

Influence of Institutional Differences on Firm Innovation from International Alliances

Despoina Filiou, Sougand Golesorkhi

Abstract

This paper explores the contribution of the institutional perspective in understanding firm innovation returns from international alliances. It argues that formal and informal national institutions are of different nature, and give rise to explicit and tacit differences respectively between alliance partners. Partners exhibit different attitudes and abilities to negotiate and address such differences in leveraging the innovation potential of international alliances. As a result, we expect such differences to have distinct effects on partners' innovation performance: a) the effect of informal institutional differences is approximating sigmoid (S-shaped), with innovation performance slightly increasing first, then improving further and finally reaching a flattening plateau as informal institutional difference between partners increase; and b) the effect of formal institutional differences resembles an inverted U. Support is provided for both our contentions in a longitudinal sample of 110 UK biopharmaceutical firms. The paper contributes to existing understanding of firm innovation performance from international alliances, and broadly, to the management of internationalization in alliance portfolios.

Keywords: Culture; Firm performance; Institutional theory; Organizational capabilities; Strategic alliances

Introduction

Firms increasingly use alliances to pursue a range of objectives: to gain access to complementary resources and competencies, technologies and skills, to expand their operations in different markets and to share the risks and costs of high-end R&D (Mowery et al., 1996; Rothaermel, 2001; Rothaermel and Hill, 2005). Despite the extensive use of alliances, their role in firm innovation and financial performance is equivocal (de Man and Duysters, 2005; Deeds and Hill, 1996; Hoang and Rothaermel, 2005). Potential explanations are the heightened coordination challenges as partners' knowledge bases become increasingly dissimilar and the firms' limited abilities to manage alliances effectively (Rothaermel and Deeds, 2006; Sampson, 2007).

A prominent feature of alliances is their international dimension with firms forming more international alliances compared with domestic (Hagedoorn, 2002; Kang and Sakai, 2000). The international location of alliance partners can introduce additional coordination problems in sharing and exchanging knowledge and resources. Nations and institutions acting at the national level remain an important and distinct factor underpinning differences across international firms (Carlsson, 2006; Gertler, 2001). Such differences can affect partners' learning (Lyles and Salk, 1996; Parkhe, 1991; Simonin, 1999) and firm financial performance from alliances (Lavie and Miller, 2008; Vasudeva et al., 2013).

In this paper, we employ the institutional perspective (North, 1990) to argue that formal and informal institutions shaped at the national level (Edquist and Johnson, 1997) give rise to different sources of enablers and constraints in international alliances and have distinct effects on firm innovation performance. The differing nature of such institutions shape partners' attitudes and abilities to coordinate the liabilities of such differences and to leverage the innovation potential of international alliances. First, we propose that informal institutions give rise to tacit (Polanyi, 1966) and elusive differences between international alliance partners and as a result their impact on firm innovation performance is approximately sigmoid. Second, we argue that

formal institutions give rise to explicit and codified (Polanyi, 1966) differences between international alliance partners and as a result the effect of formal institutional differences in international alliances on firm innovation performance resembles an inverted U-shaped pattern. Our study complements existing literature, which proposes a linear effect between institutional differences and international alliance performance, and sheds new light on existing conflicting empirical evidence (Lyles and Salk, 1996; Parkhe, 1991; Simonin, 1999).

Indeed, existing empirical literature on the role of institutional differences on the performance of international alliances and partners is highly ambiguous and emphasizes greatly the role of informal institutions compared with formal institutions. A part of this literature finds informal institutional differences to be insignificant in determining alliance performance (Fey and Beamish, 2001); another favours local alliances over international ones (Hennart and Zeng, 2002; Mowery et al., 1996); and a remaining group of studies shows that alliances between partners from different informal institutional settings perform better compared with domestic alliances (Park and Ungson, 2001).

Our study contributes to the extant literature in several ways. First, by distinguishing between the different character, explicit and tacit, of formal and informal institutions we provide a solid foundation for theorizing about international alliances and their effect on firm innovation (Dunning and Lundan, 2008; Estrin et al., 2009; Gelbuda et al., 2008; North, 1990). Second, this work enriches our understanding of the role of institutions in firm innovation from international alliances, contributing to the literature on alliance performance and management. These contributions are appealing as institutions determined at the national level have long been argued to facilitate firm innovation and to influence cross-national differences in firm innovation competitiveness (Lundvall et al., 2002; Lundvall, 1992). However, how institutional differences may influence firm innovation from international alliances is not yet thoroughly explored. This paper could inform managerial practice and decision making with regards to internationalization

in alliance portfolios (Bierly and Gallagher, 2007; Madhok, 2006; Yung-Chul, 2008). Finally, this study explores an original empirical setting using a bespoke dataset of innovation alliances initiated by 110 UK biopharmaceutical firms between 1991 and 2001.

The remainder of this paper is structured as follows. Section 2 discusses the existing empirical literature and elaborates on the role of institutional differences in firm innovation from alliances. Section 3 elaborates on the type of liabilities raised by formal and informal institutions and develops our hypotheses. Section 4 discusses the methodological approach, the data sampled and empirical variables used. Section 5 provides our analysis and results, and Section 6 discusses our findings and concludes the paper.

Background and Literature Review

Liability of Foreignness and International Alliance Performance. The national systems of innovation literature (Lundvall, 1992; Nelson, 1993) argues nation-specific characteristics, embedded in national institutions, such as the educational, legal, intellectual property and financial systems, to underpin firm competitiveness and innovation performance. For example, the strength and characteristics of such institutions have contributed to the enduring competitiveness of the UK's pharmaceutical industry (Georghiou, 2001; Nelson, 1993). The role that national institutions can play in firm innovation becomes particularly apparent in cases of institutional transformations and transitions in political systems. Liberalization of markets could strengthen aspects of national institutions over time, boost investments in R&D, encourage an entrepreneurial ideology, and foster innovation and local capacity for learning (Steensma et al., 2005). The international business literature has emphasized the importance of the institutional perspectives as a key determinant of firm structure and behaviour (DiMaggio and Powell, 1983; North, 1990; Scott, 1995). Scott's (1995) institutional perspective, encompassing the regulatory, normative and cognitive pillars, is mainly employed discussing the development of appropriate

entry mode decisions, and in particular gaining corporate legitimacy in the local context (Xu and Shankar, 2003; Luo, 2001; Meyer, 2001). The institutional perspective which also encompasses and operationalizes the distinct but related aspects of informal and formal institutions (Edquist and Johnson, 1997; North, 1990), is more appealing in understanding how the “liability of foreignness” shapes partners asymmetries in alliances. Therefore, our study is grounded in a relatively broad conception of formal and informal institutions which we view as a framework to provide guidelines to depict partners’ knowledge exchange, sharing and learning in alliances¹ shaped by institutional differences. Research in this domain also argues, cross-border partners represent the values and norms of the institutions determined at their home nation (Hennart and Zeng, 2002; Park and Ungson, 1997; Parkhe, 1991; Shenkar and Zeira, 1992).

Herein, we determine formal and informal institutions as follows. Formal institutions give rise to cross-national differences due to employment regulations, intellectual property systems and appropriability regimes, business systems and rules of operation, the functioning of financial markets, and levels of fiscal and economic stability (North, 1990). Informal institutions are systems of shared meanings embedded in norms, values, beliefs and collective understanding of a society, that are not codified into documented rules and standards (North, 1990). Representing shared values and non-codified standards, culture is an important reflection of national informal institutions and reflects a socially constructed reality-shaping cohesion, logics of action, and coordination among individuals within a society (North, 1990; Orr and Scott, 2008; Peng et al., 2008). Literature indicates social norms and cognition are influenced by national culture, provide a foundation that shapes how individuals view the world (Chui et al., 2002), and may influence how they make sense of events occurring in that world (Witt and Redding, 2009), helping them to interpret explanations offered by others (Zilber, 2006). Informal

¹ In this paper we use the term alliances to refer to any type of collaborative agreement between two or more organizations (Gulati, 1998). These agreements can take any form and may involve equity ownership or joint ventures.

institutions represent cultural-cognitive elements by influencing attitudes to work, ways of thinking and behaving, perceptions of organizational purpose, communication, approaches to problem solving and conflict resolution (Cullen et al., 1995; Szulanski, 1996).

Institutional frictions can increase the costs of conducting business in countries embedded in disparate institutions, due to the increasing unfamiliarity of a firm with the local institutional setting (Brouthers et al., 2008; Scott, 1995). Increasingly unfamiliar institutional environments lead to higher unfamiliarity hazards, reduced transparency, uncertainty, and to a lesser degree, of international partners building trust (Mahoney, 1992). Firms facing large institutional differences with their alliance partners bear escalated alliance coordination costs, due to the magnified information asymmetries and the higher partner-related risks (Meyer, 2001), which in turn necessitate spending a greater amount of resources on information searching (Tong et al., 2008).

Existing empirical research shows the relationship between national institutional differences and firm performance from alliances to be multifaceted (Hennart and Zeng, 2002; Park and Ungson, 1997; Parkhe, 1991; Shenkar and Zeira, 1992). As detailed below, the thrust of this literature focuses either on exploring the role of country-wide differences between alliance partners on their performance, or on the role of national cultural differences (Hofstede, 1980), a means of capturing informal institutions². Research shows that, despite higher cultural differences, alliances between U.S. and Japanese partners last longer compared with alliances between U.S.-U.S. and U.S.-European partners (Park and Ungson, 2001). This evidence runs contrary to expectations that cross-cultural differences establish barriers to effective international collaboration. Park and Ungson (2001) attribute their findings to certain characteristics of the Japanese culture, such as the value attributed to collaboration, loyalty, commitment, receptivity

² The international business literature has used cross-national cultural differences to refer to informal institutional differences (Estrin et al., 2009).

and goodwill, which could facilitate trust and cross-partner knowledge sharing in alliances (Hamel, 1991). Fey and Beamish (2001), using data from Russia, find cultural differences between alliance partners to have an insignificant impact on performance.

Other research finds U.S.-Japanese partnerships to exhibit inferior performance compared with domestic (U.S.-U.S.) partnerships (Mowery et al., 1996). Hennart and Zeng (2002) also find support for domestic alliances being more effective than international. Although the authors attribute this to cultural conformity, their empirical operationalization—country-specific dummy variables (see also Mowery et al., 1996)—it is not tailored to measure national culture (Hofstede, 1980; Witt and Redding, 2009) and it accounts for broad differences across nations. This is addressed in Lyles and Salk (1996), that find cultural conflicts and misunderstandings to have a significant negative impact on knowledge exchange between international joint venture partners, but only when partners share equity, control and management of the venture. There is broader empirical support of the negative implications of cultural differences in international alliances on performance (Barkema et al., 1996; Barkema and Vermeulen, 1997). Only recently has the alliance literature explored nonlinear relationships on the role of international institutions on partners' performance. Evidence from a sample of software firms shows the overall level of internationalisation³ of alliance portfolios to have a sigmoid impact on partners' financial performance, with performance first declining, then improving and finally declining again as internationalization levels increase between partners (Lavie and Miller, 2008). Although an important contribution, Lavie and Miller's (2008) work does not address the differing character of formal and informal institutions in international alliances.

³ Lavie and Miller (2008) proxy alliance portfolio internationalization with an aggregate measure, comprising institutional (formal and informal) and geographic distance between alliance partners.

International Alliances and Firm Innovation Performance. Alliances can enhance firm innovation performance by providing the opportunity to access and acquire complementary capabilities (Grant and Baden-Fuller, 2004; Rothaermel, 2001; Rothaermel and Hill, 2005). Alliances with international partners could convey richer opportunities for firm innovation, as they provide access to distinct capabilities and resources compared with those domestically available. A certain extent of difference in cross-partner knowledge bases is conducive to firm innovation, as it widens the variation of knowledge accessible to partners (Mowery et al., 1996, 1998; Sampson, 2007). International alliances provide exposure to diverse markets, stimulating innovations to competently meet local, idiosyncratic demand. International alliances provide access to knowledge that not only is firm-specific (Eisenhardt and Schoonhoven, 1996; Nelson, 1991; Nelson and Winter, 1982) but also highly geographic and nation-specific (Jaffe et al., 1993). The sustainability and persistence of institutions at the national level underpin differences in the competitiveness of firms across nations, and drive international collaboration as firms strive to tap into international centers of excellence, or to compensate for home-country resource and capability deficiencies. Indeed, the drivers of R&D internationalization are similar (e.g., Ma et al., 2013; Patel and Pavitt, 1991).

Increasing internationalization in alliances widens the variety of knowledge accessible to firms, enhancing the richness of opportunities for innovation, as partners tap into knowledge of greater diversity, new technologies and trends in demand (Eisenhardt and Schoonhoven, 1996; Hagedoorn, 1993). Indeed, early writings in innovation emphasize the importance of connecting to varied knowledge (Schumpeter, 1934) in firm innovation. The literature on networks and alliances argues access to diverse knowledge enriches the knowledge pool that firms can use to guide problem solving, in turn increasing the possibilities of finding novel solutions and enhancing innovation (e.g., Capaldo, 2007).

Differences arising from both formal and informal institutions could enrich diversity of knowledge accessible to firms in international alliances. Embeddedness in formal institutional settings that foster the logic of collaboration influences firm's ability to manage its partnerships and recombine the knowledge residing in its network, as well as the extent of knowledge flows among network participants (Gurneeta and Zaheer, 2013). Exposure to increasingly different formal institutions in alliances could facilitate firm innovation performance, as firms become more knowledgeable of the diverse regulatory regimes underpinning research, benefit from preferential legal frameworks surrounding emerging technologies, and become more familiar with the functioning and rules of different intellectual property regimes (e.g., Levinson and Asahi, 1995). In biotechnology, for instance, alliances with U.S. firms allowed UK firms to benefit from stem cell research due to the more favorable indigenous legal system compared with the UK (Argyres and Liebeskind, 1998; Kaiser and Prange, 2004). International alliances allow firms to observe how formal institutions are translated and employed within specific organizational and industry contexts (see Gurneeta and Zaheer, 2013). This may facilitate the efficacy of technical research, as firm innovation processes are more likely to accommodate and comply with international rules and standards. Similarly, increasingly diverse informal institutional systems provide exposure to varied approaches and attitudes to problem definition and solving, a richer set of heuristics and diversity in systems for managing and integrating knowledge that could benefit firm innovation performance (e.g., Park and Ungson, 2001).

Despite institutional differences being potentially conducive to partners' innovation, international alliances accentuate the challenges of knowledge sharing between partners. Accessing increasingly diverse knowledge can constrain firm's processing, internalizing and coordination abilities to the detriment of firm performance and innovation (Katila and Ahuja, 2002; Laursen and Salter, 2006). Increasing cross-partner differences pose challenges on the absorptive capacity of partners (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998). The

relative ability of partners to identify, absorb and use knowledge brought to the collaboration is fundamental to effective knowledge sharing in alliances (Lane and Lubatkin, 1998). Relative absorptive capacity allows partners to first establish a common language facilitating their collaboration and, second, to build interorganizational routines⁴ for effective management of their interaction (Zollo et al., 2002). Such routines include patterns of action for joint problem solving, contractual compliance, intellectual property sharing and improve firm performance from alliances (Heimeriks and Duysters, 2007; Heimeriks et al., 2007; Heimeriks et al., 2009). Gradually firms may develop superior alliance management capabilities by redeploying such routines across alliances, developing standardized approaches for alliance management, and refining and adapting alliance routines based on experiential and deliberate learning (Anand and Khanna, 2000; Kale and Singh, 2007). Such alliance management capabilities are limited in enabling firms to effectively manage an ever-increasing number of alliances (e.g., Rothaermel and Deeds, 2006) and alliances of a higher learning content (Anand and Khanna, 2000).

The Distinct Liabilities of Formal and Informal Institutions and their Role in Firm Innovation Performance from International Alliances

This paper proposes that it is not only the extent but also the type of difference (due to formal or informal institutions) between international alliance partners that affects innovation performance from such alliances. We argue the nature of institutions to be explicit (formal) or tacit (informal) and as a result we conceptualize distinct and nonlinear relationships between such institutional differences in alliances and partners' innovation performance. Partners exhibit different attitudes and abilities to negotiate and address such differences due to the differing character of formal and informal institutions.

⁴ Interorganizational routines are also referred to as collaborative or alliance routines in this paper.

Partners from more proximate and institutionally symmetric nations, with respect to informal institutions, are more able to establish a smooth collaboration, as conformities in perception and attitudes towards problem solving allow them to establish a shared meaning of rules of engagement to underpin their collaboration. This facilitates knowledge and resource sharing (Lane and Lubatkin, 1998; Mowery et al., 1996), inducing partners to focus on how they can combine their knowledge and take advantage of their different competences to foster their innovation performance. Indeed, Lane and Lubatkin (1998) supported that congruence in partners' perception of their external environment, practices for knowledge management, attitudes to problem solving and worldviews can facilitate knowledge sharing in alliances. Therefore, we expect that, at low levels, differences due to informal institutions would not substantially impair collaborations, and that partners' relative absorptive capacities (Lane and Lubatkin, 1998) would enable them to establish effective communication channels to leverage the innovation potential of international alliances. Returns to firm innovation performance are expected to be low, as the extent of diversity introduced still remains at low levels.

Informal institutions give rise to tacit and elusive differences between international alliance partners. Such differences, influencing the interpretation and responses to strategic and managerial issues, are difficult to be fully perceived and recognized (Chui et al., 2002; Park and Ungson, 2001), making their conscious accommodation within existing alliance routines uncertain and less timely. Informal institutional differences incorporate linguistic barriers, and involve partners' awareness of cultural-cognitive elements such as nonverbal cues and body language⁵. This affects knowledge sharing in alliances, as there are barriers in interpreting and understanding the exact meaning of knowledge that is contributed to the collaboration (see Lane and Beamish, 1990). This is particularly relevant for tacit knowledge transfer, such as

⁵ The international business literature has used language as one of the key factors of cultural differences across nations that has been found to prevent information about the local market from reaching headquarter decision makers (see also Dow and Karunaratna, 2006; Johanson and Wiedersheim-Paul, 1975).

management beliefs, experiences, and contextualized practices, including team-based R&D and business-process development, as they are better facilitated by face-to-face communication (DiMaggio and Powell, 1983). Lack of full awareness about the nature, extent and type of barriers to an effective collaboration reduces partners' aptitudes to employ the appropriate alliance routines. Existing literature supports that partners' inaccurate judgment of the factors raising barriers to effective collaboration may procrastinate addressing cross-partner differences and can trigger the application of unsuitable routines and inappropriate business and alliance specific practices (Heimeriks, 2010). As cross-partner differences due to informal institutions increase, firms are constrained in fully detecting, perceiving and consciously overcoming such barriers to effective interaction, with the conducive implications of knowledge diversity in alliances for firm innovation not being fully leveraged, resulting in firm innovation performance experiencing a likely stagnation or a slight decline.

As informal institutional differences in international alliances increase further, firms are becoming more observant, aware and perceptive of how such differences can pose barriers to effective knowledge sharing in alliances. Increasing awareness could facilitate partner agility and willingness to invest in additional time and alliance-specific resources necessary to explicitly and directly manage differences (Dyer and Hatch, 2006; Dyer and Singh, 1998). Existing literature supports that investments in cross-cultural training, recruitment of personnel with higher levels of education and with prior exposure to diverse cultures can facilitate the management of cross-cultural conflicts in alliances (Shenkar and Zeira, 1992). Indeed, higher informal institutional differences require higher investments in resources for effective practice transferring, as firms need to recruit and train staff to develop a workforce with qualifications and values that fit their partners' practices, and to create local structures that bridge the institutional differences with their partners (Dow and Karunaratna, 2006; Witt and Redding, 2009). Firms can accommodate existing alliance routines, or develop new ones, through investments in training, and consultancy

advice (Kale and Singh, 2007; Zollo and Winter, 2002), improving the resolution of conflicts and misunderstandings in alliances and facilitating partners in bridging their cultural differences. This has implications on firm innovation performance, which it is expected to increase, because firms can manage more effectively the frictions caused by informal institutional differences and are better positioned to combine and exchange the increasingly varied knowledge offered in international alliances.

However, the abilities of firms to manage cross-cultural differences in alliances become increasingly constrained as firms start to progressively manage a greater extent of difference in alliances (Deeds and Hill, 1996; Rothaermel and Deeds, 2006). The higher the coordination challenges raised by cross-partner dissimilarities, the faster will firms face such constraints (Rothaermel and Deeds, 2006). Increased levels of cross-cultural differences result in relational ambiguities and mistrust that impair learning (Parkhe, 1991), because they impede communication channels (Szulanski, 1996) and weaken firm's ability to absorb its partners' knowledge, leading to lower alliance performance (Johanson and Wiedersheim-Paul, 1975). Innovation-focused alliances are highly uncertain and risky, and often demand frequent reviews in light of unforeseen research results. Extensive differences in partners' perception and cognition can affect the timely resolution of any disagreements on such project revisions (Orr and Scott, 2008; Peng et al., 2008). In addition, Barkema and colleagues note that an international alliance is less likely to survive when cultural differences between alliance partners are large, due to the weaker ability of the firm to effectively operate the alliance (Barkema et al., 1996; Barkema and Vermeulen, 1997; Barkema et al., 1997). Increasing informal institutional differences heighten the barriers in firms' ability to implement firm-specific practices to the collaboration, as partners' cross-cultural differences make their attitudes and approaches to work exorbitantly distant (Björkman et al., 2007). The amount of investment in resources necessary to bridge cross-cultural differences increases further, imposing high constraints on the effectiveness

of cross-partner knowledge and resource sharing. We argue that, as informal institutional differences expand, the alliance coordination challenges compound constraining firms' abilities to manage alliances effectively and to benefit from the knowledge variation in alliances, leading to declining innovation performance (see Eisenhardt and Schoonhoven, 1996; Hagedoorn, 1993; Lavie and Miller, 2008). Existing literature supports the costs of combining knowledge of increasingly widening scope to be dynamically increasing, which alludes to our expectations of diminishing returns (Katila and Ahuja, 2002). This relates to the heightened costs of establishing effective interfaces across elements of knowledge that are increasingly varied and the costs associated with the need to alter communication relationships to accommodate such integration (ibid.). Literature on returns from alliances has argued for diminishing and eventually declining performance as firms access increasingly varied knowledge (Laursen and Salter, 2006; Rothaermel and Deeds, 2006).

Hypothesis 1: The relationship between informal institutional differences in international alliances and firm innovation performance is approximately sigmoid, with innovation performance first declining slightly, then improving, and finally declining again with increases in informal institutional differences.

The nature, effectiveness and transparency of formal institutions introduce cross-partner differences in international alliances that are explicit, visible in advance to ensuing the collaboration, making such differences more easily addressable compared to informal institutional differences. The legal system underpinning research, intellectual property laws, and the nature of financial institutions and markets, are manifested in tangible and explicit form. This allows partners to readily access information on the requirements of disparate formal institutional settings and to explicitly negotiate any related cross-partner incongruences likely to affect

international collaboration. For example, it is intuitive to expect that aspects of formal institutional differences are likely to be negotiated in advance and accommodated in clauses forming the contracts underpinning alliances (Chang and Rosenzweig, 2001).

Due to the higher transparency of formal institutions, firms are able to identify and use the appropriate alliance routines to manage and overcome disparities in cross-partner business practices arising from such institutional differences. Partners can learn about the functioning of foreign formal institutions, obtain access to related networks and become familiar with nation-specific industrial standards, regulatory requirements and procedures (Levinson and Asahi, 1995). Gathering intelligence on foreign institutions improves compliance with international rules and regulations which can enhance firm innovation performance (*ibid.*). At low levels of difference, cross-national formal institutions are still more familiar than distant, making international differences more easily to be handled and accommodated within existing alliance routines. Such standardized approaches to collaboration can be particularly effective when firms face little variation in alliances (Heimeriks, 2010). Therefore, such levels of dissimilarity due to formal institutions are not substantially threatening collaboration effectiveness, and are not expected to pose considerable barriers in accessing knowledge and resources in international alliances (e.g., Gurneeta and Zaheer, 2013). This is beneficial for firm innovation performance as firms can access knowledge from diverse partners (e.g., Capaldo, 2007).

However, formal institutional differences can pose formidable barriers to international collaboration when rising at higher levels. For instance, extensive differences in the functioning of financial markets may introduce conflict into alliances, as partners may prioritize different types of outputs and time horizons to achieve them (Park and Ungson, 1997). This leads to disparities in alliance goals-setting, creating disagreements during alliance revisions and reevaluations, prolonging negotiations between partners and necessitating additional resources. Increasing diversity in formal institutional settings due to differing legal systems, gives rise to

higher transaction and coordination costs as it increases the costs of contracting (Chang and Rosenzweig, 2001). Differences in formal institutions have been found to inhibit the transfer of business practices to international alliances (Kostova and Roth, 2002). Differences in antitrust and competitive laws establish different frameworks underpinning international alliances and can influence the extent of partners' openness to the collaboration and the level of transparency in alliances (Parkhe, 1991). Acute differences in intellectual property laws become particularly relevant for innovation-focused alliances and can affect partners' abilities to retain fairness in appropriating innovation return from alliances. Indeed, the risks of undesirable resource spillover and misappropriation of value increase with the disparity in the level of economic development between partners (Hamel, 1991; Lavie, 2006).

The complexity and diversity rooted in regulatory, legal, and economic factors have important implications for learning and coordination (Li et al., 2012). Large administrative, and economic differences between cross border partners lead to bounded-rationality constraints on the management of alliances (see Rugman and Verbeke, 2007) increasing the costs of accommodating such differences within alliance management practices. Owing to such dissimilarities, a firm's ability to absorb and use valuable resources and knowledge of institutionally distant partners becomes constrained (Phene et al., 2006), undermining partners' ability to effectively share knowledge, adapt, and coordinate their value-adding activities (Meyer, 2001; Slangen and Beugelsdijk, 2010; Tong et al., 2008). As formal institutional differences between partners broaden, firms experience higher inefficiencies in bridging such differences and leveraging the innovation potential of international alliances. As a result, firms start experiencing diminishing returns on their innovation performance, with performance subsequently experiencing a potential decline. Indeed, studies on innovation performance have linked increasing access to varied knowledge from alliances to diminishing and declining returns to innovation (Laursen and Slater, 2006; Rothaermel and Deeds, 2006).

Hypothesis 2: The relationship between formal institutional differences in alliances and firm innovation performance resembles an inverted U.

Methods

Data and Sample. Our hypotheses are tested on a panel of 110 UK biopharmaceutical firms observed between 1991 and 2001. The sample includes the whole population of UK-based firms that use and develop biotechnologies as listed in the 2000 and 2002 editions of the UK Biotechnology Directory (Coombs and Alston, 2000, 2002). The biopharmaceutical sector provides an appropriate setting to explore our hypotheses. Cross-national differences in the advancement of emerging technologies are common, usually arising from wide variations in the flexibility of legal systems to establish the appropriate standards for the development of such technologies (Kaiser and Prange, 2004). For biotechnologies, the flexibility of legal systems, the provision of a coherent framework surrounding stem cell research, and the freedom of academic entrepreneurship, have all contributed to the lead of U.S.-based organizations at least during the 1990s (Argyres and Liebeskind, 1998).

Biopharmaceuticals is amongst the most alliance intensive sectors (Hagedoorn, 2002; Hagedoorn and Roijakkers, 2006), with alliances playing an important role in firm innovation (Powell et al., 1996). International collaboration is particularly prevalent in high-technology and rapidly advancing sectors such as information technologies, new materials and biotechnologies (Hagedoorn and Roijakkers, 2006). High knowledge-intensity and rapid pace of technological advance induce firms from such sectors to share technologies and to collaborate in R&D. Indeed, collaboration in research and technology sharing are common at the early stages of development of such technologies (Cainarca et al., 1992).

Data on alliances is collected from ReCap.com and BioScan, two sector-specific databases that have extensively informed previous research in this sector (e.g., Deeds and Hill, 1996; George et al., 2002). Data is collected for each firm in the sample, capturing all alliances formed between 1991 and 2001. This time period witnessed an upsurge in alliance activity (Kang and Sakai, 2000), making it particularly suitable to frame our study.

Data on the country of origin of international corporate alliance partners is gathered from Thomson's Analytics and from company websites. Data on partners' location is collected at the headquarter level based on ownership information provided by Who Owns Who (2003 edition). Location data for non-corporate partners such as universities and research centers is collected via websites. To capture firm innovation performance we use data on patents successfully filed to the UK Patent and Trademark Office (UKPTO) between 1991 and 2001. As we focus our study on UK-based independent firms and the UK subsidiaries of multinational enterprises, it makes sense to use the UKPTO data. Information on patents granted is obtained through the publicly available data source Esp@cenet. We identify patents granted by the UKPTO to the firms in our sample by matching the address of the patent assignee to those of the firms in our sample (Arora et al., 2011). We account for potential changes in addresses and variations in firm names over time by tracing firm records in FAME. Moreover, we use information on inventors' location to identify any additional patents of firms in our sample, that although assigned to their headquarters, had at least one inventor employed by a firm in our sample. Inventor's location can signal patents stemming from collaborations across dispersed corporate R&D units (Patel and Vega, 1999). Finally, we use company accounts, obtained by FAME and Thomson's Analytics, to collect information on firm-level indicators, such as number of employees and corporate affiliations. Information on R&D is collected from Thomson's Analytics and the R&D Scoreboard.

Measures

Dependent Variable. Following existing literature exploring firm returns from alliances (Hagedoorn and Schakenraad, 1994; Sampson, 2005; Shan et al., 1994) we use patent counts to capture firm innovation performance. Patents are a good proxy for innovation especially in science-based sectors such as biopharmaceuticals (e.g., Ziedonis, 2008).

Patent data have several limitations (Griliches, 1990; Pavitt, 1985). Using a sample of firms operating in the same sector and exploiting the statistical strengths of panel data models helps to alleviate some of these limitations. First, firms experience different propensities to patent, however, such variation is of concern especially when sampling firms across nations and industries (Cantwell, 1989). Second, variation over time in opportunities to patent, due to changes in appropriability regimes, legal systems, technological opportunities and economic growth (Pavitt, 1985) can be accounted for by time specific heterogeneity in panel data models. Finally, we use patent filing rather than publication dates to better approximate the time of innovation, due to the differences between publication and application dates varying over time depending on resource availability and variation in patent office working practices (Jaffe, 1986).

Core Independent Variables. The indicators used to measure formal and informal institutions provide a fine grained approach to operationalize cross-national differences compared to the use of country-specific dummy variables (Hennart and Zeng, 2002; Mowery et al., 1996). The role of informal institutions in raising barriers to international collaboration has been captured by indicators of national cultural differences (Lavie and Miller, 2008; Park and Ungson, 1997) as measured by Hofstede (1980). Following existing research on alliances (e.g., Lavie and Miller, 2008), we measure informal institutional differences between a focal firm and its international alliance partners by using information on the cultural differences between alliance partners' countries of origin and the United Kingdom, as the firms in our sample are UK-based. Cultural

difference is computed by using Kogut and Singh's (1988) index of Hofstede's (1980) four dimensions of culture: uncertainty avoidance, individuality, tolerance of power distance, and masculinity-femininity⁶. Kogut and Singh (1988) designed an overall index which defines the cultural difference between a given nation and other nations as follows (Formula 1):

Formula 1

$$(\text{Cultural distance } _j) = \sum_{i=1}^4 \left\{ (I_{ij} - I_{iu})^2 / V_i \right\} / 4$$

Where, I_{ij} stands for the index for the i th cultural dimension and j th country, V_i is the variance of the index of the i th dimension, u indicates the nation from which the cultural difference is calculated (which is the UK in this paper) and cultural difference j is the cultural difference of the j th country from the UK. Formula 1 is used to estimate cultural difference between the UK and the country of origin for each one of the alliance partners. These differences are averaged across the total number of international alliances established by each firm in our sample per year.

Cross-national differences due to formal institutions are approximated by using information on the quality of formal institutions enforced across nations. Our contentions suggest that regulatory, economic and legal institutional differences may impact the collaboration, in terms of knowledge transfer and firm ability to innovate. Country-level data is gathered annually to construct indicators reflecting the quality of such institutions. Therefore, in line with a number of empirical studies, we proxy formal institutions by items selected from the economic freedom

⁶ We acknowledge that recent discussions in the literature question such notion of *distance* and argue that *friction* captures better the impact of cultural, or informal institutional differences (Shenkar, 2001; Shenkar et al., 2008). Nevertheless empirical studies invariably employ distance-based constructs and measures and their findings indicate that the various proxies for such difference are broadly consistent (Dow and Larimo, 2011; Drogendijk and Slangen, 2006; Estrin et al., 2009; Kim and Gray, 2008).

index developed by the Heritage Foundation (Berggren and Jordahl, 2005; Meyer et al., 2009; Stroup, 2007). This index provides aggregate annual values including evaluations of a country's systems in relation to business activity, trade, investment, labor markets, financial freedom, freedom from corruption and property rights. In addition, previous studies have highlighted that the index is highly correlated with other, possibly alternative, proxy measures such as the Global Competitiveness Report (World Economic Forum) or the World Bank indicators (Berger and Bristow, 2009; Hanke and Walters, 1997). We computed the average formal institutional difference a focal firm faces in its international alliances by using the absolute value of the sum of the differences between the Heritage Foundation values for the UK and the countries residing each one of its international alliance partners. These values are averaged over the total number of international alliances established per year.

Control Variables

Accumulated Alliance Experience. We include a measure of a firm's accumulated experience in managing alliances, as it can positively affect a firm's ability to enhance its performance from alliances (Hoang and Rothaermel, 2005; Kale et al., 2002; Kale and Singh, 2007; Rothaermel and Deeds, 2006). By accumulating experience firms "learn-by-doing" how to manage alliances and how to overcome potential frictions and coordination problems. Firms with greater experience are more likely to develop a range of alliance routines and to invest in further developing and refining such routines to accommodate new alliance requirements (Kale and Singh, 2007). Consistent with the literature, we measure alliance experience at each year t as the natural logarithm of the stock of the accumulated alliances each firm formed since 1991, and to more accurately capture the contribution of alliance experience we lag these values by one year (Lavie et al., 2011).

Co-located Alliances. We estimate the within-nation alliance activity of each firm in our sample by the total number of alliances each firm establishes within each year t with alliance partners located in the same country. We use information at the headquarter level to assess co-location. This introduces consistency across our location data, as location of alliance partners can only be identified at the headquarter level⁷.

Alliance Content. Alliances may offer different opportunities for firm innovation depending on their content (e.g., Anand and Khanna, 2000). Innovation-focused alliances can exhibit wide variation in content, as they may involve a combination of R&D, collaborative research, technology licensing, joint production, marketing and manufacturing. Existing research argues alliances of pure R&D focus to bear higher opportunities for innovation compared with alliances for further product development (see Hagedoorn and Schakenraad, 1994). Following the literature (Zollo et al., 2002), we account for alliance content by including a dummy variable which takes the value of 1 for each year t that a firm establishes an alliance that contains R&D and/or joint research and the value of 0 otherwise.

Firm Size and Investments in R&D. Finally, we account for two established firm-level indicators of innovation: firm size and investments in R&D. Firm size, is captured by total number of employees. This is more appropriate to turnover, as the later may not adequately reflect the size of resources and the activities undertaken by firms in this sector (Daly, 1985)⁸. Investments in R&D account for cross-firm differences in directing resources to innovation generating activities (e.g., Cohen, 1995). We use natural logarithmic transformations of both of these variables to adjust for skewed distributions.

⁷ We estimated our models using the alternative operationalization, when feasible. Our results remained the same.

⁸ The use of turnover did not affect our empirical results.

Analysis and Results

Distribution of International Alliances per Country of Origin and Descriptive Statistics. Figure 1⁹ shows the distribution of international alliance partners' country of origin. International alliance partners are distributed across twenty-seven nations, with the vast majority being located in the USA (59%), with Germany (5.5%), Japan (4.4%) and France (3%) following the U.S. lead. UK-based partners reflect 17.7% of the cases. The attractiveness of U.S.-based partners may reflect the prowess of the country in biotechnologies. The UK, Germany and France are the most developed European nations in this sector during the period studied (e.g., Kaiser and Prange, 2004).

Insert Figure 1 about here

Table 1 provides information on descriptive statistics and bivariate correlation coefficients for all variables used in our empirical analysis.

Insert Table 1 about here

Firms in the sample obtained 0.328 patents on average between 1991 and 2001. The average firm values of formal and informal institutional difference in international alliances are 3.482 and 0.419 respectively. There is a significant correlation between these two variables, whilst correlations remain at acceptable levels (0.581). Firm size and investments in R&D are

⁹ Values and percentages refer to the alliance level. There is a total of 2,442 alliances formed between 1991 and 2001, whilst data on partners' head-quarter location is available for 1,774 alliances.

highly correlated (0.763), which consistently reflects an established pattern in the innovation literature supporting these two variables to evolve in the same direction (Cohen, 1995).

Econometric Analysis. To test our hypotheses we employ count dependent variable models for panel data, as our dependent variable, number of patents, takes only positive integer values. Count dependent variable models can follow the Poisson and Negative Binomial distributions. The Poisson assumes that the mean and variance of the dependent variable are equal, a strong assumption when there is overdispersion in the data (Greene, 2003; Wooldridge, 2002), in which case the Negative Binomial is preferred.

A virtue of the Poisson fixed-effects (FE) model over its Negative Binomial counterpart is that its estimates do not rely on the assumption of exogenous independent variables¹⁰. Exogeneity is a strong assumption in most empirical research, with only a limited research explicitly addressing it (Bascle, 2008)¹¹. Accounting for endogeneity requires a two-step empirical relationship exploring: first, firm's decisions to form international alliances, and second, the implications of such alliances on firm innovation performance (see Lavie and Miller, 2008). However, due to both innovation performance and international alliances being captured by count variables, it is statistically infeasible to estimate a two-step model (Greene, 2003; Quintana-García and Benavides-Velasco, 2008). Therefore, the FE specification becomes preferable, as it does not rely on the assumption of exogeneity. As this holds true for the FE specification of the Poisson model but not for the Negative Binomial, we employ the Poisson FE model developed by Wooldridge (1999) that corrects standard errors for

¹⁰ This is an advantage of the fixed-effects (FE) panel data specification over the alternative random-effects (RE). However, the Negative Binomial FE specification does not comply with this, as in obtaining its estimates the model emphasizes the sources of overdispersion rather than those of firm-specific heterogeneity.

¹¹ There are two exceptions within the alliance literature, Lavie et al. (2011) and Lavie and Miller (2008), which focus on financial performance.

overdispersion. This model is commonly employed in existing research (Czarnitzki et al., 2009; Huang and Murray, 2010).

Insert Table 2 about here

Table 2 provides estimates for the Poisson FE model with standard errors corrected for overdispersion (Wooldridge, 1999)¹² explaining the number of successful patents filed to the UKPTO by the firms in our sample. The unit of analysis remains the firm and the econometric models include variables both at the firm and alliance levels as is customary in research in this literature (Lavie and Miller, 2008; Zollo et al., 2002).

Model 1, as is customary in existing research, examines linear relationships of formal and informal institutional differences in alliances to firm innovation performance. First, it shows that both informal institutional differences and alliances with co-located partners positively affect firm innovation performance, suggesting there are two opposing forces affecting firm innovation. This reflects existing conflicting findings, with some studies favouring international alliances (e.g., Park and Ungson, 2001) and other studies favouring domestic (e.g., Hennart and Zeng, 2002; Mowery et al., 1996). Second, Model 1 shows a negative but insignificant relationship between formal institutional differences between alliance partners and firm innovation.

Model 2 provides support for both our hypotheses. Starting from the control variables, alliances between co-located partners are found to enhance firm innovation performance. This is consistent with expectations within institutional theory, suggesting that institutional alignment in

¹² To test whether there is overdispersion in our dataset, we rely on a standard routine available in STATA. This entails running the Negative Binomial model on the pooled cross-section time-series data, and identifying overdispersion by examining the deviance of the error terms against the degrees of freedom using the Chi² distribution. A significant Chi² statistic shows significant overdispersion in the data. The Chi² statistics for Models 1 and 2 (Table 2) are 22.21 and 27.91 respectively; both are statistically different from zero at the highest levels of significance supporting overdispersion.

alliances eases partners' ability to leverage their innovation potential. Second, the dummy for alliances containing R&D appears negative and significant. This seems counterintuitive, but it could be a result of the higher coordination challenges posed by R&D alliances due to their higher learning content (e.g., Anand and Khanna, 2000). Model 2 supports the relationship between formal institutional differences in international alliances and firm innovation performance to resemble an inverted U, suggesting that differences due to formal institutions between alliance partners could enhance firm innovation performance with the turning point being estimated to 2.779, which is below the median in our sample (3.453). The turning point in our dataset is comparable to the level of difference in the quality of formal institutions between the UK and the U.S. as measured by the Heritage Foundation in 2000 (2.1926) but almost double the difference between these two countries in 2001 (1.4692). Graph 1 depicts the estimated relationship between average formal institutional difference in alliances and firm innovation performance. It shows that differences in patenting performance between firms that lay below with those that lay beyond the turning point are marginal, as the turning point corresponds to 1.189 patents.

Insert Graph 1 about here

Model 2 shows that informal institutional differences between international alliance partners have a sigmoid impact on firm innovation performance (significant effect of a negative linear term, positive quadratic and negative cubic terms). Graph 2 depicts the S-shaped relationship as predicted by Model 2 estimates.

Insert Graph 2 about here

A close inspection of Graph 2 suggests the S curve to appear rather flat at low values of average informational institutional difference (AIID). The maximum point of inflection is achieved at 1.9373 points of AIID which corresponds to 2.7149 patents. We should note that less than 5% of our observations exceed this level of AIID, suggesting that the estimated decline in firm innovation performance which could occur beyond this point might not be substantially represented in our dataset. To contextualize our information, the cultural difference between the UK and the U.S. is 0.079, while that between the UK, Germany and Japan is 1.436 and 2.449 points respectively¹³. As a test of robustness, we estimated semiparametric regressions for panel data and the resulting graphs provide further support for our hypothesized relationships between formal, informal institutional differences in international alliances and firm innovation performance¹⁴.

Discussion and Conclusions

This study explores the role of the institutional perspective in providing a fruitful foundation to understand firm innovation returns from international alliances. Although the role of national institutions in firm innovation has been explored (Lundvall, 1992; Nelson, 1993), little is known about how alliance partners' institutional backgrounds shape their innovation returns from alliances. This paper highlights that both the nature of institutions and their extent are important in understanding the intricacies of the relationship between international alliances and firm innovation. The paper supports the idea that formal and informal institutions are of explicit and tacit character respectively, with different impacts on partners' ability to address and negotiate such institutional differences with their international alliance partners. As a

¹³ We should note that our estimates remain robust to alternative model specifications (Negative Binomial and Random-Effects).

¹⁴ We would like to acknowledge the suggestion of the reviewer encouraging the pursuance of the robustness check.

result, formal and informal institutional differences exhibit distinct and nonlinear relationships with firm innovation performance from such alliances. Existing research has mainly explored how different levels of internationalization in alliances affect firm financial performance (Lavie and Miller, 2008) and the relative performance of alliances between specific pairs of nations (Park and Ungson, 2001; Mowery et al., 1996), without considering the differing character of formal and informal institutions and their potential implications on firm innovation. Existing literature that separates formal and informal institutions tends to focus on the role of informal institutions and relatively less is known about the distinct role of formal institutions. This might overlook the tandem nature of formal and informal institutions.

The effects of formal and informal institutional differences in international alliances and firm innovation are found to be different, approximating sigmoid and concave patterns respectively. Arguing that informal institutional differences in international alliances are of a tacit character allows considering the interplay between the innovation potential and the coordination challenges of such alliances. At low levels of informal institutional differences, partners are less able to reap the innovation benefits of exposure to different cultures, due to the tacit and elusive character of such institutions which make subtle differences difficult to be deciphered and acknowledged. We argue that at subsequent levels of informal institutional differences partners become more aware of the sources of difference and are attempting their effective management via explicit investments in alliance management practices and other resources. This enhances firm innovation performance, which is found to increase at a diminishing rate, eventually reaching a plateau. The identified approximating S-shaped pattern not only enriches existing theoretical understandings on firm innovation performance from international alliances but it also offers a comprehensive approach that could embrace existing empirical evidence of both a negative (e.g., Hennart and Zeng, 2002; Lyles and Salk, 1996; Mowery et al., 1996) and a positive relationship (Park and Ungson, 2001) between informal

institutional differences and firm performance. Our dataset provides support for an S-shaped pattern which is approximately flat at both ends. An empirical exploration of this relationship with datasets comprising a wider composition of national origin of partners compared with our data might shed more light on potential variations in the type of returns observed at both ends of the S curve.

Second, the paper argues that differences due to formal institutions, because of their explicit character, are more readily addressed by allying firms, and have an immediate positive relationship with firm innovation performance. Diminishing rates establish later on, with potential negative relationships as such differences enlarge. Our empirical exploration depicts marginal negative implications on firm performance for levels of formal institutional difference that exceed the turning point. The concave pattern provides a refined approach to understanding the implications of formal institutional differences, offering greater context to research examining either linear relationships or the relative performance of alliances between specific pairs of nations (Hennart and Zeng, 2002; Mowery et al., 1996). Existing research has not explicitly explored the separate role of formal institutions on alliance performance.

Our findings have implications for understanding the role of international alliances in firm innovation performance. The extent to which firms can enhance their innovation performance by accessing diverse knowledge in international alliances depends on both existing levels of internationalization but also on the type of institutional difference, formal or informal. Our results can provide greater discretion and flexibility to decision making on compiling portfolios of international alliances for innovation. This discretion becomes appealing as pairs of nations may be more proximate with respect to one institutional indicator as compared with the other. Of course one needs to be aware that partner choice in alliances depends on a range of other factors, such as the alliance opportunities available to firms, partners' resource

endowments, assets and capabilities (Hoffmann, 2007), which although complementing a national institutional perspective, lay beyond the focus of this study.

The broader implications of our research rise within the literature on capabilities for alliance management. Our results could suggest that both informal and formal institutional differences could potentially constrain firm innovation performance as the level of institutional diversity increases between partners. In this respect, further research stemming from this paper could contribute to the exploration of firm capabilities in managing the respective type of difference in international alliances. Indeed, Rothaermel and Deeds (2006) explore manifestations of firm alliance capabilities with respect to different types of alliances via the inflection points of nonlinear relationships. Such capabilities enable effective alliance management of more downstream alliances (6.5 alliances) compared with horizontal (4) and upstream (2.5) due to differences in the challenges posed by such alliances. However, we should note that our findings are reflecting the specific context of the UK biotechnology sector in the period observed and reflect the institutions embedding UK-based firms and the international alliances of firms in a high technology sector. As such, research on other sectors and countries is encouraged. An overarching analysis would have entailed collection of data on alliances between partners across different countries in the world and across a range of sectors.

Our results suggest that the relationship between informal institutional difference and firm innovation performance is more complex compared with formal institutional difference. This begs the question whether greater attention and adjustment of existing routines is necessary to address disparities due to informal institutions compared with formal institutions. This is a fruitful avenue for future research, as current research finds standardized alliance routines to be of limited relative efficiency when managing alliances of higher ambiguity (Heimeriks, 2010). In addition, existing literature has yet to explore the content of alliance management routines to

address the specific challenges posed by international alliances and those raised by formal and informal institutions.

We wish to make readers aware of several limitations of our work. One resonates to capturing informal institutional differences proxy by the distance construct based on Hofstede's cultural indicators. This construct is broad and it could be further disaggregated, to account for normative and cognitive aspects of institutions as defined by Scott (1995). This limitation has also been stated in other studies that have attempted to conceptualize and/or empirically capture informal institutions (Gaur and Lu, 2007; Luo and Shenkar, 2011; Xu and Shenkar, 2002b). Incorporating considerations of psychic distance (Dow and Larimo, 2011), or building upon recent proposals to measure anew dimensions of informal differences and provide distance scores (Berry et al., 2010; Brewer and Venaik, 2011; Tung and Verbeke, 2010), may provide further understanding of the different dimensions of informal institutions. Similarly, informal institutional differences may be disaggregated to a range of components. Another limitation of this research is our inability to capture the dynamics of inter-firm collaboration, likely to reflect any changes in firm behavior as partners could learn to work together and become more familiar with the type of differences raised by institutions. However, understanding such dynamics entails an in-depth case-study exploration which is beyond the scope of our present work. We believe there is a substantial contribution to be made in the literature exploring the constituents of alliance capabilities for international alliance management.

In the broader context, it could also be argued that global institutional frameworks may play a role in influencing the development of institutions at the national level, however, we believe such a role is less relevant in our analysis for two reasons. First, the international legal framework for foreign investment is far from being uniform, and it is mainly carried out at the bilateral, regional and inter-regional level (Stiglitz, 2006). Second, our data mainly reflects national institutions of firms from developed economies, such as the Triad regions, that are

capturing the common policy frameworks and incentive regimes exercised on international investment at the regional level.

References

- Anand, N.B., Khanna, T., 2000. Do Firms Learn to Create Value? The Case of Alliances. *Strategic Management Journal* 21(3), 295-315.
- Argyres, N., Liebeskind, J., 1998. Privatizing the intellectual commons: Universities and the commercialization of biotechnology. *Journal of Economic Behavior and Organization* 35(1), 427-454.
- Arora, A., Benenzon, S., Rios, L.A., 2011. The Organization of R&D in American Corporations: The Determinants and Consequences of Decentralization. National Bureau of Economic Research Working Paper 17013, Cambridge, Mass.
- Barkema, H., Bell, J.H., Pennings, J.M., 1996. Foreign entry, cultural barriers, and learning. *Strategic Management Journal* 17, 151-166.
- Barkema, H., Vermeulen, F., 1997. What Differences in the Cultural Backgrounds of Partners are Detrimental for International Joint Ventures? *Journal of International Business Studies* 28(4), 845-864.
- Barkema, H.G., Shenkar, O., Vermeulen, F., Bell, J.H.J., 1997. Working Abroad, Working With Others: How Firms Learn to Operate International Joint Ventures. *Academy of Management Journal* 40(2), 426-442.
- Bascle, G., 2008. Controlling for endogeneity with instrumental variables in strategic management research. *Strategic Organization* 6(3), 285-327.
- Berger, T., Bristow, G., 2009. Competitiveness and the Benchmarking of Nations—A Critical Reflection. *International Advances in Economic Research* 15(4), 378-392.
- Berggren, N., Jordahl, H., 2005. Does free trade really reduce growth? Further testing using the economic freedom index. *Public Choice* 122, 99-114.
- Berry, H., Guillen, M.F., Zhou, N., 2010. An institutional approach to cross-national distance. *Journal of International Business Studies* 41, 1460-1480.

- Bierly, P.E., Gallagher, S., 2007. Explaining Alliance Partner Selection: Fit, Trust and Strategic Expediency. *Long Range Planning* 40(2), 134-153.
- Björkman, I.K., Stahl, K., Vara, E., 2007. Cultural differences and capability transfer in cross-border acquisitions: the mediating roles of capability complementarity, absorptive capacity and social integration. *Journal of International Business Studies* 38, 658-672.
- Brewer, P., Venaik, S., 2011. Individualism–Collectivism in Hofstede and GLOBE. *Journal of International Business Studies* 42, 436-445.
- Brouthers, K.D., Brouthers, L.E., Werner, S., 2008. Resource-based Advantages in an International Context. *Journal of Management* 34, 189-217.
- Cainarca, G.C., Colombo, M., Mariotti, S., 1992. Agreements between firms and the technological life cycle model: evidence from information technologies. *Research Policy* 21(1), 45-62.
- Cantwell, J., 1989. *Technological Innovation and Multinational Corporations*. Blackwell, Cambridge, MA.
- Capaldo, A., 2007. Network structure and innovation: The leveraging of a dual network as a distinctive relational capability. *Strategic Management Journal* 28(6), 585-608.
- Carlsson, B., 2006. Internationalization of innovation systems: A survey of the literature. *Research Policy* 35(1), 56-67.
- Chang, S.J., Rosenzweig, P.M., 2001. The choice of entry mode in sequential foreign direct investment. *Strategic Management Journal* 22(8), 747-776.
- Chui, A.C.W., Lloyd, A.E., Kwok, C.C.Y., 2002. The Determination of Capital Structure: Is National Culture a Missing Piece to the Puzzle? *Journal of International Business Studies* 33, 99-127.
- Cohen, W., Levinthal, D., 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35(1), 128-152.

- Cohen, W., 1995. Empirical Studies of Innovative Activity, in: Stoneman, P. (Ed.), Handbook of the Economics of Innovation and Technological Change. Blackwell, Oxford.
- Coombs, J., Alston, Y.R., 2000. Biotechnology Directory 2000. Macmillan, Basingstoke.
- Cullen, J.B., Johnson, J.L., Sakano, T., 1995. Japanese and Local Partner Commitments to IJVs: Psychological Consequences of Outcomes and Investments in the IJV Relationships. *Journal of International Business Studies* 26(1), 91-115.
- Czarnitzki, D., Glänzel, W., Hussinger, K., 2009. Heterogeneity of Patenting Activity and its Implications for Scientific Research. *Research Policy* 38(1), 26-34.
- Daly, P., 1985. *The Biotechnology Business: A Strategic Analysis*. Frances Pinter, London.
- de Man, A.-P., Duysters, G., 2005. Collaboration and innovation: a review of the effects of mergers, acquisitions and alliances on innovation. *Technovation* 25(12), 1377-1387.
- Deeds, D.L., Hill, C.W.L., 1996. Strategic alliances and the rate of new product development: An empirical study of entrepreneurial biotechnology firms. *Journal of Business Venturing* 11(1), 41-55.
- DiMaggio, P.J., Powell, W.W., 1983. The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organisational Fields. *American Sociological Review* 48(2), 147-160.
- Dow, D., Karunaratna, A., 2006. Developing a multidimensional instrument to measure psychic distance stimuli. *Journal of International Business Studies* 37, 578-602.
- Dow, D., Larimo, J., 2011. Disentangling the Roles of International Experience and Distance in Establishment Mode Choice. *Management International Review* 51(3), 321-355.
- Drogendijk, R., Slangen, A., 2006. Hofstede, Schwartz, or managerial perceptions? The effects of different cultural distance measures on establishment mode choices by multinational enterprises. *International Business Review* 15(4), 361-380.

- Dunning, J.H., Lundan, S.M., 2008. Institutions and the OLI paradigm of the multinational enterprise. *Asia Pacific Journal of Management* 25(4), 573-593.
- Dyer, J.H., Singh, H., 1998. The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage. *Academy of Management Review* 23(4), 660-679.
- Dyer, J.H., Hatch, N.W., 2006. Relation-specific capabilities and barriers to knowledge transfers: creating advantage through network relationships. *Strategic Management Journal* 27(8), 701-719.
- Edquist, C., Johnson, B., 1997. Institutions and Organizations in Systems of Innovation, in: Edquist, C. (Ed.), *Systems of Innovation: Technologies, Institutions and Organizations*. Pinter, London, pp. 41-63.
- Eisenhardt, K.M., Schoonhoven, C.B., 1996. Resource-based View of Strategic Alliance Formation: Strategic and Social Effects in Entrepreneurial Firms. *Organization Science* 7(2), 136-150.
- Estrin, S., Baghdasaryan, D., Meyer, K.E., 2009. The Impact of Institutional and Human Resource Distance on International Entry Strategies. *Journal of Management Studies* 46(7), 1171-1196.
- Fey, C.F., Beamish, P.W., 2001. Organizational Climate Similarity and Performance: International Joint Ventures in Russia. *Organization Studies* 22(5), 853-882.
- Gaur, A.S., Lu, J.W., 2007. Ownership Strategies and Survival of Foreign Subsidiaries: Impacts of Institutional Distance and Experience. *Journal of Management* 33(1), 84-110.
- Gelbuda, M., Meyer, K.E., Delios, A., 2008. International business and institutional development in Central and Eastern Europe. *Journal of International Management* 14(1), 1-12.

- George, G., Zahra, S.A., Wood, D.R., 2002. The effects of business-university alliances on innovative output and financial performance: a study of publicly traded biotechnology companies. *Journal of Business Venturing* 17(6), 577-609.
- Georghiou, L., 2001. The United Kingdom National System of Research, Technology and Innovation, in: Larédo, P., Mustar, P. (Eds.), *Research and Innovation Policies in the New Global Economy*. Edward Elgar Cheltenham, UK.
- Gertler, M.S., 2001. Best practice? Geography, learning and the institutional limits to strong convergence. *Journal of Economic Geography* 1(1), 5-26.
- Grant, R.M., Baden-Fuller, C., 2004. A Knowledge Accessing Theory of Strategic Alliances. *Journal of Management Studies* 41(1), 61-84.
- Greene, W.H., 2003. *Econometric Analysis* (5th Edition). Prentice Hall, New Jersey.
- Griliches, Z., 1990. Patent Statistics as Economic Indicators: A Survey. *Journal of Economic Literature* 28, 1661-1707.
- Gulati, R., 1998. Alliances and Networks. *Strategic Management Journal* 19(4), 293-317.
- Gurneeta, V., Zaheer, A., 2013. The Embeddedness of Networks: Institutions, Structural Holes, and Innovativeness in the Fuel Cell Industry. *Organization Science* 24(3), 645-663.
- Hagedoorn, J., 1993. Understanding the rationale of strategic technology partnering: Inter-organizational modes of cooperation and sectoral differences. *Strategic Management Journal* 14(5), 371-385.
- Hagedoorn, J., Schakenraad, J., 1994. The effect of strategic technology alliances on company performance. *Strategic Management Journal* 15(4), 291-309.
- Hagedoorn, J., 2002. Inter-firm R&D partnerships: An overview of major trends and patterns since 1960. *Research Policy* 31(4), 477-492.
- Hamel, G., 1991. Competition for Competence and Inter-Partner Learning within International Strategic Alliances. *Strategic Management Journal* 12(S1), 83-103.

- Hanke, S., Walters, S., 1997. Economic Freedom, Prosperity, and Equality: A Survey. *Cato Journal* 17(2), 117-146.
- Heimeriks, K.H., Duysters, G., 2007. Alliance Capability as a Mediator Between Experience and Alliance Performance: An Empirical Investigation into the Alliance Capability Development Process. *Journal of Management Studies* 44(1), 25-49.
- Heimeriks, K.H., Duysters, G., Vanhaverbeke, W., 2007. Learning mechanisms and differential performance in alliance portfolios. *Strategic Organization* 5(4), 373-408.
- Heimeriks, K.H., Klijn, E., Reuer, J.J., 2009. Building Capabilities for Alliance Portfolios. *Long Range Planning* 42(1), 96-114.
- Heimeriks, K.H., 2010. Confident or Competent? How to Avoid Superstitious Learning in Alliance Portfolios. *Long Range Planning* 43(1), 57-84.
- Hennart, J.-F., Zeng, M., 2002. Cross-Cultural Differences and Joint Venture Longevity. *Journal of International Business Studies* 33(4), 699-716.
- Hoang, H.T., Rothaermel, F.T., 2005. The Effect of General and Partner-Specific Alliance Experience on Joint R&D Project Performance. *Academy of Management Journal* 48(2), 332-345
- Hoffmann, W.H., 2007. Strategies for managing a portfolio of alliances. *Strategic Management Journal* 28(8), 827-856.
- Hofstede, G., 1980. *Culture's Consequences: Individual Differences in Work-related Values*. Sage, Beverly Hills, CA.
- Huang, K.G., Murray, F.E., 2010. Entrepreneurial experiments in science policy: Analyzing the Human Genome Project. *Research Policy* 39(5), 567-582.
- Jaffe, A.B., 1986. Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Value. *American Economic Review* 76(5), 984-1001.

- Jaffe, A.B., Trajtenberg, M., Henderson, R., 1993. Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations. *Quarterly Journal of Economics* 108(3), 577-598.
- Johanson, J., Wiedersheim-Paul, F., 1975. The Internationalization of the Firm: Four Swedish Cases. *Journal of Management Studies* 12(3), 305-322.
- Kaiser, R., Prange, H., 2004. The reconfiguration of National Innovation Systems—the example of German biotechnology. *Research Policy* 33(3), 395-408.
- Kale, P., Dyer, J.H., Singh, H., 2002. Alliance Capability, Stock Market Response, and Long-Term Alliance Success: The Role of the Alliance Function. *Strategic Management Journal* 23(8), 747-767.
- Kale, P., Singh, H., 2007. Building firm capabilities through learning: the role of the alliance learning process in alliance capability and firm-level alliance success. *Strategic Management Journal* 28(10), 981-1000.
- Kang, N.H., Sakai, K., 2000. International Strategic Alliances: Their Role in Industrial Globalisation. STI (Science, Technology and Industry) Working paper No: 93639, OECD. Paris.
- Katila, R., Ahuja, G., 2002. Something Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction. *Academy of Management Journal* 45(6), 1183–1194.
- Kim, Y., Gray, S., 2008. An assessment of alternative empirical measures of cultural distance in explaining foreign ownership mode decisions: Evidence from the Republic of Korea. *Asia Pacific Journal of Management* 26(1), 55-74.
- Kogut, B., Singh, H., 1988. The effects of national culture on the choice of entry mode. *Journal of International Business Studies* 19(3), 411-432.

- Kostova, T., Roth, K., 2002. Adoption of an Organizational Practice by Subsidiaries of Multinational Corporations: Institutional and Relational Effects. *Academy of Management Journal* 45(1), 215-233.
- Lane, P.J., Lubatkin, M., 1998. Relative absorptive capacity and inter-organizational learning. *Strategic Management Journal* 19(5), 461-477.
- Laursen, L., Salter, A., 2006. Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal* 27(2), 131-150.
- Lavie, D., 2006. The Competitive Advantage of Interconnected Firms: An Extension of the Resource-Based View. *Academy of Management Review* 31(3), 638-658.
- Lavie, D., Miller, S.R., 2008. Alliance Portfolio Internationalization and Firm Performance. *Organization Science* 19(4), 623-646.
- Lavie, D., Kang, J., Rosenkopf, L., 2011. Balance Within and Across Domains: The Performance Implications of Exploration and Exploitation in Alliances. *Organization Science* 22(6), 1517-1538.
- Levinson, N.S., Asahi, M., 1995. Cross-national alliances and interorganizational learning. *Organizational Dynamics* 24(2), 50-63.
- Li, L., Qian, G., Qian, Z., 2012. The performance of small- and medium-sized technology-based enterprises: Do product diversity and international diversity matter? *International Business Review* 21(5), 941-956.
- Larédo, P., Mustar, P. (Eds.), 2001. *Research and Innovation Policies in the New Global Economy*. Edward Elgar, Cheltenham, UK.
- Lundvall, B.-Å., Johnson, B., Andersen, E.S., Dalum, B., 2002. National systems of production, innovation and competence building. *Research Policy* 31(2), 213-231.

- Lundvall, B.A. (Ed.), 1992. *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*. Pinter Publishers, London.
- Luo, Y., Shenkar, O., 2011. Toward a perspective of cultural friction in international business. *Journal of International Management* 17(1), 1-14.
- Lyles, M.A., Salk, J.E., 1996. Knowledge acquisition from foreign partners in international joint ventures: An empirical explanation in the Hungarian context. *Journal of International Business Studies* 27, 877-903.
- Ma, X., Tong, T., Fitzg, M., 2013. How much does subnational region matter to foreign subsidiary performance? Evidence from Fortune Global 500 Corporations' investment in China. *Journal of International Business Studies* 44, 66-87.
- Madhok, A., 2006. How much does ownership really matter? Equity and trust relations in joint venture relationships. *Journal of International Business Studies* 37, 4-11.
- Mahoney, J., 1992. The choice of organizational form: Vertical financial ownership versus other methods of vertical integration. *Strategic Management Journal* 23(8), 559-584.
- Meyer, K.E., 2001. Institutions, Transaction Costs and Entry Mode Choice in Eastern Europe. *Journal of International Business Studies* 32, 357-367.
- Meyer, K.E., Estrin, S., Bhaumik, S.K., 2009. Institutions, resources, and entry strategies in emerging economies. *Strategic Management Journal* 30(1), 61-80.
- Mowery, D.C., Oxley, J.E., Silverman, B.S., 1996. Strategic Alliances and Interfirm Knowledge Transfer. *Strategic Management Journal* 17(Winter Special Issue), 77-91.
- Mowery, D.C., Oxley, J.E., Silverman, B.S., 1998. Technological overlap and interfirm cooperation: Implications for the resource-based view of the firm. *Research Policy* 27(5), 507-523.
- Nelson, R.R., Winter, S.G., 1982. *An Evolutionary Theory of Economic Change*. Harvard University Press, Cambridge, MA.

- Nelson, R.R., 1991. Why Do Firms Differ, and How Does It Matter? *Strategic Management Journal* 12, 61-74.
- Nelson, R.R. (Ed.), 1993. *National Innovation Systems: A Comparative Analysis*. Oxford University Press, New York.
- North, D.C., 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, New York.
- Orr, R.I., Scott, W.R., 2008. Institutional exceptions on global projects: a process model. *Journal of International Business Studies* 39, 562-588.
- Park, S.H., Ungson, G.R., 2001. Interfirm Rivalry and Managerial Complexity: A Conceptual Framework of Alliance Failure. *Organization Science* 12(1), 37-53.
- Park, S.H.R., Ungson, G.R., 1997. The Effect of National Culture, Organizational Complementarity, and Economic Motivation on Joint Venture Dissolution. *Academy of Management Journal* 40(2), 279-307.
- Parkhe, A., 1991. Interfirm Diversity, Organizational Learning, and Longevity in Global Strategic Alliances. *Journal of International Business Studies* 22, 579-601.
- Patel, P., Pavitt, K., 1991. Large Firms in the Production of the World's Technology: An Important Case of "Non-Globalisation". *Journal of International Business Studies* 22(1), 1-21.
- Patel, P., Vega, M., 1999. Patterns of internationalisation of corporate technology: location vs. home country advantage. *Research Policy* 28(2-3), 145-155.
- Pavitt, K., 1985. Patent statistics as indicators of innovative activities: Possibilities and problems. *Scientometrics* 7(1-2), 77-99.
- Peng, M.W., Wang, D.Y., Jiang, Y., 2008. An institutional-based view of international strategy: A focus on emerging markets. *Journal of International Business Studies* 39, 920-936.

- Phene, A., Fladmoe-Lindquist, K., Marsh, L., 2006. Breakthrough innovations in the U.S. biotechnology industry: The effects of technological space and geographic origin. *Strategic Management Journal* 27(4), 369-388.
- Polanyi, M., 1966. *The Tacit Dimension*. Doubleday Anchor, New York.
- Powell, W.W., Koput, K.W., Smith-Doerr, L., 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly* 41, 116-145.
- Quintana-García, C., Benavides-Velasco, C.A., 2008. Innovative competence, exploration and exploitation: The influence of technological diversification. *Research Policy* 37(3), 492-507.
- Roijakkers, N., Hagedoorn, J., 2006. Inter-firm R&D partnering in pharmaceutical biotechnology since 1975: Trends, patterns, and networks. *Research Policy* 35(3), 431-446.
- Rothaermel, F.T., 2001. Incumbent's advantage through exploiting complementary assets via interfirm cooperation. *Strategic Management Journal* 22(6-7), 687-699.
- Rothaermel, F.T., Hill, C.W.L., 2005. Technological Discontinuities and Complementary Assets: A Longitudinal Study of Industry and Firm Performance. *Organization Science* 16(1), 52-70.
- Rothaermel, F.T., Deeds, D.L., 2006. Alliance Type, Alliance Experience and Alliance Management Capability in High-Technology Ventures. *Journal of Business Venturing* 21(4), 429-460.
- Rugman, A.M., Verbeke, A., 2007. Liabilities of regional foreignness and the use of firm-level versus country-level data: A response to Dunning et al. *Journal of International Business Studies* 38, 200-205.
- Sampson, R.C., 2005. Experience Effects and Collaborative Returns in R&D Alliances. *Strategic Management Journal* 26(11), 1009-1031.

- Sampson, R.C., 2007. R&D Alliances and Firm Performance: The Impact of Technological Diversity and Alliance Organization on Innovation. *Academy of Management Journal* 50, 364-386.
- Schumpeter, J., 1934. *The Theory of Economic Development*. Harvard University Press, Cambridge, MA.
- Scott, W.R., 1995. *Institutions and Organizations*. Sage, Thousand Oaks, CA.
- Shan, W., Walker, G., Kogut, B., 1994. Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal* 15(5), 387-394.
- Shenkar, O., Zeira, Y., 1992. Role Conflict and Role Ambiguity of Chief Executive Officers in International Joint Ventures. *Journal of International Business Studies* 23(1), 55-75.
- Shenkar, O., 2001. Cultural Distance Revisited: Towards a More Rigorous Conceptualization and Measurement of Cultural Differences. *Journal of International Business Studies* 32(3), 519–535.
- Shenkar, O., Luo, Y., Yeheskel, O., 2008. From “Distance” to “Friction”: Substituting Metaphors and Redirecting Intercultural Research. *Academy of Management Review* 33(4), 905-923.
- Simonin, B.L., 1999. Ambiguity and the process of knowledge transfer in strategic alliances. *Strategic Management Journal* 20(7), 595-623.
- Slangen, A.H.L., Beugelsdijk, S., 2010. The impact of institutional hazards on foreign multinational activity: A contingency perspective. *Journal of International Business Studies* 41, 980-995.
- Steensma, H.K., Tihanyi, L., Lyles, M.A., Dhanaraj, C., 2005. The Evolving Value of Foreign Partnerships in Transitioning Economies. *Academy of Management Journal* 48(2), 213-235.
- Stiglitz, J., 2006. *Making Globalization Work*. W.W. Norton & Company, New York.

- Stroup, M.D., 2007. Economic Freedom, Democracy, and the Quality of Life. *World Development* 35(1), 52-66.
- Szulanski, G., 1996. Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm. *Strategic Management Journal* 17(Winter Special Issue), 27-43.
- Tong, T.W., Reuer, J.J., Peng, M.W., 2008. International Joint Ventures and the Value of Growth Options. *Academy of Management Journal* 51(5), 1014-1029.
- Tung, R.L., Verbeke, A., 2010. Beyond Hofstede and GLOBE: Improving the quality of cross-cultural research. *Journal of International Business Studies* 41(8), 1259-1274.
- Vasudeva, G., Spencer, J.W., Teegen, H.J., 2013. Bringing the Institutional Context Back In: A Cross-National Comparison of Alliance Partner Selection and Knowledge Acquisition. *Organization Science* 24(2), 319-338.
- Witt, M.A., Redding, G., 2009. Culture, Meaning, and Institutions: Executive Rationale in Germany and Japan. *Journal of International Business Studies* 40, 859-885.
- Wooldridge, J.M., 1999. Distribution-free estimation of some nonlinear panel data models. *Journal of Econometrics* 90(1), 77-97.
- Wooldridge, J.M., 2002. *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Cambridge, MA.
- Xu, D., Shenkar, O., 2002. Institutional Distance and the Multinational Enterprise. *Academy of Management Review* 27(4), 608-618.
- Kwon, Y.-C., 2008. Antecedents and consequences of international joint venture partnerships: A social exchange perspective. *International Business Review* 17(5), 559-573.
- Ziedonis, R.H., 2008. On the Apparent Failure of Patents: A Response to Bessen and Meurer. *Academy of Management Perspectives* 22(4), 21-29.
- Zilber, T.B., 2006. The Work of the Symbolic in Institutional Process: Translations of Rational Myths in Israel High Tech. *Academy of Management Journal* 49(2), 281-303.

Zollo, M., Reuer, J.J., Singh, H., 2002. Interorganizational Routines and Performance in Strategic Alliances. *Organization Science* 13(6), 701-713.

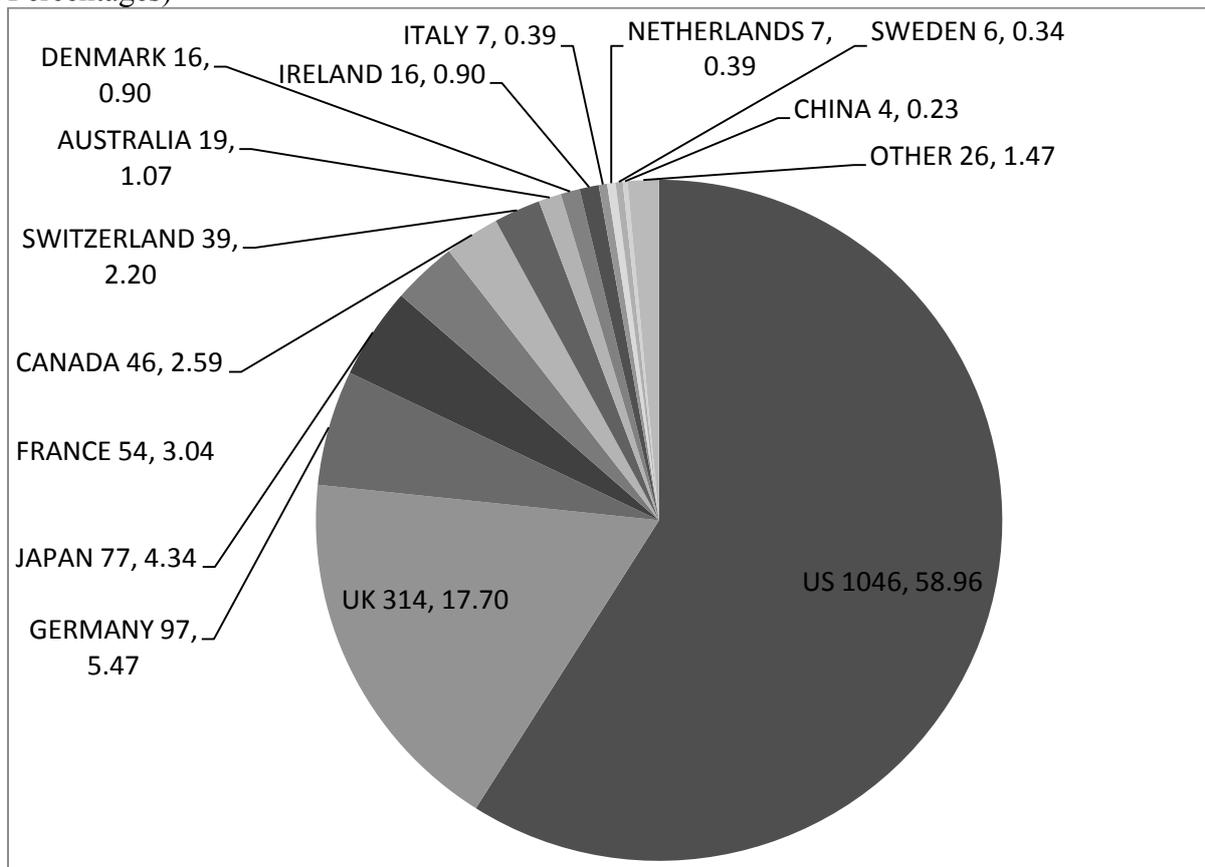
Zollo, M., Winter, S.G., 2002. Deliberate Learning and the Evolution of Dynamic Capabilities. *Organization Science* 13(3), 339-351.

Biographies

Dr. Despoina Filiou is a Senior Lecturer in Strategy and Innovation at the Centre for International Business and Innovation, Manchester Metropolitan University Business School. Her research explores the role of alliances in innovation, and has been published in the *Journal of Evolutionary Economics* and the *Academy of Management 2008 Best Paper Proceedings*. In the past, she has worked on an EU 7th Framework funded project on Public-Private Innovation Networks in Services (ServPPin). E-mail: D.Filiou@mmu.ac.uk

Dr. Sougand Golesorkhi is a Senior Lecturer in International Business at the Centre for International Business and Innovation, Manchester Metropolitan University Business School. Her research explores the role of institutional differences in the structure of international joint ventures, and has been published in the *International Business Review*. E-mail: S.Golesorkhi@mmu.ac.uk

Figure 1: Distribution of International Alliances Partners' Country of Origin (Values, Percentages)¹⁵



¹⁵ Values and percentages refer to the alliance level. There are a total of 2,442 alliances formed between 1991 and 2001, whilst data on partners' headquarter location is available for 1,774 alliances.

Table 1: Descriptive Statistics and Bivariate Correlation Matrix

| | N | Mean | Median | Mean | S.D. | 1 | 2 | 5 | 7 | 8 | 9 | 10 |
|---|------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|
| 1. Number of Patents | 1210 | 0.328 | 0 | 0.328 | 1.624 | | | | | | | |
| 2. Average Informal Institutional Differences (AIID) | 486 | 0.419 | 0.080 | 0.419 | 0.656 | 0.060 | | | | | | |
| 3. Average Formal Institutional Differences (AFID) | 398 | 3.482 | 3.453 | 3.482 | 2.920 | 0.077 | 0.581* | | | | | |
| 4. Cumulate Number of Alliances (Natural Log of 1-year Lagged Values) | 673 | 1.599 | 1.386 | 1.598 | 1.384 | 0.076 | -0.060 | 0.018 | | | | |
| 5. Number of Alliances with Co-located Partners | 492 | 1.087 | 1 | 1.087 | 1.890 | -0.043 | -0.020 | -0.016 | 0.332* | | | |
| 6. Dummy for Alliances with R&D | 1210 | 0.217 | 0 | 0.217 | 0.412 | 0.066 | 0.017 | -0.047 | 0.487* | 0.217* | | |
| 7. Number of Employees (Natural Log) | 701 | 4.789 | 4.419 | 4.789 | 2.158 | 0.392* | -0.020 | -0.015 | 0.300* | 0.102 | 0.183* | |
| 8. Investments in R&D (Natural Log) | 386 | 15.426 | 15.562 | 15.426 | 2.506 | 0.349* | 0.052 | 0.011 | 0.410* | 0.058 | 0.343* | 0.763* |

Table Note: Significance levels: * p<0.01

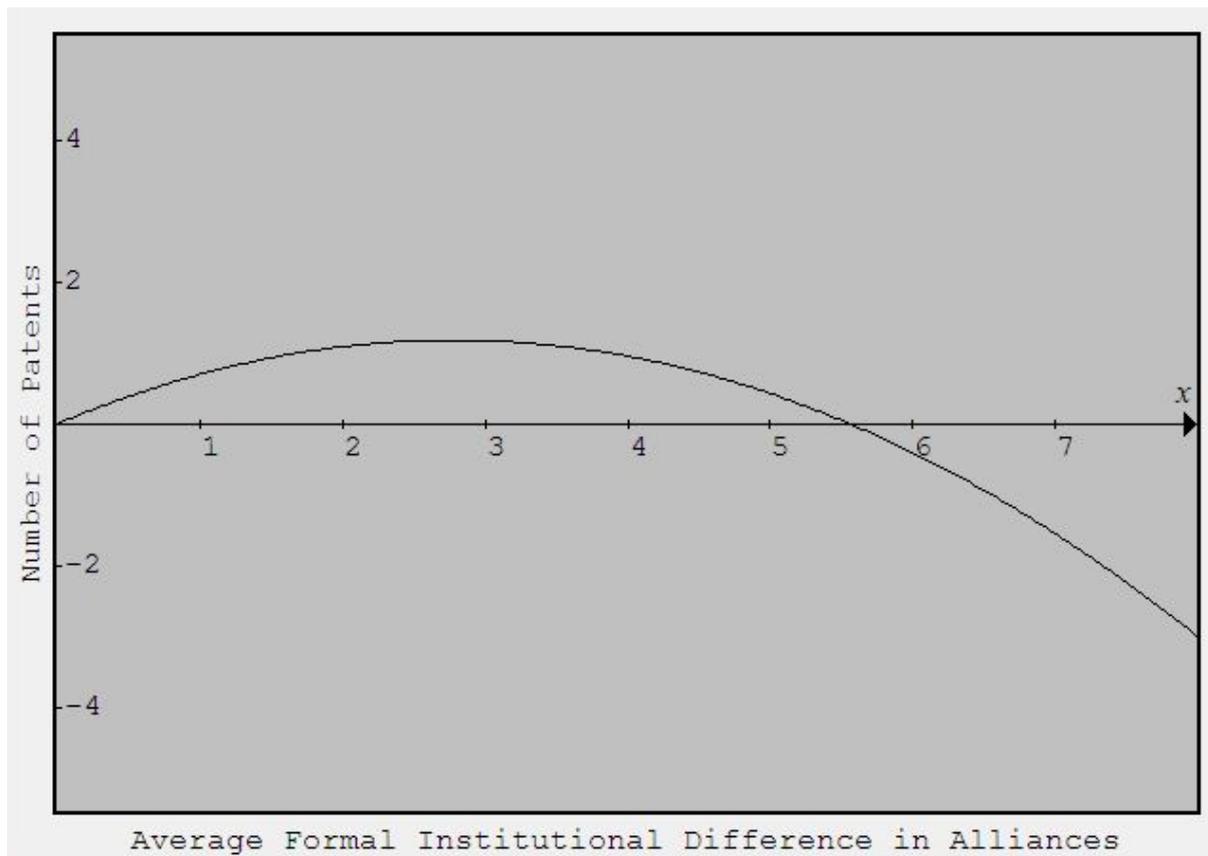
Table 2: Fixed Effects Poisson Model for Panel Data (Standard Errors Corrected for Overdispersion Provided in Brackets): Dependent Variable Number of Patents¹⁶

| | Model 1 | Model 2 |
|--|----------------|----------------|
| | FE (Robust SE) | FE (Robust SE) |
| Average Informal Institutional Differences (AIID) | 0.695** | -2.936* |
| | (0.326) | (1.819) |
| Square Values of AIID | | 5.201** |
| | | (2.647) |
| Quadratic Values of AIID | | -1.529* |
| | | (0.861) |
| Average Formal Institutional Differences (AFID) | -0.117 | 0.856** |
| | (0.103) | (0.284) |
| Square Values of AFID | | -0.154*** |
| | | (0.034) |
| <i>Controls</i> | | |
| Cumulate Number of Alliances (Natural Log of 1-year Lagged Values) | -0.420 | 0.217 |
| | (0.470) | (0.472) |
| Number of Alliances with Co-located Partners | 0.305* | 0.613*** |
| | (0.191) | (0.168) |
| Dummy for Alliances with R&D | -0.201 | -0.698** |
| | (0.266) | (0.296) |
| Number of Employees (Natural Log) | 0.047 | 0.587 |
| | (0.669) | (0.733) |
| Investments in R&D (Natural Log) | 0.688 | 0.27 |
| | (0.976) | (0.977) |
| Number of Observations | 84 | 84 |
| Wald Chi ² | 36.520 | 59.750 |
| Prob> Chi ² | 0.000 | 0.000 |
| Log Likelihood | -106.689 | -90.686 |

Table Note: Significance levels: *p<0.1, ** p<0.05, *** p<0.01

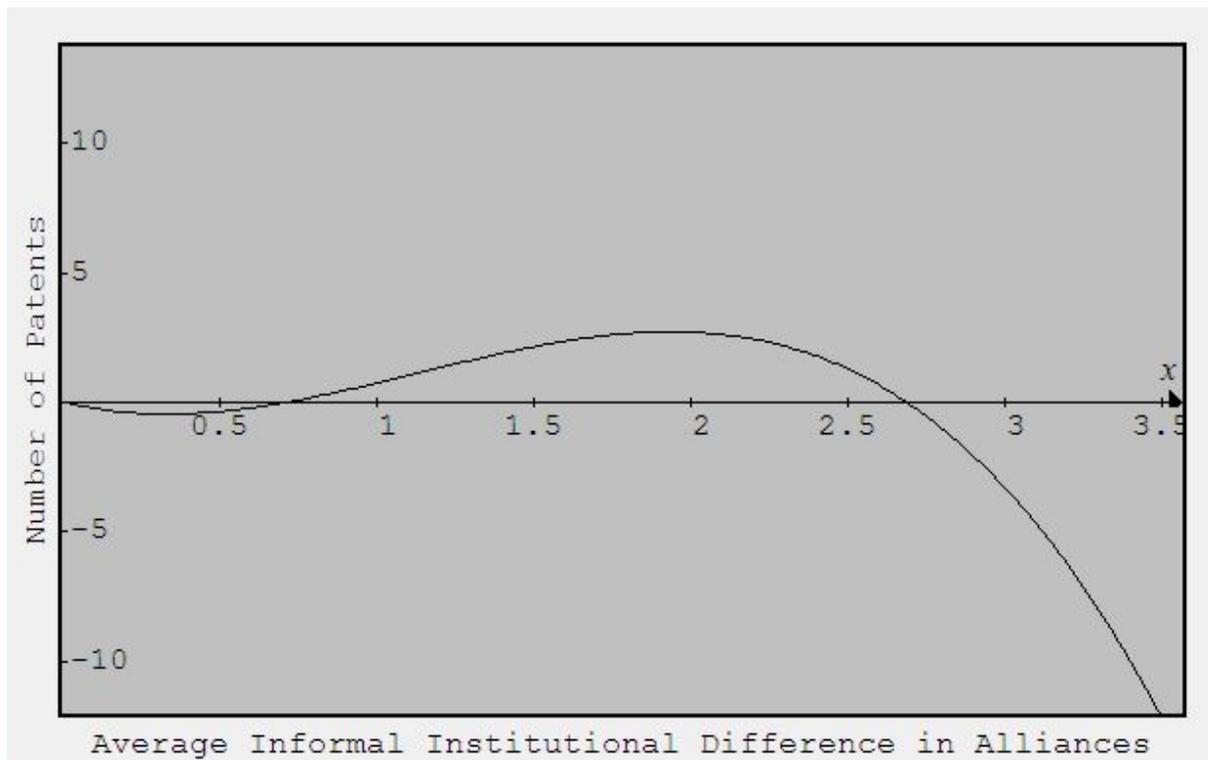
¹⁶ The panel dataset is unbalanced as missing observations lead to list-wise deletion.

Graph 1: Average Formal Institutional Difference in Alliances and Number of Patents¹⁷



¹⁷ The average value of average formal institutional difference is 3.482, while the maximum reaches 22.250 points of difference.

Graph 2: Average Informal Institutional Difference in Alliances and Number of Patents¹⁸



¹⁸ The average value of the average informal institutional distance in alliances is 0.418 points of difference and the maximum value is 3.571.