Choosing an appropriate alliance governance mode: The role of institutional, cultural and geographical distance in international research & development (R&D) collaborations

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Jeongho Choi
Instructor
Rutgers Business School
Rutgers University
1 Washington Park
Newark, New Jersey 07102-1897, USA
Telephone: 201-815-7333
E-Mail: jhochoi@scarletmail.rutgers.edu

Farok J. Contractor
Professor of Management and Global Business
Rutgers Business School
Rutgers University
1 Washington Park
Newark, New Jersey 07102-1897, USA
Telephone: 908-806-3154
E-Mail: farok@andromeda.rutgers.edu

ABSTRACT

This paper makes three principal contributions. It illustrates in detail, how international Research and Development (R&D) alliance agreements need to be classified into a wider spectrum of governance modes. The reality is far more nuanced. Agreement-based R&D collaborations (without forming a separate equity joint venture (EJV) company), may include several auxiliary provisions such as passive equity investments, real options triggers, and other clauses that ameliorate, to some extent, the market failure concerns of Transaction Cost Economics (TCE). EJVs are often not pure equity investments but include side agreements that may supersede the equity power balance between the allies. Going beyond the "market versus hierarchy" dichotomy, this paper provides a more detailed and nuanced classification, along a continuum of alliance governance modes, as our dependent variable. Second, the paper explores the determinants of the governance choice, as a function of the institutional, cultural and geographical 'distances' between the home nations of the alliance partners. Third, we describe how the choice of alliance governance mode is also influenced by whether the alliance task is in basic research 'R', or in development 'D'. This unpacks activities uncomfortably lumped together into one rubric 'R&D' -- when actually the operations, strategic objectives, risks and rewards vary considerably between R and D.

INTRODUCTION

While the factors affecting the formation and governance of international alliances have been a central topic over the past 20 years, a relatively unexplored research question is how the agreement structure and relationship between international partners depends on the *differences* between their country, institutional and industrial backgrounds. In the last decade, alliances and non-equity alliances in particular, have proliferated partly because sources of technological knowledge are widening beyond the internal capability of even large firms, and escalation in R&D costs encourages sharing the risk and expenditures of R&D (Mowery et al., 1996; Contractor and Lorange, 2002; Chung and Yeaple, 2008).

Prior literature was content to use dichotomous alliance classifications (such as Equity vs. Non-Equity alliances as their dependent variable). This overlooked the fact that agreement-based alliances in high-technology industries such as pharmaceuticals, electronics and information technology have proliferated into several varieties, and should no longer be lumped together into one "non-equity" category. This was probably because actual details of alliance agreements, held confidentially by each firm, were previously not available to scholars. In this study, the sample is based on an actual reading of the texts of international alliance agreement provisions, which have recently become more available in data bases such as ReCap and SDC. This has surfaced agreement complexities not treated by academics before, enabling scholars such as Reuer and Ariño (2007), and Contractor and Reuer (2014) to classify agreement governance over a wider spectrum of categories. It appears that the old bugbear of "contract incompleteness" (e.g., Hennart, 1988 or Hart and Moore, 1999) in Transaction Cost Economics (TCE) that would force firms into internalization -- or at most quasi-internalization via equity joint ventures (EJVs) – is being mitigated somewhat because of the willingness of allies to craft more extensive non-equity

contracts with contingency and governance clauses that specify the roles of each partner in greater detail than before. In part, this greater role for non-equity alliance modes may also reflect global improvements in institutional and legal protection. Such institutional, human capital, and rule of law differences at the country level are, in fact some of the explanatory variables in this study.

This study proposes an ordered set of international alliance categories, ranging from "low integration" modes such as pure patent licensing which does not involve extensive interaction between the allies, to "moderate integration" involving an agreement package that can include a license agreement, milestone triggers, and coordinated work by the scientists of the two firms, to "high integration" governance modes which, in the extreme, may result in the allies constituting a new EJV company to undertake R&D activities. In short, a spectrum of governance structures is available to prospective partners. The choice, or selection of alliance structure type is then explained by country and industry variables, with several of the hypotheses framed with TCE and/or knowledge-based view (KBV), as well as other contingent multiple factors such as cultural distance between the partners (Schwens et al., 2011), and firm-specific technological complementarity (Oxley and Wada, 2009).

In this study, we make three contributions. *First*, the paper illustrates in great detail, how international R&D alliance agreements need to be classified into a wider spectrum of governance modes, rather than into overly-broad categories, such as 'equity versus non-equity', as a dependent variable. The reality is far more nuanced. Agreement-based R&D collaborations (without forming a separate EJV company), may include several auxiliary provisions such as passive equity investments, real options triggers, and other clauses that ameliorate, to some extent, the market failure concerns of TCE. EJVs are described by both TCE and the KBV of the firm as preferable when transaction and knowledge transfer costs are high. However, perhaps because EJVs also

involve higher risk and resource commitment, larger sunk costs and have lower reversibility, EJVs for certain situations are not always preferred. Firms in all industries are today more likely to use non-equity or contractual alliances than EJVs for their R&D activities, using mixed or complex alliance governance provisions such as a licensing plus a joint research agreement (Mowery et al., 1996; Hagedoorn et al., 2008). (Figure 1 shows patterns in the pharmaceutical sector as an example of a general trend). In recent years, the level of detail and complexity of contract provisions has sharply escalated enabling a greater degree of monitoring, auditing and control without the need for equity participation in the partner (Reuer and Arino, 2007). Going beyond the "market versus hierarchy" dichotomy, this paper presents a more detailed and nuanced classification, along a continuum of alliance governance modes, as our dependent variable.

Second, the paper explores the choice of alliance type as a function of the human capital, institutional, cultural and geographical 'distances' between the home nations of the alliance partners, as well as industry and firm factors. *Third*, we describe how the choice of alliance governance mode is also influenced by whether the alliance task is in basic research 'R', or in development 'D'. This unpacks activities uncomfortably lumped together under one rubric 'R&D' -- when actually the operations, strategic objectives, risks and rewards vary considerably between R and D. As a generalization, basic research is typically a more internalized and conceptual activity (although increasingly a task shared with alliance partners) while development has more of a field-testing or market-oriented activity with more local market feedback and inputs needed (Prahalad and Ramaswamy, 2003). Development is therefore more widely internationally dispersed compared with basic research (von Zedtwitz and Gassman, 2002). (As an example, Figure 2 illustrates the distinction between R and D in the pharmaceutical industry. While basic research focuses more on drug discovery and molecular science which requires closer interaction/

communication between scientists, development is associated with more formalized and standardized clinical field trials).

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Thus, in line with these three contributions, this paper addresses the following three questions.

(1) "Using techniques such as cluster analysis, can we identify different classes of non-EJV (Equity Joint Venture) agreements and rank order them with an increasing degree of inter-partner involvement?

(2) "Along the continuum of international R&D alliances, with an EJV being the most integrated, can we identify the determinants of the governance modal choice, based on institutional, cultural and geographical differences between the home nations of each partner?"

(3) "How is the governance mode choice moderated by the type of activity – Research versus Development?"

THEORY AND HYPOTHESIS DEVELOPMENT:
How TCE, KBV and Institutional Perspectives Complement Each Other

For international business, scholars such as Hymer (1976) or Zaheer (1995) have conceptualized "liability of foreignness" by measuring the gap/distance between the host and home countries of firms in multidimensional terms such as culture, geography and institution, and how the distance/gap affects investment choices (e.g., the degree of ownership and control in FDI). We extend this approach here to explain how the choice of governance modes in international alliances is affected by multiple differences across nations, using underlying concepts from TCE (Transaction Cost Economics), and KBV (Knowledge-Based View) theories.

While TCE is more concerned with market failure and institutional factors such as contract incompleteness or enforcement (Hennart, 1991; Hennart and Larimo, 1998; Demirbag et al., 2010; Baik et al., 2013), KBV views the choice of alliance governance (inter-partner interaction) from knowledge characteristics -- the type, tacitness and complexity of the knowledge shared by the

partners (Contractor and Ra, 2001). For the most part, the two theories yield complementary conclusions. For example, previous research has examined the balance between uncertainty and the choice of alliance governance modes (Gulati and Singh, 1998; Steensma et al., 2000; Vrande et al., 2009). TCE suggests that when transaction costs (e.g., uncertainty or institutional differences such as the 'rule of law' in the partner nations) are great, hierarchical or equity-based alliance modes such as EJVs that "align the incentives" of the partner are preferable (Mowery et al., 1996;) over alliances that are non-equity or contract-based which are difficult to enforce when the rule-of-law is weak (Contractor, Woodley and Piepenbrink, 2011). In a similar vein, KBV suggests that more integrated alliances such as EJVs should be a preferred mode of collaboration when knowledge is complex and tacit and therefore such knowledge transfer is best effected when the personnel of the partners work together under one EJV organization (Kogut and Zander, 1992; Sampson, 2004; Oxley and Wada, 2009). This is because tacit and complex knowledge is more difficult to describe and draft into an agreement and where future contingencies or outcomes from such knowledge-sharing are also more uncertain (Contractor and Ra, 2001). So we see from the above how TCE and KBV yield complementary hypotheses. Both raise the specter of "uncertainty." TCE approaches uncertainty from an institutional and legal perspective. KBV approaches uncertainty from a technology-transfer difficulty perspective and the inability to fully articulate the outcomes of future technology developed jointly by partners.

Institutional theory compares the broader institutional environment of countries and the impact such differences have on the ownership strategy of multinationals (Davis et al., 2001; Meyer, 2001; Lu, 2002). Country institutional factors, such as political stability and rule-of-law have been used to emphasize and extend TCE concepts in explaining the ownership/international operation mode strategy, in Delios and Beamish (1999) or Brouthers (2002). More recently, Berry et al.

(2010) integrate TCE and institutional theory, by formally proposing a multidimensional cross-national construct that measures the distance/gap between nations. Thus Institutional Theory forms the backdrop and matrix of several TCE concepts.

TCE and KBV also complement each other in terms of the fear of unintended knowledge leakage or spillover to the other partner. International R&D, the context of this study, is a knowledge intensive activity including transferring and sharing tacit technological knowledge and proprietary technology. In joint R&D it is important to find a right balance between transferring/sharing tacit technological knowledge (to foster alliance creativity and synergies), versus one ally wishing also to protect its proprietary technology and intellectual assets by choosing an appropriate alliance governance mode. TCE views unintended knowledge spillover as allowing potential opportunism and future consequential costs from partner 'misbehavior'. KBV scholars suggest that a high degree of control or more organizationally embedded alliances are preferable (a) in order to provide safeguards for knowledge protection, as well as (b) to foster tacit knowledge exchange (Gulati and Singh, 1998; Macher, 2006; Oxley and Wada, 2009). TCE and KBV thus offer several rich and mostly congruent hypotheses.

However, this is not sufficient. In this paper we offer additional industrial organization perspectives. Firms engaging in international R&D alliances in a knowledge intensive industry actually take into account additional multiple factors, such as country knowledge specialization and industrial R&D intensity in each partner nation, which affects the competitive advantage of each partner's national industry and thus the alliance mode chosen.

By using our alliance governance mode classification (beyond the traditional equity-versus-non-equity dichotomy), we provide a richer classification of governance mode choices. The paper also uses a contingency perspective as a complement to TCE and KBV (as seen in Buckley and

Casson, 1996; Hagedoorn and Duysters, 2002; Schwens et al., 2011). A contingency perspective is useful particularly when the international R&D alliance governance mode choice is affected by multiple factors that are not covered under those key theories (Ambos and Schlegelmilch, 2004; Pateli and Giaglis, 2007; Choi and Yeniyurt, 2015).

In addition, this study separates research from development. This is useful since the alliance mode choice is also contingent upon tasks which are quite different in research versus development phases. We detail below hypotheses based on (1) country factors such as human capital, institutional (e.g., rule-of-law), cultural, and geographic differences between the nations of the alliance partners, (2) industry factors (e.g., industrial R&D intensity and technology specialization), and (3) firm factors such as product scope and technological base/specialty difference between the alliance partnering firms which directly impact the degree of their interaction, uncertainty and the probability of adverse selection.

Determinants of the Governance Choice in International R&D Alliances

Today, non-equity alliances outnumber equity JVs (EJVs) and the simple dichotomy of equity vs. non-equity alliances needs to be expanded. Alliances are a hybrid form, lying between markets and hierarchies (Williamson, 1979), but also described as "Quasi-Integration" (e.g., Zaheer & Venkatraman. 1995). This paper develops this concept further by proposing that the degree of inter-partner or inter-organizational integration varies across alliances, and that choosing an appropriate degree of inter-partner integration is a function of factors such as the complexity of the technology and the extent of inter-partner interactions needed for their intended joint R&D. For details, the Appendix later on gives details of the operationalization of the dependent variable (which is based on an actual reading of hundreds of agreements). However, so that the hypotheses appear more tangible, we briefly state here that the objective is choosing from an ordered ranking,

or spectrum, of alliance relationships, where the '*Degree of Overall Integration'* ranges from Low-integration non-equity alliance modes => Moderately-integrated non-equity modes => Highly-integrated non-equity modes => to EJV as seen in Figure 3. The first three categories are purely contractual alliances; the fourth is an EJV exhibiting the highest degree of inter-partner integration.

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Hypotheses as to the choice of appropriate alliance mode are now stated below.

1. Country factors

Differences in the Quality of Human Capital

Prior studies have analyzed the acceleration in offshore R&D (Atkinson, 2007; Demirbag and Glaister, 2010) driven, in part, by the availability of low-cost yet skilled technicians and scientists. But besides cost, the *quality* of human resources (i.e., availability of skilled and educated workers) plays a critical role in international collaborations. A TCE perspective suggests that a greater difference in the quality of human capital between the countries of the partnering firms increases partner uncertainty and fears that large human capital differences.

If partner firms are from countries with widely different levels of human resource skills, it would not be prudent for them to increase their resource commitment using a more-integrated R&D alliance mode. Instead, they are likely to choose a less-integrated alliance mode, requiring a lower level of resource commitment and interaction, such as pure licensing (e.g., simply license-out old technology to a partner as licensee). This is our general hypothesis, for all international R&D alliances. However, we next modify or qualify our hypothesis depending on whether the alliance task is in basic research "R", versus development "D."

Basic research and development involve rather different activities and skills. We use the example of the pharmaceutical sector below. However the same concepts apply to most industries.

Basic research activities "R" entail greater creativity, tacit knowledge and experience. In development "D" technology choices are narrowed down and more deterministic, and tasks typically entail more field work, trials, and market feedback. In the pharmaceutical industry, for example, in beginning research, molecules are developed from medical and DNA theories (Tapon and Thong, 1999). The nature of basic research requires educated scientists in laboratories in close communication and interaction between the research teams of the partners. KBV suggests that skill levels and absorptive capacity are essential elements for knowledge transfer involving basic research activities (Minbaeva, 2007). When firms consider a research alliance in a country where they can find and liaise with skilled and educated workers, they may prefer to use more organizationally integrated alliance governance modes in order to enhance knowledge transfer and learning between partnering firms.

On the other hand, development activities involve field trials on human subjects (See Figure 2), and clinical experimentation is done under more standardized routines and "templates" supplied by one alliance partner to the other for their nation's trials. Given this, we hypothesize that less-integrated modes will be preferred, *ceteris paribus*, in the development stage, whereas a more-integrated alliance mode will more likely to be used by firms in the research phase. Hence, we propose our first hypothesis with a general statement covering both R *and* D, in general, followed by a qualifying statement that distinguishes between the two activities.

H1: *The greater the difference in the quality of human capital of the nations of the allies, the lower is the likelihood of using a more-integrated (more interactive and more complex) alliance mode. Moreover, this negative relationship will be even stronger when the R&D is in the development phase rather than the research phase.*

Differences in an Institutional Factor: Rule-of-Law

The institutional environment is one of the critical determinants of the location and alliance governance mode choice for firms involved in R&D. Kostova and Roth (2002) and other studies under institutional theory such as Delios and Beamish (1999) conclude that the greater the difference between the institutional environment of the home countries of partnering firms, the greater the need on the part of a foreign investor (concerned about ownership and control) or alliance partner to adapt and be more responsive. For joint R&D conducted with a foreign partner, there is one institutional criterion which is particularly crucial: *Rule-of-law*[1]. Firms in knowledge intensive industries (like pharmaceuticals where patents are key strategic assets) are concerned about protecting their intellectual property when they license-out or transfer those technologies. Other things being equal, they are more likely to use low-integration alliance modes involving arm's length contracts (e.g., license) only when the transaction cost is low, where countries provide strong enforcement of contract law, regulations and an intellectual property protection regime.

On the other hand, when the Rule-of-law is weak, firms with valuable proprietary technologies in the form of patents (or 'knowhow' which is even more difficult to legally defend) are more likely to use higher-integration alliance governance modes (Contractor, Woodley and Piepenbrink, 2011) Gulati and Singh, 1998; Pan and Tse, 2000). There are at least three reasons for this hypothesis. First, in TCE terms, a more-integrated alliance mode (especially an EJV) enables the technology providing partner to monitor and control partner opportunism through, for instance, establishment of 'Joint Steering Committees' which are found in both contractual as well as EJV alliances. Second, weak legal enforcement regimes are also characterized by higher search and information costs. Third, appropriation of a reasonable share of alliance returns is better effected

[1] Rule-of-law captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, and the courts.

and more assured in nations with weak rule-of-law through more integrated alliance modes (Oxley & Wada, 2009; Contractor & Reuer, 2014). As such, when the difference in institutional environment (i.e., rule-of-law) between countries of partnering firms is high, firms will prefer to choose a more-integrated alliance governance mode.

However, the above hypothesis is moderated, depending upon the stage of R&D. Unlike basic research "R", field development processes "D" can be highly regulated (in industries ranging from automobiles to pharmaceuticals where human subjects are involved). Firms are required to follow safety standards and procedures (Rowberg, 2001), and risks or liabilities are high. According to the US FDA (United States Food & Drug Administration), new drugs developed by foreign firms cannot be sold in the U.S. if the clinical trials were not conducted under stricter U.S. investigational new drug application rules. In alliance partner countries with relatively weak legal standards and regulations, the focal partner is even more zealous to carefully monitor, support, and have control over clinical trials. For this reason, firms in the development phase are more likely to choose a more-integrated alliance mode in nations where the rule of law is weaker. Hence,

H2: *As the difference between the nations of the allies increases, in terms of institutional factors such as the rule of law, there will be a greater likelihood of using a more-integrated (more interactive and more complex) alliance mode. And this positive relationship will be even stronger when the R&D is in the development phase rather than the research phase.*

Cultural Factors

Cultural differences between partnering firms increase the level of uncertainty (Richards and Yang, 2007) and this is particularly pertinent in R&D. Recent studies suggest that the different dimensions of culture (such as power distance, uncertainty avoidance, individualism, masculinity and long-term orientation used by Hofstede) have different effects on the organizational modal choice and each should be examined separately (Tse et al., 1997; Delerue and Simon, 2009). Here

we focus specifically on power distance[2] and long-term orientation[3] as determinants of the alliance governance mode.

In general, the sub-field of cultural distance studies has been characterized by contrasting conclusions (Shenkar, 2011) so that scholars need to take several, sometimes contradictory, views into account before deciding on one as their formally-stated hypothesis. Some prior studies under TCE have shown a positive relationship between power distance and the choice of a hierarchical mode. Firms from high power distance countries, accepting inequality and hierarchy of power in the organization, prefer to have greater control in inter-organizational relationships, and seek more integrated modes towards the right hand side in Figure 3. Firms from low power distance countries are more open and willing to work as a group or a team for a certain project without formally integrating rules or hierarchies (Richards and Yang, 2007). With greater power distance between partners, those allies may also prefer more integrated modes in order to reduce opportunistic behaviors.

However, other studies under a contingent perspective have made a counter argument that similar national cultures facilitate the formation of equity joint ventures (Buckley and Casson, 1996) and more integrated relationships between partners. In addition, cultural differences are said to increase alliance conflict (Lane and Beamish, 1990), collaboration problems in technology R&D alliance activity (Mowery et al., 1996) and knowledge transfer problems (Hamel, 1991) – the latter two from a KBV perspective. As mentioned earlier, we will adopt this latter point of view as our formally-stated hypothesis. Because R&D activity requires intensive collaboration accompanying the close communication and coordination between partners, greater power distance increases the

[2] In Hofstede 1994; power distance is referred to as the extent to which the members of a society expect po wer to be distributed equally in organizations and institutions.
[3] In Hofstede 1994; long-term orientation is defined as the degree to which individuals' actions are driven by long-term goals and results, rather than short-term results, and the need for immediate gratification.

cost of communication and coordination in more integrated alliance modes. In this sense, firms may prefer to choose a more flexible, lower-integration governance mode in uncertain organizational environments (Schwens et al., 2011). By adopting a looser and more flexible alliance mode, firms can reverse an initial alliance agreement at a lower cost in the case of adverse selection caused by the culturally different partner.

Long-term orientation also fits into this study since R&D in the pharmaceutical industry is long-term and time consuming (see Figure 2) and reaping the fruits of the research in the commercialization stage even longer – up to twenty years. Firms from a long-term orientation culture, that focuses more on future interactions and rewards, perceive more clearly the shadow of the future (Das and Teng, 2000; Delerue and Simon, 2009), as opposed to those with a short-term oriented organization which tend to be more opportunistic, and less likely to build inter-firm trust in an alliance. Hence, we hypothesize that with greater long-term orientation differences, partner firms will prefer a less-integrated alliance governance mode where the investment is lower and where consequences of opportunism are less onerous (compared with say the dissolution of an EJV that necessitated a large up-front investment in capital and personnel). Less-integrated modes are in that sense more reversible, or can be terminated with lower costs or consequences.

The perceived uncertainty of an R&D project is much higher in the early research phase compared to the later development phase (and this applies to all sectors, including pharmaceuticals, e.g., Rothaermel, 2001). In the early discovery or basic research stage, the commercial utility of early ideas is highly uncertain and researchers do not know whether – for example in pharmaceuticals, the compound will progress further through additional development stages, or not. On the other hand, in the development stage cultural differences play a lesser role since the product design and technology choices are already narrowed down to just one or a few,

and joint decision-making is more driven by technological factors, rather than cultural. For example, in pharmaceuticals, a drug that has completed Phase II, and awaits large scale human trials in Phase III is a safer bet. Consequently, the impact of cultural difference can be reduced in the later development stage. And this promotes the choice of less-integrated alliance governance modes. Hence,

H3A: *As the difference between the allies increases, in terms of the power distance scores for their home countries, the likelihood of using a more-integrated (more interactive and more complex) alliance mode will decrease. Moreover, this negative relationship will be stronger for R&D in the development phase rather than in the research phase.*

H3B: *As the difference in long-term orientation between the allies increases, the likelihood of using a more-integrated (more interactive and more complex) alliance mode will decrease. Moreover, this negative relationship will be stronger for R&D in the development phase rather than in the research phase.*

National Geographic Distance between Nations of the Allies

Geographic distance has been used as a proxy in empirical studies. R&D, by nature, is a knowledge intensive activity requiring collaborating firms to closely interact -- preferably through face-to-face communication for a better exchange of technological knowledge. As geographic distance increases, the cost and complexity of knowledge search and communication increases (Daft and Lengel, 1986), and efficacy of communication degrades (Katz and Allen, 1982) making R&D units more difficult to create collaborative environments and build close relationships (De Meyer, 1991; Westney, 1990). In addition, geographic distance limits the effectiveness of knowledge transfer (Hansen and Lovas, 2004). Different time zones and long transmission channels between R&D units limit knowledge transfer effectiveness (Ambos and Ambos, 2009). By contrast, close geographic proximity facilitates face-to-face as well as other means of contact with partner scientists that fosters cooperative environments (Ganesan et al., 2005).

The right choice of alliance governance mode plays a critical role, especially when firms collaborate with geographically distant partners. As emphasized by the TCE and KBV perspective, firms prefer a more interactive (i.e., bilateral interaction) or organizationally embedded modes such as EJVs in order to facilitate knowledge sharing activity. As such, the use of more-integrated alliance governance modes can transcend the geographical distance obstacle and mitigate the barriers of coordination and communication between allies. And this will be more salient for firms in more complex joint operations such as basic research that requires closer communication, than for firms in the development phase dealing with standardized and formalized experimentation and field testing. Therefore,

H4: *As the geographic distance between allies increases, the likelihood of using a more-integrated (more interactive and more complex) alliance mode is increased. And this positive relationship will be stronger for R&D in the research phase rather than in the development phase.*

2. Industry and Firm factors

Industry Factors

According to Alcacer and Chung (2007), knowledge spillovers are the result of firm activity through interactions with diverse actors. We hypothesize here that when the alliance partners are based in less similar industry contexts, in terms of (1) *Industrial R&D intensity*, and (2) *industrial technology specialization*, then that decreases the likelihood of more-integrated alliances. From a KBV perspective, a large difference in the level of R&D intensity between the host and home country industry is said to depict a gap in absorptive capacity, and this can create high costs in international knowledge transfer (Teece, 1981; Oxley, 1997). Firms in a knowledge intensive industry with a knowledge-seeking motive tend to locate their R&D activity in countries with similar levels of industrial technology development. The same logic can be applied to R&D

alliance activity. By allying with a partner firm in the industry with a similar level of R&D intensity to that of the home country, and by increasing resource-commitment through a more-integrated governance mode, they can promote learning, exchange of technological knowledge, and create better fruits from their R&D program. However, firms in high (low) R&D intensive industry involved in an R&D alliance in a country with low (high) industrial R&D intensity can choose a less-integrated governance mode (such as licensing) where the up-front commitment is lower than in EJVs and the consequences of dissolution of the partnership less onerous. Both partners can reduce search and monitoring costs while protecting their core technologies. In a similar vein, when partnering firms collaborate in an industrial environment where there is a greater dissimilarity in terms of specialization of industrial technologies (sub-sector specialization) between nations of partnering firms, that can increase uncertainty in monitoring, learning and absorbing new specialized technologies. Firms in this case will more likely choose less-integrated alliance modes that are closer to arm's length market transactions (e.g., licensing, towards the left side of Figure 3) in order to reduce technological uncertainty and monitoring costs, and to be remain flexible in case they have made an incorrect R&D decision or strategy move.

This desire for lower commitment, reversibility and flexibility will, we hypothesize, be even stronger in the development phase, because, as discussed earlier, if one approach (i.e., protocol: study plan) in a clinical trial fails, firms can try another with different concepts and study plans. And firms will be able to do this over again through a more flexible governance mode by simply changing terms of the alliance contract. Hence,

H5A: *As the gap between allies in Industrial R&D intensity increases, the likelihood of using a more-integrated (more interactive and more complex) alliance mode will decrease. And this negative relationship will be stronger for joint work in the development phase rather than in the research phase.*

H5B: *As the gap between allies in Industrial technology specialization increases, the likelihood of using a more-integrated (more interactive and more complex) alliance mode will decrease. And this negative relationship will be stronger for joint work in the development phase rather than in the research phase.*

Firm Factor

Firms within the same industry concentrate on different product types. This is, obviously, true for all industries. Specifically, in pharmaceuticals depending upon their technological background and/or specialty, firms will cover different disease or therapeutic areas. One may have strengths in oncology, while another may focus its research and patenting on heart disease. Then, the questions is how product or sub-sector differences between the prospective allies affect the alliance governance mode choice. The literature provides some contrary suggestions which we summarize below and then adopt one as our hypothesis.

Prior studies have emphasized the critical role of complementarities in technological knowledge sharing. One view is that new product and new processes comes not from the combination of similar technologies but from the combination of different technologies or complementarities (Breschi et al., 2003). However, accessing, learning and absorbing complementary technologies are not easy tasks, but require absorptive capacity in related technology areas (Girma, 2005). Accordingly, firms need to choose a right knowledge sourcing mode in order to be able to generate benefits from the unique complementary technologies. Others conclude from the KBV that collaborating firms choose more integrated/ hierarchical alliance modes in order to facilitate understanding, learning and transferring complementary technologies (Mowery et al., 1996; Gulati and Singh, 1998). In a similar vein, TCE also argues that when partnering firms have greater technological distance, due to the emergence of information asymmetries leading directly to adverse selection, firms can choose more integrated alliance modes to minimize relationship-specific uncertainty.

However, a contrary perspective can be found in other studies -- that firms are more likely to choose less-integrated or more flexible governance modes when firms focus on different sub-fields because then technological uncertainty is high. In such a case, the desire for flexibility and lower commitment prevails over the need for a stronger administrative control to avoid partner's opportunism (Folta, 1998; Colombo, 2003; Vrande et al., 2009). In this study, we formally adopt the arguments of the latter view especially in the context of our study, where it is strategically important for firms under highly uncertain environments to remain flexible in the face of adverse selection possibilities.

Finally, alliances in the development phase will have a greater desire to choose contractual modes because of a greater desire, and ability to remain flexible. The desire for flexibility comes from the need to adapt clinical test procedures in the face of negative and unsuccessful results. Contract clauses allow for this flexibility. Under a loosely structured governance mode, the alliance can adopt a try-it-again approach or abandon the alliance. By contrast an EJV entails a heavy commitment that is not easily reversible. Hence,

H6: *As the Product scope or Sub-sectoral Difference between allies increases, the likelihood of using a more-integrated (more interactive and more complex) alliance mode will decrease. And this negative relationship will be stronger in the development phase than in the research phase.*

METHODOLOGY

Data and Sample

The unit of analysis of this study is the alliance agreement. We used a unique data source, *Current Agreements Database*, which covers details on global alliance agreements in the bio-pharmaceutical sector (U.S. SIC 2833 through 2836) ranging from equity joint ventures to technology licenses, and joint research/development contracts. Other clauses include loans, and passive equity purchases. (Please see the Appendix for details). The database contains the alliance

deal announcement date, alliance partners (e.g., nationality and address), actual contract documents (although financial information is sometimes not disclosed), alliance deal components (i.e., types of alliance- licensing, development, and so on), and stages of development ranging from discovery to phase III clinical trials. Because of the need for complete agreement detail, cases lacking details on all variables had to be eliminated. After this, the final sample we used consisted of 237 alliances formed during 2000 and 2003.

In addition to this, we used a variety of publically available data sources to measure independent variables: OECD library data to measure economic and industrial factors, World Bank Governance Indicators for institutional environment variables, Hofstede's Cultural index for cultural differences, the latest version of IMS Health's USC 3 (The Uniform System of Classification) for product scope differences, and 10-K annual reports for firm-level data (e.g., size and age).

Dependent Variable

The dependent variable, as shown in Figure 3, is '*Degree of Overall Integration',* our categorization of alliance governance modes. The dependent variable is coded on an ordered basis as follows: Low-integration alliance modes = '1', Moderately-integrated modes = '2', High-integration modes = '3', and EJV = '4'. The first three are purely contractual; the fourth is an EJV. The ranking goes from 'Least (1) to the most (4) integrated alliance governance mode'. Please see the Appendix for further details.

Independent Variables

Several of the explanatory variables have to do with the *differences* between the home nations of the alliance companies, in terms of the countries' human capital indicators, rule of law rankings,

culture and geography. For each of these, the difference (or 'distance') between the home nations of the allies was calculated through the following formula:

$$\sum_{i=1}^{4}\{(\text{Index}_{iX} - \text{Index}_{iY})^2 / V_i\} / 4$$

where Index ix (iy) stands for the score of country X (or Y) in ith year and V_i stands for the variance of ith year. And we averaged the 4-year period scores (i.e., 2000 through 2003), since the scores vary with each year in each country.

Economic Factor: Quality of Human Capital (HUMAN). To measure the availability of skilled/ well-educated labor, participation rates in tertiary education (i.e., percentage of population that enrolls in tertiary education) were used.

Institutional Factor: Rule-of-law. We used the World Bank's Governance Indicators (as in Kaufmann et al., 2005; Dikova, 2009) which provide a score for each nation (on items such as contract enforcement, intellectual property rights, the police, and the courts).

Cultural factors: (A) *Power Distance* (POWER DIST.) and (B) *Long-term Orientation* (LONG-TERM). We measured those two dimensions of national culture by using Hofstede's cultural scores, and used the same calculation formula shown above. These two cultural attributes were chosen (over others such as masculinity/femininity) since they are more closely related to alliance and joint venture governance.

National Geographic Distance (GD): In previous studies, the geographic coordinates of countries (i.e., latitude and longitude) of the geographic center of the country have been used to measure the geographic distance between the two countries (Berry et al., 2010). However, this is not a precise measurement because in many cases the GD between two cities in two countries (e.g., between western part of U.S. and eastern part of Canada) is much larger (or smaller) than GD from

the geographic centers of two countries. Instead, we used the physical address/location of the alliance companies and the "great circle distance" formula in order to calculate the geographic distance between the two firms.

Industry Factors: Alliance partner companies vary in terms of their (A) *R&D intensity (RDINT)*, and (B) *technology specialization (TECHSP)*. Industrial R&D intensity was measured by pharmaceutical industry R&D expenditure as a percentage of GDP of the country. Industrial technology specialization was measured by the patent concentration in the pharmaceutical industry of a nation relative to the total patent concentration of the pharmaceutical industry in the entire world. It is important to distinguish R&D intensity for a particular sector, from national R&D intensity in general for a nation. Each has a different signaling effect. For instance, firms in the pharmaceutical industry may seek a partner in a country they believe attractive due to its high national R&D expenditure, in general. However, the pharmaceutical industry in that nation may have a relatively low R&D expenditure compared to that of other industries in the nation. Hence, an industry-specific measurement for R&D intensity and technology specialization allows us to capture unbiased firm heterogeneity in the industry. We used the following formula.

Industrial technology Specialization = $\dfrac{P_{ijX} / \sum_a P_{iX}}{\sum_j P_{iw} / \sum_a P_{iw}}$, where P_{ijX} stands for the number of patents in ith year in the pharmaceutical industry (j) of country X. $\sum_a P_{iX}$ represents the total number of patents in ith year in the all industry (a) of country X. $\sum_j P_{iw}$ is the total number of patents in ith year in the pharmaceutical industry (j) of the world (w). And finally, $\sum_a P_{iw}$ is the total number of patents in ith year in the all industry (a) of the world (w). And then we used the above distance formula to calculate the gap in the alliance partners' industrial R&D intensity and technology specialization.

Firm Factor: Product Scope Difference (PSD). Different biotech and pharmaceutical firms specialize in different disease (or therapeutic) areas, as seen in their product scope and technological bases. To measure the technological knowledge base gap/difference between partnering firms, we used a product-related technology measurement (i.e., each firm's therapeutic classification of commercialized drugs approved by either the US FDA (Food and Drug administration) or European Medicines Agency. We used IMS health data and its-USC (the Uniform System of Classification) code for therapeutic classification of commercialized drugs. In order to calculate product scope difference between partnering firms, we first made drug lists of each firm. And then, we tabulated the 3-digit USC therapeutic classification to which each drug belongs, and then finally we used the following calculation method (Sampson, 2004; Vrande et al., 2009).

$$\textit{Product Scope Difference} = 1 - \frac{T_i T_j'}{\sqrt{(T_i T_i')\,(T_j T_j')}}$$

Where T_i (j) represents the distribution of firm i (j)'s number of drugs across therapeutic classification. This creates a multidimensional vector. For instance if T_i= (1, 4, 5, 6) in therapeutic class A, B, C and D while T_j = (0, 3, 2, 0). Then, the product scope difference will have a value from 0 to 1 -- with a value of 1 indicating the greatest possible product scope difference between two partnering firms; in this example, the product scope difference between firm i and j is 0.309.

R&D Phase: As can be seen from Figure 2, R is significantly different from D in terms of strategic goals and activities. For moderating effects of R&D phase, we use a subsample method separating alliances formed in the Research phase (Drug discovery) from those in the Development phase (Phase I, II and III clinical trials) (Rothaermel and Deeds, 2006).

Control Variables

We employed several control variables that may affect the alliance governance mode choice. We controlled for '*firm size: the number of employees'* because a larger firm, due to its greater capability to cope with uncertain environments, may feel less susceptible to external environment fluctuations and partner opportunism (Aulakh et al., 2013). '*Firm age'* controls for capability to conduct research and development, because older firms, due to experience, are more likely to perform better (Rothaermel and Deeds, 2004). Since the unit of analysis of this study is a dyad, or an alliance deal, we calculated the size and age differences between two partnering organizations (whether they be firms, universities or research institutes) by using the basic difference calculation formula. '*Prior alliance experience*' is measured by the number of prior alliance ties with the same firms, universities or R&D institutes (Rothaermel and Deeds, 2006; Vrande et al., 2009). Finally, we introduced a dummy variable as a control for *'university, and R&D institute',* since universities and R&D institutes are not direct competitors of firms, and thus may be more cooperative and exhibit low opportunistic behavior.

Statistical Model

Since our dependent variable, *Degree of Overall Integration (DOI) (aka. Alliance governance modes)*, is rank ordered (Low Overall Integration…1…2…3…4…High Overall Integration), we use an *ordinal logistic regression* (Oxley, 1997; Santoro and McGill, 2005; Yamin and Golesorkhi, 2010). This is an appropriate methodology even with independent variables that are a combination of categorical (e.g., universities and R&D institutes) and continuous measures (e.g., geographic distance). The ordinal logistic regression model is specified as follows:

$$\mathrm{DOI}_i = \sum_{k=1}^{k} \beta_k \; X_{ik} + \varepsilon_i = Z_i + \varepsilon_i$$

Where β_k is the coefficient of k^{th} variable and X_{ik} is the vector of k^{th} independent variable. Z_i is an unobservable measure of alliance mode *i* expressed in the degree of overall integration, and ε_i is a

random error term. Since DOI_i categorized into four alliance modes is estimated by the latent variable Z_i, Z_i has three threshold points δ_1, δ_2 and δ_3.

$$DOI_i = 1, \text{ if } Z_i \leq \delta_1$$
$$DOI_i = 2, \text{ if } \delta_1 \leq Z_i \leq \delta_2$$
$$DOI_i = 3, \text{ if } \delta_2 \leq Z_i \leq \delta_3$$
$$DOI_i = 4, \text{ if } Z_i \geq \delta_3$$

Based on this, we can calculate the probabilities of choosing various alliance modes as

$$\Pr(DOI_i=1) = \Pr(Z_i+\varepsilon_i \leq \delta_1) = \Pr(\varepsilon_i \leq \delta_1 - Z_i)$$
$$\Pr(DOI_i=2) = \Pr(\delta_1 \leq Z_i+\varepsilon_i \leq \delta_2) = \Pr(\delta_1 - Z_i < \varepsilon_i \leq \delta_2 - Z_i)$$
$$\Pr(DOI_i=3) = \Pr(\delta_2 \leq Z_i+\varepsilon_i \leq \delta_3) = \Pr(\delta_2 - Z_i < \varepsilon_i \leq \delta_3 - Z_i)$$
$$\Pr(DOI_i=4) = \Pr(Z_i+\varepsilon_i \geq \delta_3) = \Pr(\varepsilon_i \geq \delta_3 - Z_i)$$

RESULTS

Table 1 provides descriptive statistics and the correlation matrix for the variables used in our empirical analysis. The correlation matrix, *prima facie*, suggests some multi-collinearity between say for example geographic distance and the quality of human capital, and long-term orientation and rule-of-law. However, such seeming correlation is mainly because of the same distance calculation formula indicated earlier used for difference measures. Nevertheless, a multi-collinearity test was conducted and VIF (Variance Inflation Factor) scores in Table 1 are all lower than 10 (Neter, Wasserman and Kutner, 1985), indicating no multi-collinearity among the variables. To make sure, we further checked condition indices for both geographic distance and quality of human capital which show very low values of 3.00 for these two. In addition, values on variance proportions for geographic distance and quality of human capital show 0.00 for almost all variables -- meaning that all other variables are not independently influenced by these two variables.

Table 2 and 3 present the estimation results for the ordinal logistic regression models on the factors affecting the likelihood (or choice) of R&D alliance governance mode choice. And since we observe the same country pairs over several years (e.g., U.S.-U.K. alliances), the standard errors of country clusters may be similar to country pair clusters. Thus, the standard errors reported in the parentheses in result tables are robust clustered at the country pair level. Table 2 shows the results for the full sample while Table 3 shows separate subsamples for alliances involving basic research "R" versus alliances covering development "D". This is similar to Rothaermel and Deeds (2006). Activities in research phase are significantly different from those in development phase and should, we hypothesized, produce different results with regard to the choice of alliance governance mode.

Among the controls (Model 1 in Table 2), only 'university' shows a strong negative relationship with the dependent variable in all models except Model 6. This indicates that when firms form R&D alliances with universities, there is a greater likelihood of choosing less-integrated alliance modes such as licensing.

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Insert "**TABLE 1, 2 & 3**" Here

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This is not surprising because universities do not commercialize drugs, and are not direct competitors of firms. Secondly, universities patent their discoveries and typically license the patent rights to partner firms without undue fears of competition or opportunism. Hence such alliances use relatively low integration types of alliances as their choice of governance mode (such as licensing).

Hypothesis 1 is about the effect of differences in the Quality of Human Capital between the home nations of the partners with respect to the choice of R&D alliance governance mode. This is

significant at 10 % level (Model 2). A larger difference or gap in the availability of skilled/educated labor between the countries of partner firms decreases the likelihood of using more-integrated alliance governance modes. However, unlike our hypothesis, when the sample is partitioned into alliances tackling basic research "R" versus development, "D", we find that it is in alliances tackling basic research that the significant negative effect is more accentuated (See Model 5).

Hypotheses 2 is about the effect of national institutional difference (i.e., rule-of-law) on the choice of R&D alliance governance modes. And our empirical test shows a positively significant result (Model 2; $\beta = 0.399$, $p<0.1$). In addition, as can be seen from model 6, rule-of-law differences provide an even more marked effect on alliance governance mode, but only for firms in the development phase. Thus, the results support hypothesis 2.

Model 2 also tests ***Hypothesis 3.*** The results are negative and significant for both power distance and long-term orientation at 5% level. However, when the sample is partitioned, the results for each sub-sample are weak. It is only in the development phase that allies are more likely to choose a less-integrated alliance mode, and that too only for power distance differences. Thus, there is strong support for hypothesis 3A, and only partial support for hypothesis 3B (no moderating effect).

A greater geographic separation between alliance partners increases the likelihood of more-integrated R&D alliance governance modes. This is strongly supported at 1% level (Model 2; $\beta = 0.002$, $p<0.01$). In addition, the likelihood of using a more-integrated alliance mode is stronger for firms involved in research phase rather than for firms in development phase (Model 5). Thus, ***Hypothesis 4*** is strongly supported.

Unfortunately, there were no significant results for industrial and firm factor differences on the R&D alliance governance mode choice in general. However, as seen in Model 6, when there is a high level of difference in industrial technology specialization, the likelihood of using a less-integrated alliance mode is stronger for firms in development phase. This provides partial support for ***hypothesis 5B***. Finally, when there is greater difference in the product scope of partnering firms, the likelihood of using a less-integrated alliance governance mode is stronger for firms particularly in development phase – providing partial support for ***hypothesis 6***.

In sum, the international R&D alliance governance mode choice supports TCE and KBV predictions in results for country-level differences (e.g., quality of human capital, rule-of-law and geographic distance between partnering firms). In addition, the nature of the joint alliance task -- whether firms are conducting research or development, influences the choice of alliance mode. The various theory perspectives are not mutually exclusive but are complementary in explaining the alliance governance mode choice in an uncertain R&D context.

Robustness check

In addition to marginal probability effects, we also performed a discriminant analysis for the dependent variable (i.e., classification of alliance governance modes) to see if the results hold up under a different operationalization[4]. First, we coded four governance modes by using the mean value of two items (i.e., degree of interaction and degree of complexity) since our classification contains type 1, 2A, 2B and 3 alliance governance modes; (1) Mean of degree of interaction= 4, and (2) Mean of degree of complexity=33. Our classification through this discriminant analysis is statistically very significant and well-classified; the eigenvalue of degree of interaction is high indicating that it is significantly discriminated from degree of complexity. Canonical correlations

[4] An anonymous referee is to be thanked for this suggestion.

for both are high (close to 1) meaning that these two functions are very important to classify four different alliance governance modes. Based on this classification as a dependent variable, we ran the ordinal logistic regression to examine the hypotheses. As we expect, most of results remain unchanged as shown in Table 2 and 3, except the power distance in model 4. And some changes with a better significance are as follows. Model 4 in Table 2 (when the dependent variable is measured by the discriminant analysis): The significance and the coefficient of "Quality of human capital" has changed from -0.066 ($P < .10$) to -0.091 ($P < .05$), "Geographic distance" from 0.001 ($P < .05$) to 0.0001 ($P < .01$), and "Power distance" are not significant, thus not supported. Model 6 in Table 3 (when the dependent variable is measured by the discriminant analysis): The significance of "Industrial technology specialization" dropped from -1.372 ($P < .05$) to -0.449 ($P < .10$), but "Product scope difference" showed an even stronger result from -3.206 ($P < .10$) to -2.89 ($P < .05$). All robustness tests including the discriminant analysis and ordinal logistic regression are available upon request.

DISCUSSION AND CONCLUSION

This study advances the academic understanding of alliance governance by going beyond the overly broad, traditional categories of "equity vs. non-equity" alliances. In several sectors, especially pharmaceuticals, contractual alliances greatly outnumber equity joint ventures (EJVs). And therefore probing the distinctions between the varieties of non-equity alliances is essential to understand the complexities of alliance formation and governance.

In this paper, the dependent variable comprises four rank-ordered alliance governance categories (three purely contractual types 1, 2, 3…plus one EJV variety 4) with rising levels of inter-partner integration. What we label "inter-partner integration" is a composite construct built from two salient building blocks, or concerns, in alliance formation (i) the extent of inter-partner

interaction (depending on the incidence of pooled, sequential and/or reciprocal joint activities), and (ii) the degree of complexity of the task undertaken by the alliance (based on the number of deal components in the agreement as well as its length). While the domain of this study is pharmaceutical R&D, it would be useful for any high-tech sector to distinguish between basic research "R", and development "D", to assess the extent to which the alliance governance type is influenced by whether the alliance's purview is R versus D.

This paper is also different from the mass of alliance empirical studies because data were coded from an actual reading of 237 international alliance agreements. Although some scholars such as Contractor, Woodley and Piepenbrink, (2011); Zhou, Poppo and Yang (2008) or Reuer and Arino (2007) have begun to probe the details of actual agreements, most previous studies only used broad classifications drawn from synopses published by news abstracts like SDC (Securities Data Corporation). Without tracking (i.e., reading) actual agreement provisions and probing the anatomy of agreements, a study is akin to practicing medicine without dissection. In this research, each agreement was read and scored for the inclusion of 12 elements ranging from licensing, to asset purchase, to the partial (passive) acquisition of partner shares, to milestone triggers (real options), to manufacturing or supply chain links between the partners, loans, and finally the creation of a separate EJV company (Please see the Appendix). From these components we calculated the 'degree of complexity' of each alliance which, together with the 'degree of integration,' enabled us to construct an overall index, rank-ordered into four categories with a rising "overall degree of integration" (Figure 4).

An ordinal logistic regression procedure then assessed the accuracy of classification for each alliance (in terms of its governance mode in the four categories) based on the differences between

the home nations of the allies and their sub-sectoral specialization (i.e., which therapeutic areas each pharmaceutical partner company has worked in the past).

Our main conclusion is that the choice of R&D alliance governance mode is not attributable to a single factor but rather is influenced by multiple contingent factors. Country-level differences in institutions, human factors, culture and geography between the home nations of the allies play a role, as do sectoral and firm factors. In addition, our empirical results show that the KBV and TCE, and contingency perspectives complement each other, and indeed provide richer explanations about the complexity of alliance governance modes used in today's radically changing R&D environment in high-tech industries. Our findings from an additional analysis (not reported here), particularly for alliance mode choice with geographically distant partners, enriches the foundations of KBV and TCE theories. For instance, under the KBV, a hierarchical alliance mode (i.e., EJV) is deemed to be preferable, because it is said to promote collaboration and knowledge sharing activity, and minimize partner opportunism (Oxley and Wada, 2009). Furthermore, in EJVs organizational "co-embeddedness" is said to facilitate tacit or complex knowledge sharing and transfer (Kogut, 1988; Kogut and Zander, 1992; Sampson, 2004; Macher, 2006; Oxley and Wada, 2009). However, this study supports a recently evolving trend that firms in industries exhibiting increasing research intensity and rate of change in technology, instead prefer more flexible yet organizationally-embedded contractual alliances that contain strong control mechanisms such as a joint steering committee. Such non-EJV agreements also provide greater flexibility or reversibility, in the sense that they do not involve as large a capital or personnel commitment as would an EJV. Sometimes it is considered too risky to use an EJV as a knowledge sourcing/development mode, because technological uncertainties such as failure of drug discovery and clinical trials may actually lead to an adverse selection problem. Instead, firms can diffuse such risks by using a

moderately-integrated alliance mode that lies in between a license (more akin to an arm's length contract) and an organizationally fully embedded mode such as an EJV. This reduces the adverse selection problem. A moderately-integrated contractual mode (e.g., DV = 2 in this study) provides a more flexible organizational structure than an EJV since it allows partners to more easily change or modify their research and development contracts in the face of technological uncertainties and changes in the regulatory or R&D environment – while at the same time a greater degree of integration allows for a closer relationship between the allies.

Another practical implication that our framework addresses is that firms can strategically choose an alliance governance modes for different stages of R&D. Research is obviously different from development in the sense that research requires more frequent and closer interaction between partners, as opposed to development which often entail more formalized/standardized field trials with much larger inputs from diverse country markets (von Zedtwitz and Gassman, 2002). Our study reveals that the likelihood of using a more-integrated governance mode is stronger for firms in the research phase especially when partners are located in geographically distant places. This is reasonable, because research alliances have a greater need for coordination involving transfer of tacit knowledge across organizational and geographical boundaries (Lane and Lubatkin, 1998; Rothaermel and Deeds, 2004), and thus are more likely to choose a more-integrated mode to promote knowledge sharing between partners. On the other hand, firms in the development phase -- where technology or design choices are already narrowed down and where protocols and templates have already been developed for field trials -- are more likely to use less-integrated modes in the face of uncertainties rising from cultural or institutional differences at the field or country level, industrial technology specialization and product scope differences between partnering firms.

The dependent variable construct of this study (identification of 12 salient agreement provisions detailed in the Appendix), as well as its conclusions about how country and sectoral differences influence the structure of alliances, also provides rich insights for managers. Firms can diversify their risks and the location of their R&D activity by using different alliance governance modes, thus leading to better-crafted agreements. Finally, while the empirical analysis covers just the pharmaceutical industry, the detailed description of alternate alliance governance modes developed in this study, and agreement components, should also be applicable to other high-tech industries such as information technology, aerospace and electronic equipment (Hagedoorn and Duysters, 2002; Hagedoorn et al., 2008). Our study provides a future research opportunity to see if the findings from this study are generalizable to other sectors.

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APPENDIX: Methodology for Constructing the Dependent Variable – Degree of Overall Integration

An optimum alliance governance choice -- along a continuum between arms-length transactions and a fully integrated mode (i.e., EJV) (Gulati and Singh, 1998; Contractor and Lorange, 2002; Vrande et al., 2009), minimizes uncertainties and maximizes benefits. Below, we identify diverse agreement-based governance modes used in the pharmaceutical industry, and rank order them into distinct categories with ascending inter-partner integration. In a subsequent section of this paper, we add EJVs to the right hand side of the spectrum, and then explore the determinants of the governance choice in each international alliance.

Classifying Alliance Governance Types Using Cluster Analysis

This empirical study constructs a dependent variable we label as the *"Degree of Overall Integration"* in the governance of the international alliance. In reading and analyzing international alliance R&D agreements in the pharmaceutical sector, we identified different types of tasks and provisions that constitute the overall bundle of an agreement. These include

Contractual Provisions (further details in the box below):

I. *Asset Purchase (AP)*
II. *Contract Development (CD)*
III. *Contract Research (CR)*
IV. *Cross-Licensing (CrL)*
V. *Passive Equity Purchase (E)*
VI. *Joint Development (JD)*
VII. *Joint Research (JR)*

VIII. *License (L)*
IX. Loan (Lo)
X. *Manufacturing (M)*
XI. *Supply(S)*

Equity Investment
XII. *Equity Joint Venture (EJV)*

Depending on the mix of the above twelve provisions or "ingredients" chosen for an alliance, we then classified non-EJV alliances (approximately 85 percent of the sample cases) along two dimensions which were then used for the cluster analysis.

(Dimension 1): Degree of Interaction: *The degree of workflow/task interdependence between alliance partners, after Thompson (1967):*

- *Pooled task*: Tasks that are performed independently but the allies are interdependent in in economic or financial terms; examples are Loan and Passive Equity Purchase; ***no-way interaction***
- *Sequential task*: The output of one task is an input for the other partner. In other words, the interaction between the partners is unidirectional (i.e., one way); examples are licensing, contract research and contract development; ***one-way interaction***
- *Reciprocal task*: The output of a task is inputted simultaneously to both allies or is a jointly performed task. The interaction between the partners is therefore bilateral or joint; examples are cross-licensing and joint research/development agreement; ***two-way interaction***

(Dimension 2): Degree of Complexity*: The degree of alliance contract complexity that stipulates resource allocation, adjustment and adaptation of ongoing tasks (i.e., Number of alliance components in an alliance, and the number of pages of the alliance agreement)*

The Degree of Complexity of an R&D alliance deal can be measured by the number of deal components in an alliance. For example, an agreement that includes licensing plus joint research can be coded with a value of two. In addition, we also considered the number of pages to capture the complexity of an alliance deal, following Hagedoorn and Hesen (2009). The number of pages is a crude index but has been used in previous studies because there is a presumed correlation between contract complexity and the number of pages. For example, if we compare a pure licensing agreement with a licensing plus option agreement, the latter is more complex and contains more details. A licensing plus option contains not only royalties but an additional contingent future financial reward which could be a lump-sum or a claim on future earnings. Thus it will tend to have more pages in the agreement.

Putting the above two dimensions together, non-equity based alliance governance modes can be classified into three clusters; (1), (2) (A and B), and (3) using the "K-Means Clustering Procedure". Figure 4 illustrates the increasing degree of overall integration rising from Cluster (1) to (2) to (3).

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Insert "**FIGURE 4**" here

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Recall that the cluster analysis was done only on the non-EJV, or agreement-based alliance subsample. This resulted in three groups of non-EJV alliances, for the dependent variable "Degree of Overall Integration" *(1) Low-Integrated, (2) Moderately-Integrated, (3) High-Integrated.* To this, on the right hand side of Figure 3, we add a fourth group, namely *(4) EJVs*. This conforms to three decades of alliance studies that conclude that when the partners create a separate JV firm, jointly staffed and operated with personnel from both partners, and often with a more substantial financial commitment than a contractual alliance, the degree of overall integration is the highest.

Since each alliance agreement is a unique mix of disparate provisions, the traditional certitudes of older theories need to be modified and adapted. No longer can we use just "markets versus hierarchies" or even a "market, versus quasi-integration (EJV), versus hierarchy" categorizations as in earlier TCE literature, because complex agreement provisions enable incentive alignment and controls without the use of equity. The role of more complex agreement provision as an incentive alignment is where TCE has been missing. Using the two clustering dimensions of degree of partner interaction and alliance structural complexity enables a more nuanced classification**.** For example, it is sometimes better for firms to add a joint collaboration provision that incentivizes knowledge sharing activities through a "joint steering committee" that constrains partner's opportunism (e.g. technological leakage) than to share knowledge simply through a single licensing agreement. This is the case where partnering firms increase interaction through a "joint steering committee", but also this increases alliance contractual/ structural complexity by adding more specifically an "operationalization of joint steering committee" provision in the alliance contract. In a similar vein, earlier studies using the KBV suggested the EJV as an ideal mode of knowledge creation and transfer due to greater organizationally-embedded control mechanisms (e.g., joint management board) (Oxley and Wada, 2009). But this can also effectively occur in complex non-equity contracts whose joint board provisions result in a high degree of partner interaction.

The Components of International Alliance Agreements in the Pharmaceutical Field

A: Alliances that are contractual and do not involve equity joint ventures

(1) ***Asset Purchase (AP)***: One company acquires legal control of one or more physical assets such as manufacturing plants, equipment, finished or work-in-progress product inventories, laboratory supplies, animals, and so on.

(2) ***Contract Development (CD)***: One party sponsors clinical trials at the other company; a pharmaceutical company sponsors clinical trials at a small biotech, which completes all development (conducts clinical trials on its own).

(3) ***Contract Research (CR)***: In a Research agreement, a sponsoring party engages another party to perform basic research services in the discovery and/or lead stages of an R&D project

(4) ***Cross-Licensing (CrL):*** One party obtains a license to the intellectual property of the other party in exchange for granting a license of its own intellectual property

(5) ***Passive Equity Purchase (E):*** An agreement in which one company issues shares of its stock to the other company, either in exchange for cash or loan amounts. Many agreements utilize minor equity purchases as part of the upfront or continuing compensation to the other company

(6) ***Joint Development (JD):*** Both parties participate in and share the costs and risks of clinical Development and/or commercial expenses.

(7) ***Joint Research (JR)***: Both parties participate in the basic research program. They may exchange data, information and materials necessary for each party to perform its obligations under the research plan. And either party may supply the other party with proprietary materials for use in the research program.

(8) ***License (L):*** One party obtains a License under the other party's intellectual property to research, develop, make, use, sell, or market or promote a product or technology.

(9) ***Loan (Lo):*** Repayment of the loan may be in the form of cash or equity from the borrowing company. A loan can be used to fund studies or research. In return, the lending partner can receive repayment upon any milestone achievement in a clinical or regulatory stage.

(10) ***Manufacturing (M):*** In a Manufacturing agreement, one party manufactures a product, usually a compound, for use by the other company in clinical development or pre-commercialization.

(11) ***Supply (S):*** In a Supply agreement, the company will make or have made a product for use or sale by the client company. The major difference between supply agreement and manufacturing is that a supply agreement usually contains delivery/distribution of products or lead compounds for clinical development trials as well as active pharmaceutical ingredients.

B: Alliances that are equity joint ventures

(12) ***Equity Joint Venture (EJV):*** Company A and company B (or more parties) create a new separate legal entity which is jointly staffed and operated by the principals.

Cluster Analysis Procedure

A. **Coding of Alliance Types (By Degree of Interaction)**

Based on these 12 different types of alliance, we scored the degree of interaction where no-way is coded as 1, one-way as 2, and two-way as 3.

- **No-way (1)**: Agreements that include Asset Purchasing, Loan and Passive Equity Purchase

- **One-way (2)**: Agreements that include Manufacturing, Supply, License, Contract Research, and Contract Development
- **Two-way (3)**: Agreements that include Joint Research, Joint Development, and Cross-licensing

If an alliance agreement contains multiple components such as a license as well as joint research, then we summed the interaction score between license (one-way: coded as 2) and joint research (two-way: coded as 3) to make a total score (i.e., 5) for the degree of interaction.

B. **Coding of Alliance Types (By Complexity of Agreement)**

We coded the degree of complexity by counting the number of alliance components in each alliance agreement (e.g., if an alliance agreement that contains three different components such as equity, license and joint research is coded as "3"), and the number of pages of the alliance agreement (after Hagedoorn and Hesen, 2009).

C. **Cluster Analysis (for classifying non-EJV alliances) in terms of Rising Levels of Overall Integration Between Partners**

Of 237 alliances in the sample, 208 are non-EJV while 29 are equity joint ventures. The cluster analysis was restricted to the 208 non-EJV alliances. Based on three items (i.e., the degree of interaction, the number of alliance components and the number of pages), we performed a K-means cluster analysis since it allows us to minimize the variance within each cluster, and this is more robust than any other hierarchical method in terms of presence outliers and errors in the distance measures (Salter and Olson, 2001). Initially we selected four clusters as a starting point. But later since the "overall degree of integration" rises generally in the 'northeasterly' direction in Figure 4, we combined two clusters labeled 2A and 2B into one cluster as representing a moderately-integrated alliance governance mode. And then we checked correlations among items.

There was a very high correlation (i.e., 0.90) between the degree of complexity measured by the number of alliance components and the degree of interaction. This is possible because alliance partners are more likely to interact as the number of alliance deal components increases. Given this fact, we decided to use the number of pages as one of dimensions of cluster analysis.

Table 4 provides ANOVA statistics. And the followings show the number of cases in each cluster (See also Figure 5 Scatter Plot (A): Four Cluster Method).

Cluster 1 (Low-Integration): 92

Cluster 2A (Moderately-Integrated): 67

Cluster 2B (Moderately-Integrated): 14

Cluster 3 (High-Integration): 35

==========

Insert "**FIGURE 5**" Here

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Insert "**TABLE 4**" Here

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Although we interested in four-classification of alliance governance modes (i.e., Cluster 1, 2A, 2B and 3) we also use three-cluster method in order to test robustness of our (four) classification. Under three-cluster method, we were able to get three non-equity based alliance clusters as follows.

Cluster 1: 124

Cluster 2: 67

Cluster 3: 17

As can be seen from Figure 5 Scatter Plot (B), there is no significant distinction between cluster 2 and 3 in terms of "Degree of Overall Integration" which undermines the goal of our study. In

addition, the empirical results based on the three-cluster method do not support our hypotheses. Therefore, we use four-cluster method for our empirical test.

TABLE 1

Descriptive Statistics and Correlation Matrix (Pearson Coefficients)

	Variables	MEAN	S.D.	VIF	1	2	3	4	5	6	7	8	9
1	**FIRM AGE**	2.602	5.753	1.45	1.000								
2	**FIRM SIZE**	2.331	4.275	1.33	0.001	1.000							
3	**ALLIANCE EXP**	0.092	0.305	1.05	-0.044	0.154	1.000						
4	**UNIVERSITY**	0.088	0.284	1.58	0.532**	-0.170**	-0.046	1.000					
5	**RESEARCH INST.**	0.097	0.296	1.13	-0.029	-0.108	-0.053	-0.102	1.000				
6	**Log GD**	7.769	1.462	3.24	-0.110	0.097	-0.036	-0.233**	0.036	1.000			
7	**RULE-OF-LAW**	0.174	0.752	2.84	-0.049	-0.034	-0.038	-0.057	0.137*	0.209**	1.000		
8	**HUMAN**	3.694	5.024	2.27	-0.091	0.239**	0.098	-0.193**	0.044	0.573**	0.080	1.000	
9	**POWER DIST.**	0.26	0.706	1.76	-0.085	0.090	0.009	-0.075	0.055	0.303**	0.551**	0.244**	1.000
10	**LONG-TERM**	0.509	1.525	2.41	-0.021	-0.073	-0.086	-0.104	0.038	0.315**	0.618**	0.142*	0.443**
11	**RDINT**	1.058	2.231	1.64	-0.026	0.384**	0.071	-0.144*	-0.102	0.326**	0.030	0.449**	-0.015
12	**TECHSP**	0.258	0.869	1.74	-0.031	0.040	-0.020	-0.091	-0.039	0.230**	0.534**	0.135*	0.367**
13	**PSD (USC3)**	0.951	0.114	1.10	0.083	-0.168**	-0.060	0.133*	0.140**	0.053	0.044	0.081	0.035

	10	11	12	13
10	1.000			
11	-0.053	1.000		
12	0.171**	0.135*	1.000	
13	0.073	-0.045	0.023	1.000

*Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level (two-tailed)

TABLE 2

Ordinal Logistic Regression:

Degree of Overall Integration as the dependent variable, With full sample used (Sample A)

Variables *(Variables for hypotheses indicate difference between partnering firms; e.g., difference in power distance)*	**Model 1: Controls** (Sample A)	**Model 2: Country-factors** (Sample A)	**Model 3: Industry-factors** (Sample A)	**Model 4: Firm-factor** (Sample A)
AGE Difference	0.373 (.031)	0.036 (.032)	0.031 (.032)	0.032 (.032)
SIZE Difference	0.017 (.028)	0.025 (.029)	0.012 (.033)	0.008 (.030)
Alliance Experience	-0.376 (.396)	-0.380 (.343)	-0.351 (.354)	-0.355 (.356)
University	-3.540 (.992)***	-3.502 (.908)***	-3.371 (.874)***	-3.323 (.887)***
Research Institute	-0.504 (.438)	-0.591 (.556)	-0.448 (.543)	-0.392 (.554)
Quality of Human Capital (H1)		-0.062(.037)*	-0.068 (.041)*	-0.066 (.042)*
Rule-of-Law (H2)		0.399 (.262)*	0.111 (.256)	0.108 (.258)
Power Distance (H3A)		-0.560 (.300)**	-0.484 (.277)*	-0.487 (.278)*
Long-Term Orientation (H3B)		-0.238 (.118)**	-0.149 (.124)	-0.149 (.123)
Geographic Distance (H4)		0.002 (.000)***	0.001 (.000)**	0.001 (.000)**
Industrial R&D intensity (H5A)			0.078 (.062)	0.076 (.062)
Industrial Technology Specialization (H5B)			0.299 (.213)	0.296 (.211)
Product Scope Difference (H6)				-0.976 (.874)
-2 Log likelihood	511.121	500.656	498.021	497.025
Chi-square	31.98***	46.27***	48.91***	49.91***
Cox and Snell R-square	0.126	0.177	0.186	0.190
Number of observations	237	237	237	237

All tests two-tailed; Robust standard errors (clustering by country pair) in parentheses
*P < .10 ; **P < .05 ; ***P< .01

TABLE 3
Moderating Effects of R&D phase

Ordinal Logistic Regression:
Samples in Research Phase (Sample B) vs. Samples in Development Phase (Sample C)

Variables *(Variables for hypotheses indicate difference between partnering firms; e.g., difference in power distance)*	**Model 5** (Sample B)	**Model 6** (Sample C)
AGE Difference	0.018 (.035)	0.274 (.115)**
SIZE Difference	0.040 (.031)	-0.025 (.058)
Alliance Experience	-0.442 (.412)	-0.374 (.561)
University	-2.974 (.837)***	-16.991 (1.28)
Research Institute	-0.574 (.602)	0.686 (.100)
Quality of Human Capital (H1)	-0.071 (.041)*	-0.068 (.151)
Rule-of-Law (H2)	-0.330 (.338)	3.134 (1.488)**
Power Distance (H3A)	-0.491 (.292)	-1.373 (.673)**
Long-Term Orientation (H3B)	-0.058 (.195)	-0.232 (.241)
Geographic Distance (H4)	0.001 (.000)**	-0.000 (.000)
Industrial R&D intensity (H5A)	0.024 (.081)	0.024 (.145)
Industrial Technology Specialization (H5B)	0.652 (.275)	-1.372 (.561)**
Product Scope Difference (H6)	0.175 (1.032)	-3.206 (1.718)*
-2 Log likelihood	320.894	151.679
Chi-square	43.39***	21.83**
Cox and Snell R-square	0.224	0.250
Number of observations	161	76

All tests two-tailed; Robust standard errors (clustering by country pair) in parentheses
*P < .10 ; **P < .05 ; ***P< .01

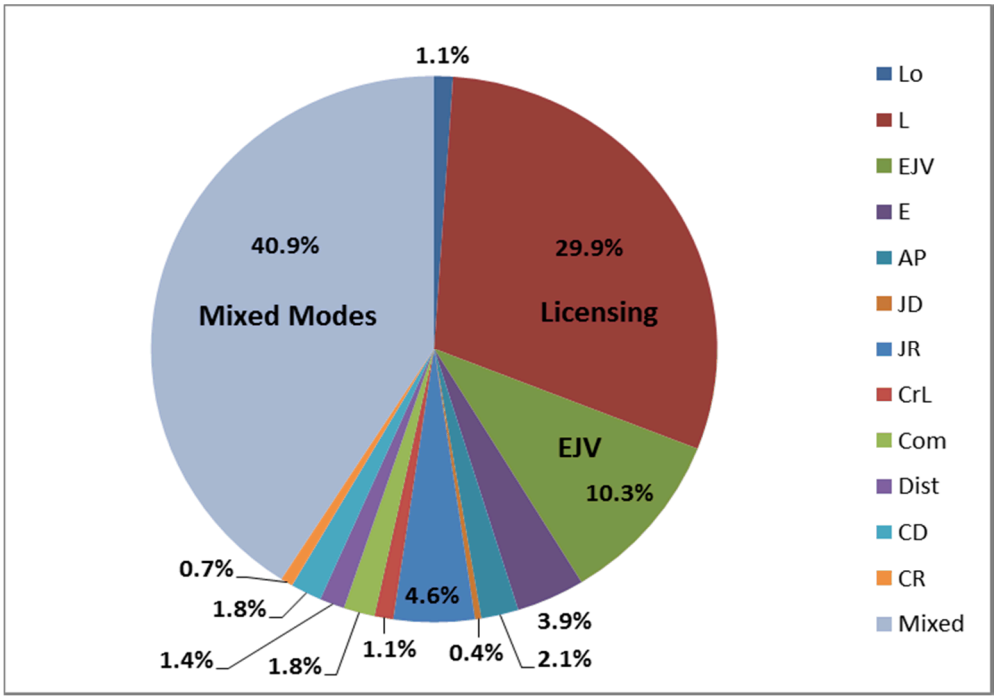
TABLE 4

ANOVA Statistics

	Cluster		Error		F	Sig.
	Mean Square	Df	Mean Square	Df		
Standardized score for ***the number of pages***	43.674	3	.372	204	117.263	.000
Standardized score for ***the degree of interaction***	60.690	3	.122	204	496.643	.000

FIGURES

FIGURE 1: Example of Clauses in Alliance Agreements



Source: Recap Data: International pharmaceutical alliances 2000 ~ 2003. Loan (Lo): 1.1%; Licensing (L) : 29.9%; Equity Joint Venture (EJV): 10.3%; Equity (E): 3.9%; Asset Purchasing (AP): 2.1%; Joint-Development (JD): 0.4%; Joint Research (JR): 4.6%; Cross-Licensing (CrL): 1.1%; Commercialization (Com): 1.8 %; Distribution (Dist): 1.4%; Contract Development (CD): 1.8%; Contract Research (CR): 0.7%; Mixed modes (Mixed): 40.9%

FIGURE 2: The Stages of Pharmaceutical R&D[5]

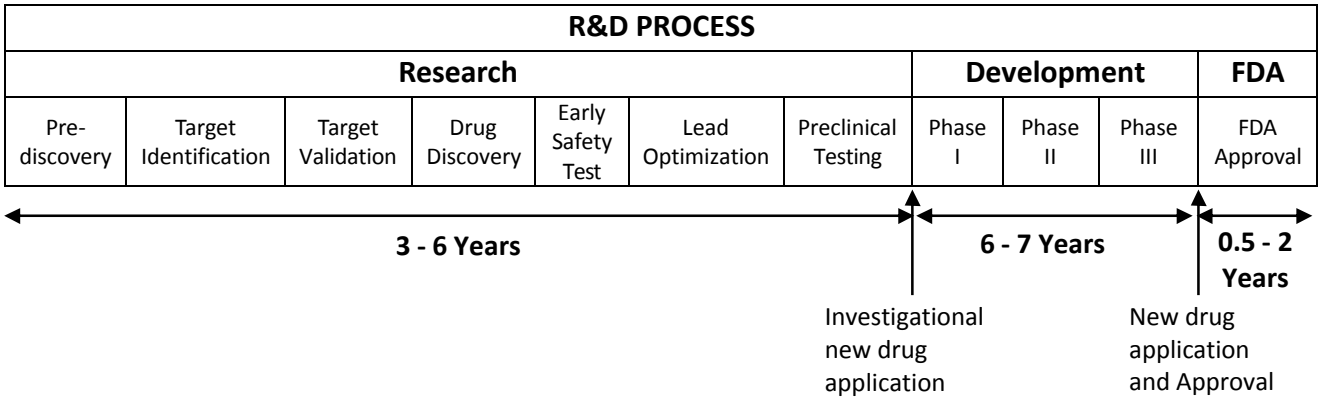


FIGURE 3: A continuum of alliance governance modes – Rising Degree of Overall Integration

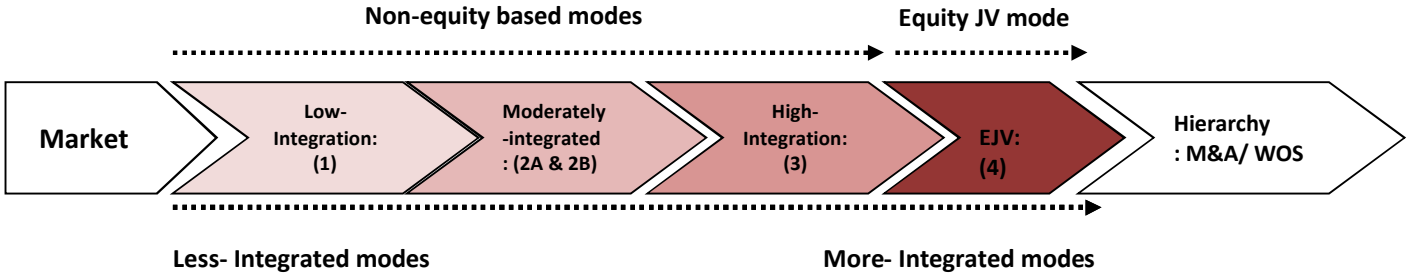


FIGURE 4: Cluster Analysis for "Degree of Overall Integration"

[5] Initially adapted from Rang (2006) and Sosa (2009), and reproduced by using PhRMA (Pharmaceutical R esearch and Manufacturers of America), 2007 and 2010 profile.

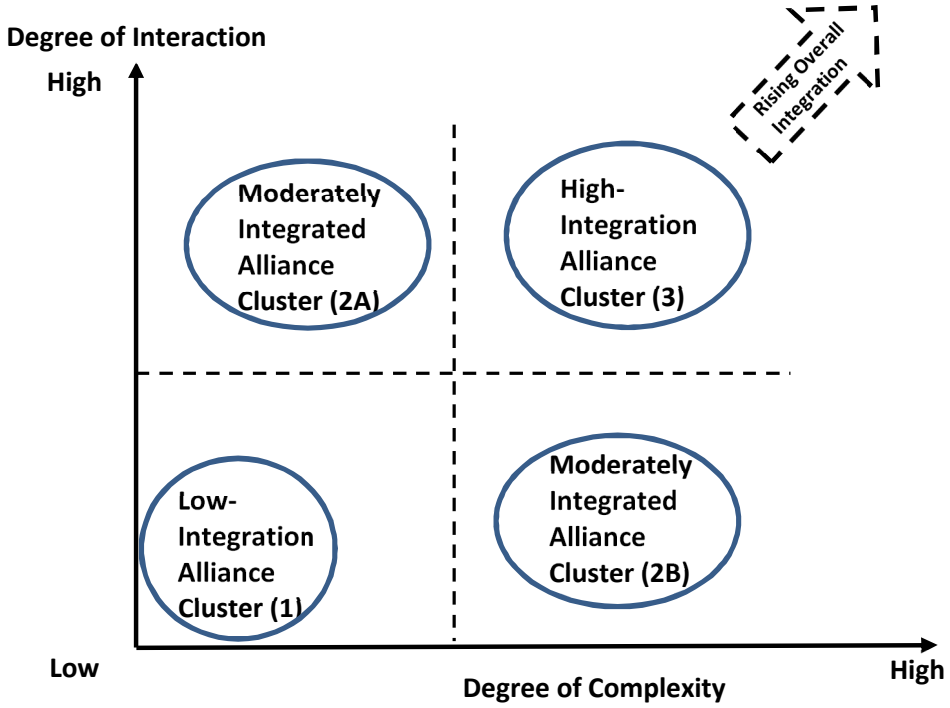


FIGURE 5: Scatter Plot for 208 non-EJV Alliances