A prominent function of alliance contracts is safeguarding against partners' opportunism (Williamson 1985). Hence, most works on the complexity of alliance contracts test whether alliance attributes associated to either greater exposure to partners' opportunism or more detrimental consequences for the focal firms in case of partners' misbehavior predict contractual complexity.

Sometimes, scholars consider partner opportunism in general, without delving into the type of hazards (e.g., hold-up hazards, knowledge misappropriation risks) that firms anticipate when making decisions concerning alliance contracts. For example, Reuer and Ariño (2007) find a positive effect on contractual complexity of the pre-specified duration of the alliance and argue that contractual complexity is greater in time-bound alliances because in these collaborations the threats of partners' misbehavior tend to be greater than in open-ended alliances. Indeed, in these latter alliances, potential gains from collaboration in future periods provide a safeguard against opportunistic behavior.

Conversely, in other cases, authors refer to specific types of hazards. Barthélemy and Quélin (2006) and Reuer and Ariño (2007) focus on hold-up hazards mitigation to motivate the positive effect on contractual complexity of asset specificity. When asset specificity is high, i.e., a focal firm invests in assets whose value outside the alliance is greatly reduced or even entirely sunk, an appropriable quasi rent is created (Klein et al. 1978) and the partner may behave opportunistically, i.e., it may threaten to terminate the alliance, with the aim of appropriating this quasi rent. The managers of the focal firm are thus induced to negotiate a more complex contract to reduce *ex ante* the hold-up hazard. Reuer et al. (2006) test whether asset specificity leads to greater contractual complexity in entrepreneurial ventures' alliances, but fail to detect any significant effect.

Reuer et al. (2006) also acknowledge that contractual complexity may alleviate the risk of "valuable resources falling into the hands of a competitor or third party" (op. cit., p.312). The authors do not provide examples of such resources. However, as regards entrepreneurial ventures, their innovative technological knowledge clearly is a very valuable resource, and frequently is the unique valuable resource these firms possess. Therefore, it would be worthwhile to delve deeper into how contractual complexity may serve the purpose of mitigating the anticipated misappropriation risks arising from unintended leakages of entrepreneurial ventures' technological knowledge to partners and use of this knowledge to the detriment of the focal ventures. To the best of our knowledge, no extant studies have comprehensively explored the mitigation of knowledge misappropriation risks' function of alliance contracts.

Besides safeguarding against partners' opportunism, contracts may also facilitate the coordination of alliance activities (Schepker et al. 2014). As both the difficulties in coordination and the risks associated to partners'

opportunism depend on who partners are, several studies look at the effect on contractual complexity of partner characteristics. In particular, authors discuss the effect of trust between partners on both the anticipated hazards generated by partners' opportunism and the coordination of partners' actions. The results of these works are controversial: while some studies provide evidence of a complementary relationship between trust and contractual complexity (Poppo and Zenger 2002; Ding et al. 2013), other studies find that a substitute relationship exists (de Jong and Klein Woolthuis 2009). The findings of Mellewigt et al. (2007) and Reuer and Ariño (2007) even suggest that trust may at the same time substitute for and complement contractual complexity depending on the function of the contract considered (i.e., safeguarding or coordination).

Finally, contracts may serve a third function: aiding the adaptation of the collaboration if unforeseen circumstances arise (Schepker et al. 2014). Considering this third function has allowed scholars to identify additional antecedents of contractual complexity, namely environmental uncertainty and the use of third parties for legal support in contracting. In particular, Barthélemy and Quélin (2006) argue and empirically demonstrate that more complex contracts are negotiated when environmental uncertainty is higher, because more complex contracts facilitate smooth adjustments as events unfold. Duplat and Lumineau (2015) argue and show that the involvement of external legal experts increases the inclusion of contractual provisions because these experts are better equipped than individual firms to highlight the significance of subtle problems that may occur during the collaboration. Moreover, legal experts are willing to avoid ex post disputes occurring because of procedural matters that may damage their own reputation.

The above literature review highlights the dearth of studies considering the alleviation of knowledge misappropriation risks when exploring the antecedents of contractual complexity. In the following section, we add to the studies reviewed above by discussing the effect on contractual complexity of a series of partners' characteristics that are associated with higher anticipated knowledge misappropriation risks for entrepreneurial ventures. We argue that when partners exhibit these characteristics, entrepreneurial ventures will negotiate alliance contracts with a more comprehensive set of contractual provisions (i.e., contractual complexity will be greater).

2.2 Contractual complexity and the characteristics of partners that generate high knowledge misappropriation risks

Entrepreneurial ventures can alleviate knowledge misappropriation risks in non-equity alliances by negotiating the insertion of suitable provisions in alliance contracts. In particular, confidentiality provisions and provisions that restrict partners' use of proprietary information reduce the probability of unintended knowledge leakages. Termination provisions and other provisions specifying rules for resolving unforeseen disputes deter the misuse of sensitive technological knowledge (see Elfenbein and Lerner 2012 and Lerner and Malmendier 2010 on internet portal alliances and alliances between biotech start-ups and pharmaceutical companies, respectively). Provisions regarding the regular reporting of relevant transactions, compulsory notification of departures from the course of action that the partners originally agreed on, and auditing rights are instrumental to the early detection of partners' misbehavior, despite the fact that these provisions are often based on conditions that are difficult to verify and enforce (see, e.g., Robinson and Stuart 2007).

Consistently with transaction cost economics argu-ments, we contend that entrepreneurial ventures that anticipate higher knowledge misappropriation risks will negotiate more complex alliance contracts. As we mentioned in the introduction, anticipated knowledge misappropriation risks are higher (i) when partners have greater ability to appropriate ventures' technological knowledge and (ii) greater incentives to misuse the appropriated knowledge, and (iii) when knowledge misappropriation by partners is more detrimental to the focal venture.

From this perspective, *competitors* are potentially the most dangerous partners for an entrepreneurial venture (Dushnitsky and Shaver 2009; Gnyawali and Park 2009). As competitors operate in the same industry as the focal entrepreneurial venture, serve similar customers, satisfy similar customer needs and offer similar products or services, their knowledge base is likely similar to that of the entrepreneurial venture (Dussauge et al. 2000). Hence, they possess high relative absorptive capacity (Lane and Lubatkin 1998), which makes it easy for them to first detect and insource the venture'srelevant knowledge and then transform and exploit this knowledge in a private manner.

In addition to the ability to assimilate an entrepreneurial venture's technological knowledge, competitors will have great incentives to misuse this knowledge. The technological, productive, and commercial resources that competitors possess (or have access to) being active in the venture's end-product market, are directly applicable to the knowledge that they can assimilate from the focal entrepreneurial venture. Indeed, this is exactly what renders them valuable partners for this venture. Then, competitors can use their resources in combination with the assimilated technological knowledge to improve their competitive position in the end-product market to the detriment of other firms operating in the same market, including the focal entrepreneurial venture. Thus, also the negative consequences of knowledge misappropriation by a competitor will be especially severe for an entrepreneurial venture because partner's misuse of appropriated knowledge will have a direct negative effect on the venture's competitive position.

As the knowledge misappropriation risks entailed by forming ties with competitors are high, one may expect entrepreneurial ventures to avoid forming non-equity alliances with competitors. However, alliances with competitors are not a rarity for entrepreneurial ventures (Dushnitsky and Shaver 2009; Colombo and Shafi 2016). Indeed, the value creation potential of these alliances is very high (Gnyawali and Park 2009, see Quintana-Garcia and Benavides-Velasco 2004 for evidence on biotech ventures), and it may be difficult for entrepreneurial ventures to find other partners that can provide them with access to similarly valuable resources. We thus argue that, when entrepreneurial ventures form non-equity alliances with competitors, they will be inclined to negotiate complex contracts that include a comprehensive set of heterogeneous provisions with the aim of safeguarding their technological knowledge from unintended leakages and allowing controlled knowledge sharing with these dangerous partners. As a result, collaborations with competitors will be safer and more productive. We thus derive the following hypothesis.

H1: When entrepreneurial ventures form non-equity alliances, contractual complexity is greater if the partners are ventures' competitors.

For entrepreneurial ventures, alliances may involve high knowledge misappropriation risks even if partners do not compete in the same end-product market. Previous work on alliances has long recognized that when partners' technological knowledge bases are similar—i.e., high *technological relatedness* exists between partners[5]—technological knowledge is easily transferred between the partners (Mowery et al. 1996; Colombo 2003). As regards entrepreneurial ventures' alliances, if partners have greater relative absorptive capacity (Lane and Lubatkin 1998), they have a greater ability to assimilate and use ventures' knowledge (Diestre and Rajagopalan 2012). Moreover, greater absorptive capacity also helps firms that do *not* compete in the same product market as the focal entrepreneurial ventures (hereafter, referred to as non-competitors) in identifying uses of ventures' technological knowledge beyond the current alliance, thereby creating greater incentives to misuse appropriated knowledge and exposing the ventures to higher knowledge misappropriation risks.

If a non-competitor assimilates a venture'stechnological knowledge and leverages it to enter the focal venture's end-product market, the venture will experience direct negative effects on its competitive position in this market. However, this knowledge misappropriation will have negative (although less detrimental) consequences for the focal venture even if the partner abstains from entering the venture's end-product market and uses the misappropriated knowledge in markets where the venture is not active yet. Indeed, the knowledge misappropriation will reduce future rents that the venture may eventually generate by transferring its technological knowledge to these markets.

Conversely, a non-competitor that is unfamiliar with the venture's technological knowledge base is unlikely to be able to recognize, assimilate, and integrate the venture's valuable technological knowledge without its active collaboration. It will also be difficult for this partner to identify opportunities to exploit such knowledge that are unrelated to the current alliance. Low technological relatedness thus acts as a shield protecting entrepreneurial ventures from knowledge misappropriation.

[5] It is worth clarifying here that technological relatedness is high when an entrepreneurial venture and its partner possess knowledge in similar technological domains, but this does *not* mean that the venture "duplicates" the partner's technological knowledge. If that were the case, the partner would likely avoid forming the alliance. As we argue in the following, an entrepreneurial venture's cutting-edge technological knowledge usually is the most attractive resource for partners. Prospective partners that already possess this knowledge are probably unable to create much value from alliances with the venture and, thus, have low incentives to ally with it.

Based on the above arguments, we expect entrepreneurial ventures that establish alliances with non-competitors to anticipate higher knowledge misappropriation risks and, thus, to negotiate more complex alliance contracts when the partners have a higher degree of technological relatedness. We thus propose the following hypothesis.

H2: When entrepreneurial ventures form non-equity alliances with non-competitors, contractual complexity increases as the technological relatedness between the ventures and their partners increases.

The severity of the knowledge misappropriation risks that entrepreneurial ventures anticipate when they establish alliances with non-competitors also depends on partners' *size*. Size does not affect partners' ability to appropriate a venture's technological knowledge. However, partners' incentives to misuse the misappropriated knowledge are positively related to partners' resource endowment as reflected by their size. Large partners' primary motivation for collaborating with an entrepre-neurial venture is typically a strategic interest in the venture's technological knowledge (Katila et al. 2008). This knowledge can generate more value if used in conjunction with complementary technical, productive, and commercial resources (Teece 1986). As larger non-competitors are likely to possess a larger bundle of complementary resources than their smaller peers, they will have more opportunities and, thus, greater incentives to commercially exploit the venture's technological knowledge in combination with their own internal resources also in ways that may not be covered by the alliance.

If knowledge misappropriation occurs, the negative consequences for the focal entrepreneurial venture will be more severe when the partner is larger. A large non-competitor having misappropriated the venture's technological knowledge may indeed leverage its own abun-dant resources to enter the venture's end-product market, a move that is out of reach for smaller non-competitors due to their poor resource endowment. Even if entry does not occur, the large partner's use of the misappropriated knowledge in other markets may harm the venture in the long term. It may indeed reduce the future rents that the venture may eventually generate by transferring its technological knowledge to these markets.

To sum up, knowledge misappropriation is more likely and its consequences are more detrimental for entrepreneurial ventures when they form collaborative ties with larger non-competitors than with smaller ones. This, in turn, renders the contractual safeguards included in complex alliance contracts more valuable. Based on these arguments, we postulate the following hypothesis.

H3: When entrepreneurial ventures form non-equity alliances with non-competitors, contractual complexity increases as partners' size increases.

3 The dataset

3.1 The data collection process

To test our theoretical hypotheses, we used a sample composed of 211 dyadic non-equity alliances that Italian entrepreneurial ventures formed with third-party companies in the 1984–2007 period. Data on sample alliances were collected through phone interviews conducted in 2007. The data collection process followed a series of steps.

First, we developed a structured questionnaire composed of three sections. The first section provided our definition of alliance[6] and asked for information on the objectives of and the activities performed in the alliance. The second section asked respondents to report the characteristics of partners at the time of alliance formation. The third section of the questionnaire comprised questions on the governance mode and the contract that regulated the alliance. To develop this latter section, we examined the measures of contractual complexity used in prior studies that investigated alliance contracts. We found that these studies either focused on alliances formed in a specific domain/industry and considered the length of the contract (see, e.g., Joskow 1987, which considered the electric power industry, or Robinson and Stuart 2007, which examined biotechnology alliances) or examined the provisions inserted in the contract and argued that contracts are more complex when they include a more comprehensive set of provisions (e.g., Parkhe 1993; Reuer and Ariño 2007; Reuer et al.

[6] We defined an alliance as any relationship regulated by a contract in which two independent firms collaborate to carry out a specific project (activity) and which poses some constraints on the future behavior of the partners. If two firms already involved in an alliance started a new project and designed a new contract to regulate their collaboration, this new project was considered as a new alliance formed by the same partners.

2006). Because our study does not focus on a specific domain/industry, we followed this latter approach. In line with the studies listed above, we considered eight classes of provisions: (1) periodic written reports of all relevant transactions, (2) prompt written notice of any departures from the agreement, (3) the right to examine and audit all relevant records, (4) designation of certain information as proprietary and subject to the confidentiality provisions of the contract, (5) non-use of proprietary information even after the termination of the agreement, (6) termination provisions, (7) arbitration provisions, and (8) lawsuit provisions. These provisions were taken from a questionnaire that Parkhe administered to a sample of U.S. companies. Therefore, they were translated from American English to Italian by an Italian lawyer who was proficient in comparative law and thus able to properly adapt Parkhe's original wording. To pilot test the questions, we asked five top managers experienced in managing alliances and employed in high-tech companies not affiliated with the sample firms to complete the questionnaire and comment on the appropriateness of its wording and length. The questionnaire was slightly modified based on their comments.

Second, we considered the firms included in the 2004 release of the *RITA* (*Research on Entrepreneurship in Advanced Technologies*) *Directory*. Developed at Politecnico di Milano (for details, see Colombo et al. 2006), the 2004 release of the RITA Directory stored information on 1974 Italian ventures that were founded in 1980 or later. Firms in the RITA Directory operate in the following manufacturing and service high-tech industries: computers, electronic components, telecommunication equipment, optical, medical and electronic instruments, biotechnology, pharmaceuticals, advanced materials, avionics, robotics and process automation equipment, multimedia content, software, Internet services, and telecommunication services. For all firms included in the RITA Directory, we identified a contact manager (in most cases, the Chief Executive Officer).

Third, we sent the identified managers contact emails stating the purpose and importance of the research project and requesting the managers' participation in our research in the form of answering a series of questions during phone interviews. In each contact email, the recipient owner-manager was informed that s/he was expected to select *one*[7] alliance that her/his company formed with a third-party firm and to answer our questions with a focus on this specific alliance. To help the contacted managers in choosing the alliances to focus on and to give them sufficient time to review the alliance contracts before the phone call, we attached the questionnaire to the contact emails. The phone interviews were conducted by trained research assistants. Because we adopted a key informant methodology, at the beginning of each phone call, the research assistant explained to the contacted manager that the questions should to be answered by the firm manager most familiar with the alliance. Whenever a contacted owner-manager declared that s/he was not the most appropriate person to answer the questions, s/he was asked to determine who should be interviewed (see Hoetker and Mellewigt 2009 for a similar procedure). In this latter case, we re-sent the contact email to the appropriate manager.

Of the 1974 firms included in the RITA Directory, 307 firms provided responses, representing a 15.6% response rate. Of the 307 questionnaires, 10 were incomplete for our purposes: 8 respondents did not want to provide any information on the partner to preserve its anonymity and 2 were unable to evaluate the technological relatedness with the partner and the partner's size, respectively. Data collected through complete questionnaires were combined with information on the focal ventures' industry of activity, year of foundation, and size at alliance formation that was already stored in the RITA Directory. For 58 ventures, no information on venture size at alliance formation was available, while in two cases the high-tech firm had already become a large company before forming the alliance under scrutiny and, thus, did not comply with our definition of entrepreneurial venture (see footnote 1). Usable data were thus available for 237 alliances, namely, 26 equity and 211 non-equity alliances. In this paper, we focus on non-equity collaborative agreements; thus, our hypotheses were tested using the latter group of 211 alliances.

3.2 Validity checks

To assess the validity of the data, we performed two tests on the 211 non-equity alliances for which usable data were

[7] As we asked respondent managers to select a specific alliance, our sample of alliances is unlikely to be representative of the (unknown) population of alliances formed by entrepreneurial ventures. In particular, unsuccessful alliances are unlikely to be included in our sample. However, this situation is common to most (if not all) previous studies on alliances that used a key informant methodology, as we do. Indeed, the samples used in these studies include only the alliances for which information was disclosed by partner firms, and firms are generally eager to disclose information on success stories, while they are reluctant to advertise failures.

available. First, to assess potential retrospective bias, we tested for possible differences in the insertion of Parkhe's (1993) eight classes of contractual provisions between more recent and less recent alliances. In particular, we split the sample into two groups by distinguishing the 145 alliances formed since 2002 (i.e., the average year of alliance formation in our sample) and the 66 alliances formed before 2002. We conducted chi-squared tests on the use of each class of provisions in alliance contracts. No significant differences were found between the two groups of alliances ($\chi^2(1)$ = 0.03; 1.21; 0.28; 0.04; 1.49; 0.30; 0.65; 0.06, respectively).

Second, we addressed the possibility that a common method bias may influence our results. We used Harman's (1967) single-factor test to assess whether a significant amount of common variance existed in the data. If so, a factor analysis of all of the variables would generate a single factor that accounts for most of the variance in the data (Podsakoff and Organ 1986). Unrotated factor analysis using the eigenvalue-greater-than-one criterion revealed five factors, and the first factor explained only 19.6% of the variance in the data, indicating that our findings cannot be attributed to com-mon method bias.

3.3 Descriptive statistics

Let us first focus on the entrepreneurial ventures that formed sample alliances. All these firms had less than 250 employees (i.e., according to the EU recommenda-tion 2003/361, they were SMEs). The majority of these entrepreneurial ventures were in service industries: 29%in software and 28% in Internet and telecommunication services.

Let us now consider the contracts that regulate sample alliances. The average number of provision classes inserted in these contracts was 4.77, indicating a level of contractual complexity similar to that detected by previous studies (Deeds and Hill 1996; Malhotra and Lumineau 2011; Reuer and Ariño 2007; Reuer et al. 2006).

Table 1 reports the incidence of the eight classes of contractual provisions we examined. The provisions most frequently appearing in alliance contracts were confidentiality provisions (85% of sample alliances). The high incidence of these provisions confirms that entrepreneurial ventures consider it fundamental to protect their proprietary technological knowledge. Conversely, auditing rights were included in only a small number of alliances (18% of sample alliances).

Table 1 Incidence of the classes of contractual provisions under scrutiny across the sample alliances

	% sample alliances ($N = 211$)
1) Rights to reports of relevant transactions	34.6%
2) Notification rights for departures from the agreement	57.4%
3) Auditing rights	18.5%
4) Confidentiality provisions	85.3%
5) Restrictions on proprietary information	63.5%
6) Termination of the agreement	80.6%
7) Arbitration provisions	57.4%
8) Lawsuit provisions	79.6%
Average number of provisions	4.77

4 The methodology of the econometric analysis

As we mentioned above, to measure contractual complexity, we followed previous studies in arguing that alliance contracts are more complex when they include a more comprehensive set of contractual provisions. In particular, we started from the data on the use of Parkhe's (1993) eight classes of provisions, and we built the following variable:

$$\text{Contractual\_Complexity} = \sum_{i=1}^{8} D_i \quad (1)$$

where D_i equals 1 when provisions included in class i had been used and 0 otherwise. *Contractual_Complexity* ranges from 0 to 8. Higher values on this variable indicate that the alliance contract includes provisions belonging to a greater number of different provision classes, i.e., the alliance contract is more comprehensive and complex. *Contractual_Complexity* was used as the dependent variable in simple OLS regressions.

We recognize that, out of Parkhe's (1993) eight classes of provisions, two classes, namely designation of certain information as proprietary and subject to the confidentiality provisions of the contract (i.e., provision class number 4) and non-use of proprietary information even after the termination of the agreement (class number 5), are more clearly connected to knowledge misappropriation risks. Therefore, as a robustness check, we built an alternative measure of contractual complexity (*Contractual_Complexity_45*) that is computed as the sum of the two dummy variables, respectively equaling 1 when confidentiality provisions and provisions that

restrict partners' use of proprietary information had been used in the alliance contract. In the following, this latter variable is used to check the robustness of our results.

To test hypothesis 1, we inserted *DCompetitor*, a dummy variable capturing alliances formed with competitors, into the models. To identify these alliances, we asked each respondent manager whether the focal entrepreneurial venture and the partner (i) operated in the same business lines, (ii) had largely overlapping product/service portfolios, (iii) operated in largely overlapping geographical markets, and (iv) had largely overlapping customer portfolios. We assigned a value of one to *DCompetitor* when the respondent gave positive answers to all the above questions and a value of zero when the answer to at least one question was negative.

We tested hypothesis 2 by including in the models the interaction term between (*1-DCompetitor*) and an indicator of the technological relatedness between the focal entrepreneurial venture and its partner. Most previous studies have evaluated the technological relatedness between two firms by using patent data and computing measures of the overlap between the technological fields in which the firms patent (e.g., Jaffe 1986; Colombo 2003) or of common and cross-patent citations (e.g., Mowery et al. 1996). Such an approach relies on the assumption that patents (and patent citations) indicate the technological areas that comprise the firms' knowledge base. Obviously, this approach cannot be used when one or both firms are granted a very small number of patents (or no patents). This is the case in our work, as the patenting activity of sample entrepreneurial ventures was scarce: only 27% of sample firms (i.e., 57 entrepreneurial ventures) obtained at least one patent before 2007. An alternative approach consists in asking informed managers of (one of) the focal firms the extent to which they had R&D operations in the same technological fields and similar technological capabilities as the other firm (see, e.g., Cassiman et al. 2005; Colombo and Rabbiosi 2014). Due to the absence of patent data, in this study, we followed this latter approach. We asked each interviewed manager to evaluate, on a seven-point Likert scale, her/his degree of agreement with the three sentences listed in the first column of Table 2. These sentences assessed the similarity of the expertise, technological fields, and knowledge base of the respondent entrepreneurial venture and its partner at alliance formation. In the Likert scale used to evaluate the degree of agreement with the sentences, 1 indicates that the interviewed manager totally disagreed with the sentence, while 7 indicates that s/he totally agreed. Therefore, for each item, smaller values indicate less similarity of the expertise, technological fields, and knowledge bases of the two firms involved in the alliance. Then, we carried out a principal components factor analysis with varimax rotation on the three items. One factor with eigenvalue greater than one was extracted. It accounted for 81.8% of the explained variance in the data and exhibited strong internal consistency (Cronbach's alpha: 0.82) (see Table 2). Positive (negative) predicted values of the factor indicate greater (lesser) technological relatedness. We labeled this standardized factor *Technological_Relatedness*.

Table 2 Factor analysis to build the measure of technological relatedness

Items	Factor 1	Communalities
1) At alliance formation, we had common technological expertise	0.915	0.837
2) At alliance formation, we operated in the same technological fields	0.929	0.863
3) At alliance formation, the technological fields in which we operated shared the same knowledge base	0.868	0.753
Eigenvalue	2.45	
Cumulative variance explained	81.8%	
Cronbach's alpha	0.82	

We tested hypothesis 3 by including in the models the interaction term (*1-DCompetitor*) × *DLarge_Partner*. *DLarge_Partner* is a dummy variable capturing partner's size at the time of alliance formation; it equals 0 when the partner is a SME (i.e., as abovementioned, it has less than 250 employees), and 1 for large partners.[8] We do not have any predictions relating to the association between the explanatory variables *Technological_Relatedness*, and *D_Large_Partner*, and the dependent variable *Contractual_Complexity* when the partner firm is a

[8] Unfortunately, we could not build a precise measure of partner size. Many respondents (117) did not provide the name of their partner; hence, we could not use public sources of information to collect data on the size of partners. Therefore, we asked entrepreneurial ventures' respondents to provide information on partner size. They found it difficult to provide the precise number of employees of their partners at the time of alliance formation; hence, we asked them to indicate their partners' size category to reduce measurement errors. To check the reliability of the information provided by the respondents, for the 190 cases in which the name of the partner was available, we searched for the number of employees of the partner through public sources of information (i.e., annual reports and websites of the partners). All the data we collected through public sources were in line with the answers provided by entrepreneurial ventures' respondents.

competitor of the focal entrepreneurial venture. However, in an alternative specification, we added the interactions between these two explanatory variables and *DCompetitor* as a robustness check.

Then, we introduced some control variables into the models. Contractual provisions aimed at protecting proprietary technological knowledge and regulating its use by partners should be more effective in industries where a strong intellectual property protection (IPP) regime provides effective "legal defenses", favoring use of more complex contracts in these industries (Dushnitsky and Shaver 2009). Moreover, previous studies have shown that entrepreneurial ventures can alleviate knowledge misappropriation risks through the use of "timing defenses" generated by postponing the collaboration to a late stage of ventures' development when ventures' technology and products are more mature and defensible (Katila et al. 2008). If timing defenses are available, alliance contracts should be less complex. Therefore, we inserted in the model specification *DIPP_Regime* and *DExploitation*. *DIPP_Regime* is a dummy variable capturing the strength of the IPP regime in entrepreneurial ventures' industries. Following Dushnitsky and Shaver (2009), we set *DIPP_Regime* to one if the focal entrepreneurial ventures operated in the following industries: pharmaceuticals, biotechnology, biological products, chemical products, surgical instruments, and other medical equipment. *DExploitation* is another dummy that denotes late-stage exploitation alliances, i.e., alliances where timing defenses are available. To build *DExploitation*, we asked the respondents to indicate whether, at the time of alliance formation, the *main objective* of the alliance was (i) the joint development of a new technology, product, or service with the partners or the joint investigation of a research field new to the partner firms or (ii) one partner's acquisition, use, or commercialization of a technology, product, or service developed by the other partner or the joint investigation/creation of a new market for an existing technology, product, or service. Then, following Rothaermel and Deeds (2004), we coded alliances aimed at performing the activities in the above point (i) as early-stage exploration alliances (i.e., *DExploitation* = 0). Conversely, alliances focused on the activities in the above point (ii) were coded as late-stage exploitation alliances (*DExploitation* = 1).[9]

[9] As firms may have different objectives, we followed Yang et al. (2014) and coded alliances based on the perspective of the focal firm (i.e., the entrepreneurial venture, in our study).

In accordance with previous works on contractual complexity, we introduced additional control variables into the models. First, as previous work has emphasized the role of trust emerging from prior ties between firms (for a discussion, see again section 2.1), we included in the models a dummy equal to one if the focal entrepreneurial venture and the partner had already formed one (or more) alliance(s) with each other before forming the alliance under scrutiny (*DPrior_Alliance*). We also included a dummy equal to one for cross-border alliances (*DCross_Border*). As Reuer et al. (2006) suggest, more information is known about domestic firms than foreign firms, as a consequence of ventures' unfamiliarity with the environment of foreign countries, because of cultural, political, and economic differences (for a similar argument on the costs associated to doing business abroad, see Zaheer 1995). Hence, trust tends to emerge more readily between firms that are located in the same country. There-fore, opportunistic behavior is more likely to arise in cross-border alliances, thus increasing anticipated knowl-edge misappropriation risks and, consequently, the need for contractual safeguards. Second, we included a proxy of the availability of several potential partners at the time of alliance formation. *N_Prospective_Partners* is comput-ed as the number of companies (in millions of firms) that were active in Italy in the year of formation of the focal alliance and were operating in the same 2-digit NACE industry of the selected partner (source: data provided by the Italian Chambers of Commerce and made available on the Web by Movimprese, see https://www.infocamere.it/movimprese). As we mentioned earlier, anticipated knowledge misappropriation risks influence partner selection first and contract complexity subsequently, once the partner has been selected. Hence, the larger the number of potential partners, the less likely that a focal venture will be forced to select a dangerous partner to ally with because of absence of alternative options. Lastly, we incorporated controls for focal ventures' size, computed as the logarithm of the number of employees (plus one), and age at alliance formation (*Venture_Size* and *Venture_Age*) because smaller and younger ventures may lack the experience, slack resources, or staff to negotiate more complex alliance agreements (Reuer and Ariño 2007).

Table 3 illustrates descriptive statistics for the explanatory and control variables. In less than 8% of the alliances under consideration, the entrepreneurial venture's partner was a competitor. This percentage is small, but non-negligible. This result is in line with the view that firms tend to avoid forming alliances with competitors

because these collaborations engender high knowledge misappropriation risks, but sometime they cannot avoid to do so because of lack of alternatives. Technological relatedness in sample alliances was moderate: on average, interviewed managers rated their degree of agreement with the sentences reported in Table 2 at a value of 4. Only 9% of the alliances were established with partners that exhibit a high degree of knowledge overlap (i.e., the questionnaire respondents reported a value of 7 for their degree of agreement with all the sentences). Alliances with partners at very low level of technological relatedness also are rare (in less than 8% of sample alliances the respondents reported a value of 1 for their degree of agreement with all the sentences). In most sample alliances (69%), the partner of the entrepreneurial venture was a firm with less than 250 employees.

Table 3 also shows the correlation matrix. Quite unsurprisingly, there is a quite high (0.273) and highly significant correlation between *DCompetitor* and *Technological_Relatedness*. The correlations between the other key independent variables are low. To assess potential multicollinearity, we computed the variance inflation factors (VIFs) on Model 2 of Table 4. The mean VIF was 1.11, and the maximum was 1.33. These values are well below the thresholds of 6 and 10 that are commonly used in empirical studies. We thus conclude that multicollinearity is not an issue in our estimates.

5 Results

5.1 Results of the econometric analyses

The results of the econometric analyses are illustrated in Table 4. Model 1 includes the controls alone and serves as a baseline. Model 2 augments the baseline with the key explanatory variables. Model 3 allows to better understand the effects of the key explanatory variables.

The results of the estimates of Model 1 indicate that three controls have an impact on the dependent variable. In line with prior studies on contractual complexity (Reuer et al. 2006; Reuer and Ariño 2007), *DCross_Border* and *Venture_Size* have positive effects (both *p* values: 0.008). In addition, *DPrior_Alliance* has a positive coefficient, but it is only weakly significant in Model 1 (*p* value: 0.093) and it is not significant in Models 2 and 3.

Regarding the test of our hypotheses, the estimates of Model 2 are in line with our predictions. The positive and significant coefficients of *DCompetitor*, (*1-*

Table 3 Descriptive statistics of the explanatory and control variables and correlation matrix

	Variable	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	*DCompetitor*	0.076	0.265	1.000								
(2)	*Technological_Relatedness*[a]	4.351	1.800	0.273***	1.000							
(3)	*DLarge_Partner*	0.308	0.463	0.042	0.072	1.000						
(4)	*DIPP_Regime*	0.133	0.340	− 0.059	− 0.053	− 0.019	1.000					
(5)	*DExploitation*	0.730	0.445	− 0.027	0.218***	0.082	− 0.077	1.000				
(6)	*DPrior_Alliance*	0.109	0.312	0.072	− 0.012	0.096	0.087	− 0.027	1.000			
(7)	*DCross_Border*	0.237	0.426	0.009	0.120*	0.087	0.143**	0.063	− 0.088	1.000		
(8)	*N_Prospective_Partners*	0.085	0.150	− 0.087	− 0.045	− 0.084	− 0.048	0.156**	− 0.037	− 0.132*	1.000	
(9)	*Venture_Size*	2.162	1.028	0.087	0.016	0.074	0.063	− 0.145*	− 0.055	0.084	− 0.035	1.000
(10)	*Venture_Age*	10.308	6.629	0.041	0.042	− 0.011	0.136*	− 0.054	− 0.019	0.079	− 0.027	0.462***

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%

[a] As the standardized factor *Technological_Relatedness* has zero mean and unitary standard deviation, to ease the interpretation of the results, we report here the mean of the item scores relating to the factor

DCompetitor) × *Technological_Relatedness* and *(1-DCompetitor)* × *DLarge_Partner* (*p* values: 0.001, 0.016, and 0.000, respectively) indicate that contractual complexity is greater when the partner is a competitor and, in case of alliances established with non-competitors, when the technological relatedness between the entrepreneurial ventures and their partners is greater and partners are large firms. To assess the economic magnitude of these relations, we computed the predicted value of *Contractual_Complexity* for different values of the explanatory variables. The predicted value of *Contractual_Complexity* increases by 36% (from 3.93 to 5.34) when the value of *DCompetitor* increases from 0 to 1, with all other variables at their mean values (median values for dummy and discrete variables). When *DCompetitor* equals zero, the predicted value of the dependent variable increases by 18% (from 3.60 to 4.26) when *Technological_Relatedness* increases from −1.01 (i.e., the variable's mean value minus one standard deviation) to 0.89 (i.e., the mean value plus one standard deviation), whereas *Contractual_Complexity* increases by 25% (from 3.93 to 4.90) when *DLarge_Partner* switches from 0 to 1.[10]

In Model 3, we include in the list of regressors *DCompetitor* × *Technological_Relatedness* and *DCompetitor* × *DLarge_Partner*. The aim is to check whether technological relatedness and partner size are positively associated with contractual complexity also when the partner is a competitor. The coefficients of these two interactive terms are negative and jointly not significant ($F(2, 198) = 1.92$), indicating that these two variables do not have any additional explanatory power of contractual complexity when the partner of the focal entrepreneurial venture is a competitor.

It is worth acknowledging that in addition to knowledge misappropriation risks, greater coordination issues and hold-up hazards may lead to greater contractual complexity. Hence, it is important to consider the relation between coordination issues and hold-up hazards and the partner characteristics under consideration in this study. As for *DCompetitor* and (*1-DCompetitor*) × *Technological_Relatedness*, both coordination and hold-up arguments suggest that contracts should be more complex when partners are *non-competitors* and the technological relatedness with the focal ventures is *low-er*. Indeed, coordination issues are more severe when the entrepreneurial ventures and their partners operate in different end-product markets and have more distant knowledge bases. In these situations, entrepreneurial ventures should be inclined to negotiate more complex contracts to alleviate the anticipated coordination prob-lems, contrary to the arguments we have developed in this paper. Moreover, to make coordination more effective, entrepreneurial ventures and their partners must invest in specialized communication channels, monitor-ing mechanisms, and organizational practices (Colombo 2003). To mitigate the hold-up hazards generated by these alliance-specific investments, entrepreneurial ventures may be inclined again to negotiate more complex contracts. The positive coefficients of *DCompetitor* and (*1-DCompetitor*) × *Technological_Relatedness* in Mod-el 2 of Table 4 are at odds with coordination and hold-up hazards' mitigation arguments. Conversely, these find-ings are fully in line with our predictions based on the need to mitigate knowledge misappropriation risks.

The positive association between (*1-DCompetitor*) × *DLarge_Partner* and contractual complexity may be driven by the greater coordination problems that entrepreneurial ventures encounter when allying with large firms. Alternatively, it may simply be that large partners negoti-ate more complex contracts as they have greater legal resources (e.g., in-house lawyers). However, these coor-dination and resource availability arguments hold for both competitor and non-competitor partners. As in Model 3 of Table 4, we do not find any evidence of a positive association between partner size and contractual complex-ity when the partner of the focal entrepreneurial venture is a competitor, we conclude that coordination and resource availability arguments alone cannot explain our results.

5.2 Robustness checks

To ensure the reliability of the results, we performed several robustness checks (see Appendix 1). First, we reran the estimates of Model 2 of Table 4 using alternative dependent variables. First, *Contractual_Complexity* was replaced by *Contractual_Complexity_45* (for a descrip-tion of this variable, see again the methodology section), that considers only the two provision classes more clearly connected to knowledge misappropriation risks. Second,

[10] To gain further insights on the relationships between the explanatory variables and contractual complexity, we also included in the model specification the three way interactive term (*1-DCompetitor*) × *Technological_Relatedness* × *DLarge_Partner*. The coefficient of this term is not significant. Hence, the positive association between *Technological_relatedness* (*DLarge_Partner*) and contractual complexity that we detected when the partner is a competitor is not magnified at higher level of the other moderator.

Table 4 The antecedents of contractual complexity in non-equity alliances

		Model 1			Model 2			Model 3		
a_0	*Constant*	3.889	(0.414)	***	3.841	(0.395)	***	3.759	(0.398)	***
a_1	*DCompetitor*	–			1.391	(0.413)	***	3.063	(0.834)	***
a_2	(*1-DCompetitor*) × *Technological_Relatedness*	–			0.342	(0.141)	**	0.335	(0.141)	**
a_3	*DCompetitor*× *Technological_Relatedness*	–			–			− 1.207	(0.629)	*
a_4	(*1-DCompetitor*) × *DLarge_Partner*	–			0.976	(0.263)	***	0.974	(0.265)	***
a_5	*DCompetitor* × *DLarge_Partner*	–			–			− 1.367	(0.857)	
a_6	*DIPP_Regime*	0.401	(0.390)		0.534	(0.385)		0.509	(0.390)	
a_7	*DExploitation*	− 0.462	(0.299)		− 0.715	(0.281)	**	− 0.666	(0.284)	**
a_8	*DPrior_Alliance*	0.607	(0.359)	*	0.416	(0.382)		0.413	(0.388)	
a_9	*DCross_Border*	0.790	(0.296)	***	0.638	(0.298)	**	0.660	(0.296)	**
a_{10}	*N_Prospective_Partners*	− 0.450	(0.993)		0.074	(0.901)		0.083	(0.906)	
a_{11}	*Venture_Size*	0.357	(0.134)	***	0.281	(0.138)	**	0.280	(0.139)	**
a_{12}	*Venture_Age*	0.017	(0.021)		0.020	(0.021)		0.025	(0.021)	
Number of observations		211			211			211		
R^2		0.115			0.206			0.215		
F-test: $a_2 = a_4 = 0$		–			9.92 (2, 200)***			9.60 (2, 198)***		
F-test: $a_3 = a_5 = 0$		–			–			1.92 (2, 198)		

Robust standard errors and degrees of freedom are in parentheses

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%

we used *Weighted_Contractual_Complexity*, a measure of contractual complexity that takes into account not only the number but also the stringency of the classes of provisions incorporated in the contract. Following Parkhe (1993), the eight provision classes were arrayed in increasing order of severity (for the order, see Table 1, where the first provision class is the least severe). *Weighted_Contractual_Complexity* was then measured as follows:

$$\text{Weighted\_Contractual\_Complexity} = \frac{1}{36}\sum_{i=1}^{8} iD_i \qquad (2)$$

Third, we considered the distinction between enforcement and coordination provisions proposed by Reuer and Ariño (2007). As coordination provisions, geared to improving coordination of alliance activities, are not connected to knowledge misappropriation risks, we focused on enforcement provisions. In line with Reuer and Ariño (2007), we computed *Enforcement_Provisions* using Eq. (1) with i ranging from 4 to 8 in the list of provision classes provided in Table 1. The results of all these estimates (see Appendix Table 5) confirm the findings discussed above.

Second, we resorted to different model specifications. We first reran the estimates of Model 2 of Table 4 using an ordered logit model specification to take into account the fact that *Contractual_Complexity* is a discrete variable (for a similar specification, see Reuer and Ariño 2007). Then, we considered *Contractual_Complexity* as a count of the number of provision classes included in the alliance contract using a Poisson model. The results of both estimates are similar to those reported in Table 4 (see Appendix Table 6).

Third, we controlled for the influence of potential retrospective bias. Although one of the validity checks that we ran (see section 3.2) revealed no significant differences in the frequency of usage of the clauses included in the eight provision classes under scrutiny between older and more recent alliances, a retrospective bias may still affect our results. Therefore, we reran the estimates of Model 2 of Table 4 on a sample composed only of the 145 alliances that were formed after 2002 (i.e., the average year of alliance formation in our sample). By restricting the sample, we substantially reduced the efficiency of the model. Despite *DCompetitor* is only close to significance in these estimates, the results are reasonably in line with those reported in Table 4 (see Appendix Table 7), which alleviates our concerns about a systematic retrospective bias.

Fourth, we controlled for respondent status by including in the estimates a dummy equal to one when the respondent was the CEO. This variable was not

significant, and its inclusion did not change our results (see Appendix Table 8, Model 1). Moreover, we replaced *Technological_Relatedness* with *Avg_Technological_Relatedness*, an alternative measure of technological relatedness calculated as the average of the values that the respondents assigned to the three items included in *Technological_Relatedness*. Again, the re-sults of the estimates do not change significantly (Appendix Table 8, Model 2). Then, we distinguished small and medium-sized partners by including also the interactive term between (*1-DCompetitor*) and the dum-my *DMedium_Partner*, equaling 1 for partner companies having between 50 and 249 employees. The coefficient of this additional interactive term is not significant while the coefficients of the remaining explanatory variables are in line with those presented in the previous section (Appendix Table 8, Model 3). Lastly, we inserted four industry dummies into the model, and the results were again unchanged (Appendix Table 8, Model 4).

Fifth, we built a control for the scope of the alliance (*Alliance_Scope*; for details, see Appendix B). Entrepreneurial ventures may purposefully limit the scope of their alliances if they fear partners' opportunism (Oxley and Sampson 2004). Hence, the omission of a control for alliance scope may downward bias our estimates. Because data on scope were available for 115 alliances, we reran the estimates of Model 2 of Table 4 on this smaller sample and included *Alliance_Scope* in the set of regressors. The coefficient of this variable was not significant, although it was negative, as expected. The signs and significance of the coefficients of the explanatory variables are in line with those reported in Table 4 (see Appendix Table 9).

Sixth, as many arguments leading to our hypotheses should be valid for non-equity alliances only, we reran the estimates of Model 2 of Table 4 using a sample that also included the 26 equity alliances for which we had complete information. We also added a dummy variable equaling one for equity alliances (*DEquity*) to the set of control variables. The coefficient of this variable is not significant (see Appendix Table 10), indicating that the contracts of equity alliances are no more (or less) complex than those of non-equity alliances (see, e.g., Reuer and Ariño 2007 for similar results). The signs of the coefficients of the explanatory variables are in line with those reported in Table 4; however, despite the increased size of the sample, (*1-DCompetitor*) × *Technological_Relatedness* is not significant. This result suggests that the arguments we have developed regarding the contractual complexity of non-equity alliances are less pertinent for equity alliances.

6 Discussion and conclusion

In this study, we have explored the impact of a series of partner firms' characteristics on contractual complexity in non-equity alliances formed by entrepreneurial ventures. We have argued that in these alliances, contractual complexity is used to mitigate anticipated knowledge misappropriation risks. Accordingly, we have tested three hypotheses about the relationship between contractual complexity and partner characteristics associated to higher knowledge misappropriation risks. In line with our predictions, the results indicate that contractual complexity is greater when partners have the ability and/or the incentives to absorb entrepreneurial ventures' technological knowledge, and the negative consequences of knowledge misappropriation for entrepreneurial ventures are severe. This is clearly the case of alliances established with competitors. This is also the case of alliances established with firms that do not compete in the same end-product market as the focal entrepreneurial venture, but either have a knowledge base that largely overlaps with the one of this venture or, being of large size, have a large endowment of resources that can be used in combination with venture's knowledge.

Our study provides a twofold contribution to research on alliances. First, we contribute to the literature on the complexity of alliance contracts by extending our understanding of its antecedents. As we have shown in section 2.1, prior studies on alliance contracts have argued that contractual complexity primarily serves to mitigate the anticipated hazards generated by partners' opportunism. Accordingly, these studies have posited a positive relationship between contractual complexity and alliance attributes associated to higher anticipated risks of partner opportunism in general or hold-up hazards. Our work complements these studies and extends the insight provided by Reuer et al. (2006)thatcontractual complexity may limit the risk that valuable resources possessed by the focal venture fall into the hands of partners. Technological knowledge is a strategic resource for entrepreneurial ventures and its protection from misappropriation by partners is fundamental. We argue that contractual complexity can be used to alleviate these knowledge misappropriation risks, which can be extremely detrimental to entrepreneurial ventures' destiny. We then show that contractual complexity is positively associated with partners' characteristics that point to higher knowledge misappropriation risks

inherent in an alliance. So far, such characteristics have gone unnoticed in this stream of literature.

Second, our study also contributes to enlarging the perspective of the "swimming with sharks" literature. This literature emphasizes the value creation versus value appropriation dilemma that entrepreneurial ventures face while forming an alliance. Partners that potentially contribute the greatest value to an alliance often also have the ability and incentives to misappropriate entrepreneurial ventures' valuable technological knowledge (Katila et al. 2008; Dushnitsky and Shaver 2009; Diestre and Rajagopalan 2012; Colombo and Shafi 2016). Entrepreneurial ventures can safeguard their knowledge through careful selection of their partners. Specifically, they should select partners that pose less severe knowledge misappropriation risks, even if such partners will contribute less valuable resources. The results of our study add to this literature by suggesting that if an entrepreneurial venture forms non-equity alliances with dangerous partners, it can negotiate the inclusion of suitable provisions into the alliance contracts with the aim of creating a shield against the misappropriation of its technological knowledge. Moreover, we have shown that high levels of anticipated knowledge misappropriation risks are generated not only by "sharks" (i.e., large firms), as prior studies have recognized, but also by other "fishes" (namely, small competitors and firms having high technological relatedness with the focal ventures).

Despite the merits of our study, we recognize that it suffers from limitations that open interesting avenues for future research. First, while exploring the role of knowledge misappropriation risks in the design of alliance contracts, one should take into consideration that contract design decisions are endogenous to the choice of the alliance partner. In our study, we have used a rather crude proxy to control for the number of potential partners available to a focal entrepreneurial venture and have assumed that when there are few potential partners, it is more difficult for entrepreneurial ventures to avoid forming alliances with potentially dangerous partners. However, we are aware that both our study and prior works on the design of alliance contracts fail to properly address this endogeneity issue. Future studies on contract design in alliances could take advantage of prior research on partnering decisions to develop databases that allow to take into account the partner selection process. For example, alliance scholars using data collected through surveys, could insert in their survey questionnaire questions aimed at collecting information about the industries, technological fields and geographical areas where focal firms looked for alliance partners and the difficulties they encountered in finding suitable partners (in line with Reuer et al. 2006). Second, all the entrepreneurial ventures we have considered in this study are located in Italy. Because the institutional characteristics of countries are likely to influence the level of the appropriability concerns (e.g., because of different strength of the IPP regime, e.g., Park 2008 or different levels of trust, e.g., Guiso et al. 2009), one may wonder about the generalizability of our findings to samples of alliances involving entrepreneurial ventures located in other countries. Third, we have obtained information on alliance contracts through interviews with key informants. Although the method and the categories used here to classify contract provisions are rather standard in the alliance literature, the availability of the contracts would have allowed a more fine-grained analysis of their characteristics. Fourth, in our dataset, we had no measures of the strategic importance of the alliance, a variable that has been considered in prior studies (e.g., Reuer et al. 2006) and, more importantly, no information about the performance impact of contract design choices. This latter information would have allowed us to address other intriguing research questions. For instance, we could have tested whether contractual complexity effectively mitigates knowledge misappropriation risks, resulting in more successful alliances. In addition, based on previous work on alliance governance misalignment (Sampson 2004; Hoetker and Mellewigt 2009), the availability of data on alliance performance would have allowed us to analyze whether the insertion of too many or too few provisions ultimately results in a deterioration of alliance performance.

Despite the above limitations, the results of our study can provide the managers of entrepreneurial ventures with guidelines for making decisions concerning the negotiation of alliance contracts, contingent on partner characteristics. Our findings suggest that entrepreneurial ventures forming alliances with dangerous partners like competitors that pose serious knowledge misappropriation risks could indeed try to mitigate ex ante these risks by forming non-equity alliances and negotiating complex contracts that include a comprehensive set of heterogeneous provisions. The value that dangerous partners potentially contribute to an alliance may indeed outweigh the great transaction costs associated with designing more complex contracts (Barthélemy and Quélin 2006).

Appendix 1

Table 5 Check of robustness: use of alternative dependent variables

		Model 1 Dep. var.: *Contractual_Complexity_45*			Model 2 Dep. var.: *Weighted_Contractual_Complexity*			Model 3 Dep. var.: *Enforcement_Provisions*		
a_0	*Constant*	1.329	(0.154)	***	0.518	(0.053)	***	2.917	(0.287)	***
a_1	*DCompetitor*	0.270	(0.161)	*	0.187	(0.047)	***	0.890	(0.245)	***
a_2	(*1-DCompetitor*) × *Technological_Relatedness*	0.120	(0.056)	**	0.052	(0.019)	***	0.295	(0.107)	***
a_3	(*1-DCompetitor*) × *DLarge_Partner*	0.252	(0.098)	**	0.125	(0.035)	***	0.653	(0.189)	***
a_4	*DIPP_Regime*	− 0.007	(0.124)		0.027	(0.052)		0.038	(0.273)	
a_5	*DExploitation*	− 0.263	(0.101)	**	− 0.069	(0.037)	*	− 0.333	(0.198)	*
a_6	*DPrior_Alliance*	0.122	(0.133)		0.045	(0.047)		0.174	(0.245)	
a_7	*DCross_Border*	0.104	(0.108)		0.094	(0.038)	**	0.478	(0.196)	**
a_8	*N_Prospective_Partners*	− 0.355	(0.356)		0.029	(0.120)		− 0.064	(0.673)	
a_9	*Venture_Size*	0.118	(0.052)	**	0.038	(0.019)	**	0.218	(0.099)	**
a_{10}	*Venture_Age*	0.000	(0.008)		0.003	(0.003)		0.015	(0.015)	
Number of observations		211			211			211		
R^2		0.143			0.200			0.194		

Robust standard errors are in parentheses

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%.

Table 6 Check of robustness: use of alternative estimation approaches

		Ordered logit model			Poisson model		
a_0	*Constant*	–			1.356	(0.085)	***
a_1	*DCompetitor*	1.274	(0.449)	***	0.274	(0.075)	***
a_2	(*1-DCompetitor*) × *Technological_Relatedness*	0.342	(0.144)	**	0.073	(0.030)	**
a_3	(*1-DCompetitor*) × *DLarge_Partner*	0.878	(0.265)	***	0.198	(0.053)	***
a_4	*DIPP_Regime*	0.633	(0.425)		0.107	(0.071)	
a_5	*DExploitation*	− 0.780	(0.284)	***	− 0.143	(0.056)	**
a_6	*DPrior_Alliance*	0.276	(0.390)		0.081	(0.075)	
a_7	*DCross_Border*	0.584	(0.302)	*	0.130	(0.057)	**
a_8	*N_Prospective_Partners*	0.067	(0.877)		0.013	(0.207)	
a_9	*Venture_Size*	0.292	(0.130)	**	0.057	(0.028)	**
a_{10}	*Venture_Age*	0.009	(0.019)		0.004	(0.004)	
	Cut-off point 1	− 3.112	(0.578)		–		
	Cut-off point 2	− 1.898	(0.450)		–		
	Cut-off point 3	− 1.069	(0.404)		–		
	Cut-off point 4	− 0.415	(0.381)		–		
	Cut-off point 5	0.135	(0.376)		–		
	Cut-off point 6	1.260	(0.381)		–		
	Cut-off point 7	2.357	(0.399)		–		
	Cut-off point 8	3.818	(0.499)		–		
Number of observations		211			211		
Pseudo R^2		0.053			0.040		

Robust standard errors are in parentheses

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%

Table 7 Check of robustness: focus on the alliances formed after 2002

		Contractual_Complexity		
a_0	*Constant*	4.358	(0.485)	***
a_1	*DCompetitor*	0.657	(0.437)	
a_2	(*1-DCompetitor*) × *Technological_Relatedness*	0.417	(0.167)	**
a_3	(*1-DCompetitor*) × *DLarge_Partner*	0.716	(0.307)	**
a_4	*DIPP_Regime*	0.920	(0.445)	**
a_5	*DExploitation*	− 0.698	(0.308)	**
a_6	*DPrior_Alliance*	− 0.234	(0.463)	
a_7	*DCross_Border*	0.347	(0.345)	
a_8	*N_Prospective_Partners*	0.194	(1.128)	
a_9	*Venture_Size*	0.255	(0.145)	*
a_{10}	*Venture_Age*	0.003	(0.025)	
Number of observations		145		
R^2		0.178		

Robust standard errors are in parentheses

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%

Table 8 Check of robustness: use of alternative explanatory variables and inclusion of additional controls

		Model 1			Model 2			Model 3			Model 4		
a_0	*Constant*	3.960	(0.473)	***	3.016	(0.497)	***	3.757	(0.409)	***	3.966	(0.523)	***
a_1	*DCompetitor*	1.369	(0.420)	***	2.217	(0.533)	***	1.513	(0.429)	***	1.374	(0.434)	***
a_2	(*1-DCompetitor*) × *Technological_Relatedness*	0.328	(0.141)	**	–			0.356	(0.142)	**	0.328	(0.140)	**
a_3	(*1-DCompetitor*) × *Avg_Technological_Relatedness*	–			0.191	(0.078)	**	–			–		
a_4	(*1-DCompetitor*) × *DLarge_Partner*	0.962	(0.266)	***	0.976	(0.263)	***	1.097	(0.286)	***	1.027	(0.268)	***
a_5	(*1-DCompetitor*) × *DMedium_Partner*	–			–			0.399	(0.399)		–		
a_6	*DIPP_Regime*	0.533	(0.386)		0.534	(0.385)		0.546	(0.380)		0.666	(0.528)	
a_7	*DExploitation*	−0.733	(0.288)	**	−0.715	(0.281)	**	−0.739	(0.283)	**	−0.678	(0.288)	**
a_8	*DPrior_Alliance*	0.432	(0.386)		0.416	(0.382)		0.403	(0.383)		0.475	(0.381)	
a_9	*DCross_Border*	0.657	(0.294)	**	0.637	(0.298)	**	0.631	(0.294)	**	0.649	(0.308)	**
a_{10}	*N_Prospective_Partners*	0.092	(0.899)		0.072	(0.901)		0.092	(0.907)		0.034	(0.860)	
a_{11}	*Venture_Size*	0.274	(0.136)	**	0.281	(0.138)	**	0.270	(0.138)	*	0.285	(0.141)	**
a_{12}	*Venture_Age*	0.020	(0.021)		0.020	(0.021)		0.021	(0.021)		0.024	(0.023)	
a_{13}	*DCEO*	−0.171	(0.266)		–			–			–		
a_{14}	*DSoftware*	–			–			–			−0.088	(0.436)	
a_{15}	*DICTManufacturing*	–			–			–			−0.654	(0.464)	
a_{16}	*DOtherManufacturing*	–			–			–			0.141	(0.795)	
a_{17}	*DInternet*	–			–			–			−0.230	(0.470)	
Number of observations		211			211			211			211		
R^2		0.208			0.206			0.211			0.220		

Robust standard errors are in parentheses

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%

Table 9 Check of robustness: control for alliance scope

		Contractual_Complexity		
a_0	*Constant*	3.039	(0.571)	***
a_1	*DCompetitor*	2.499	(0.687)	***
a_2	(*1-DCompetitor*) × *Technological_Relatedness*	0.425	(0.185)	**
a_3	(*1-DCompetitor*) × *DLarge_Partner*	1.110	(0.372)	***
a_4	*DIPP_Regime*	− 0.108	(0.477)	
a_5	*DExploitation*	− 0.497	(0.427)	
a_6	*DPrior_Alliance*	0.962	(0.531)	*
a_7	*DCross_Border*	0.767	(0.430)	*
a_8	*N_Prospective_Partners*	− 0.128	(0.877)	
a_9	*Venture_Size*	0.350	(0.208)	*
a_{10}	*Venture_Age*	0.027	(0.030)	
a_{11}	*Alliance_Scope*	− 0.278	(0.215)	
Number of observations		115		
R^2		0.288		

Robust standard errors are in parentheses

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%

Table 10 Check of robustness: estimates on both equity and non-equity alliances

		Contractual_Complexity		
a_0	*Constant*	3.867	(0.396)	***
a_1	*DCompetitor*	1.255	(0.399)	***
a_2	(*1-DCompetitor*) × *Technological_Relatedness*	0.209	(0.138)	
a_3	(*1-DCompetitor*) × *DLarge_Partner*	0.894	(0.257)	***
a_4	*DIPP_Regime*	0.332	(0.362)	
a_5	*DExploration*	− 0.509	(0.278)	*
a_6	*DPrior_Alliance*	0.643	(0.344)	*
a_7	*DCross_Border*	0.626	(0.291)	**
a_8	*N_Prospective_Partners*	− 0.154	(0.923)	
a_9	*Venture_Size*	0.263	(0.134)	*
a_{10}	*Venture_Age*	0.012	(0.020)	
a_{11}	*DEquity*	0.094	(0.502)	
Number of observations		237		
R^2		0.157		

Robust standard errors are in parentheses

*Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%.

Appendix 2

To build a control for alliance scope, we asked the managers of sample firms to evaluate through a seven-point Likert scale their agreement with three sentences concerning the size of the activities to be performed within the alliance. These sentences assessed whether, in order to leave less room for partner's opportunistic behavior, the alliance initially focused (i) on a limited number of products/services or (ii) on a limited number of technologies compared to those that could have been focus of the alliance, or (iii) partner firms committed less human, financial and/or physical resources than the ones they could have engaged in the collaboration. In the Likert scale used to evaluate the degree of agreement with the sentences, 1 indicated that the interviewed manager totally disagreed with the sentence, while 7 meant that s/he totally agreed. Therefore, for each item, higher values indicated that the scope of the alliance has been reduced to decrease the risk of opportunistic behavior, thus decreasing knowledge misappropriation risks as well. Answers to the above questions were available for a sample composed of 115 alliances. Then, we carried out a principal components factor analysis with varimax rotation on the three items. One factor with eigenvalue greater than one was extracted (*Alliance_Scope*).

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