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TECHNOLOGY ALLIANCE GOVERNANCE, PARTNER SELECTION, AND FIRM INNOVATIVENESS

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INTRODUCTION

Interfirm technology alliances represent an important mechanism through which firms develop new technologies, products, and processes (Hagedoorn, 1993; Stuart, 2000). Prevailing research shows that the governance structure of technology alliances is a particularly important factor affecting the contribution of such alliances to a firm's innovativeness. Extant research argues and shows that joint ventures are more effective knowledge transfer and innovation vehicles than contractual agreements (Gomes-Casseres, Hagedoorn, & Jaffe, 2006; Mowery, Oxley, & Silverman, 1996; Oxley & Wada, 2009). However, alliance formation research shows that firms often govern their technology alliances by contractual agreements. If innovation motivates technology alliance governance decisions and if especially joint ventures increase firm innovativeness, then it is not obvious why so many technology alliances are governed by contractual agreements, *ceteris paribus*.

Motivated by this puzzle, this paper aims to advance our understanding of the mechanisms connecting alliance governance to a firm's innovativeness. It bridges alliance governance and partner selection research by introducing partner selection behavior as a distinct mechanism by which alliance governance across a firm's set of technology alliances affects its innovativeness. It then proposes and shows empirically that technological dynamism weakens the direct innovative benefits of more hierarchical alliances, such as a joint venture, while it strengthens the indirect benefits of less hierarchical alliances, such as a contractual agreement. In so doing, the paper generates more integrative insight into the mechanisms by which alliances affect both firm behavior (i.e., partner selection) and performance (i.e., innovativeness).

BACKGROUND AND HYPOTHESES

A firm's innovativeness, defined as its ability to generate technologically significant knowledge, is essential to its commercial and financial performance (Bayus, Erickson, & Jacobson, 2003; Hall, Jaffe, & Trajtenberg, 2005). Technology alliances are interfirm cooperative agreements established to perform joint research and development relating to new technologies, products, and processes (Hagedoorn, 1993) and so they represent a major factor influencing a firm's innovativeness (Ahuja, 2000; Hagedoorn & Schakenraad, 1994; Stuart, 2000). However, not all technology alliances are equally effective because their governance structure greatly affects their contribution to interfirm knowledge flows and the partner firms' innovativeness (Gomes-Casseres et al., 2006; Mowery et al., 1996; Oxley & Wada, 2009; Pisano, Russo, & Teece, 1988).

Technology alliances are hybrid organizational arrangements situated between markets and hierarchies (Oxley, 1997) and they are governed either by nonequity contractual agreements or by equity-based joint ventures, the latter resembling the governance attributes of internal

organization. Contractual agreements are project- or program-based agreements between independent firms but in joint ventures, the partner firms 'share ownership of the assets and derived revenues and, thus, share monitoring and control rights' (Kogut, 1988: 175).

Joint ventures are thought to contribute more strongly to interfirm knowledge flows and partner firms' innovativeness than more arms-length contractual agreements (Gomes-Casseres et al., 2006; Mowery et al., 1996; Oxley & Wada, 2009; Pisano et al., 1988). First, the joint venture's parent firms share equity and, per transaction cost economics theory, this economic commitment aligns incentives and so it should mitigate the hazards of opportunism (Oxley, 1997; Pisano, 1989; Williamson, 1991). Second, contrary to many contractual agreements, the employees of the parent firms collocate in a joint venture, which allows them to coordinate informally. From a knowledge-based perspective, such collocation in turn eases the transfer of fine-grained, tacit, and context-specific technological knowledge (Kogut & Zander, 1992; Teece, 1992). Finally, a joint venture is a separate legal and physical entity with a joint management board, allowing the partner firms to monitor and control employee responsibilities, mobility, and, by implication, knowledge leakage (Kogut, 1988; Oxley & Wada, 2009).

Hypothesis 1: The larger the proportion of joint ventures in a firm's set of technology alliances, the greater that firm's innovativeness.

Though alliance governance affects innovativeness by helping a firm tap the technological potential of its technology alliances, a second key factor affecting a firm's innovativeness is its propensity for novel partners (Hagedoorn, 2002; Lavie & Rosenkopf, 2006). Indeed, an adjacent body of research on alliance partner selection suggests that over time, performance diverges across firms based on differences in the extent to which they engage in technology alliances with novel partners – i.e., partners they have not collaborated with before (Beckman, Haunschild, & Phillips, 2004; Lavie & Rosenkopf, 2006).

Novel partners add diversity to a firm's set of technology alliances, which will improve complex decisions concerning the value of alternative technological opportunities (Beckman & Haunschild, 2002). They also provide access to relatively new technological knowledge that will aid exploration and thus spark a firm's innovativeness (Lavie & Rosenkopf, 2006; Stuart, 2000). Finally, they reduce a firm's reliance on prior partners. Reliance on prior partners weeds out novelty and diversity and so it tends to generate suboptimal performance (Goerzen, 2007). Avoiding such lock-in effects is especially important in technology alliances where novel and diverse ideas and perspectives can be crucial. Thus, in the context of technology alliances, a firm's propensity for novel partners should increase its innovativeness.

Hypothesis 2: The greater a firm's propensity for novel technology alliance partners, the greater that firm's innovativeness.

Together, hypotheses 1 and 2 require the assumption that firms can simultaneously employ more hierarchical governance and optimize their ability to engage into alliances with novel partners. However, descriptive studies have repeatedly suggested that the governance of a firm's technology alliances may have systematic implications for its partner selection behavior. At least three theoretical mechanisms suggest that this may be the case.

First, a joint venture represents greater commitments by the alliance partners than a contractual agreement (Hagedoorn, 1993; Pisano et al., 1988). Across a firm's technology alliances, accumulated relational commitments decrease search costs and perceptions of risk and uncertainty in selecting partners because they allow a firm to assess the reliability, priorities, and

capabilities of its partners, which is much more difficult with novel or more arms-length partners (Goerzen, 2007; Gulati & Gargiulo, 1999; Larson, 1992; Uzzi, 1997). Commitments to prior partners also represent sunk costs that would have to be incurred again when engaging with novel partners. Consequently, greater commitments will motivate firms to engage in repeated rather than novel ties (Li & Rowley, 2002).

Second, partner dependence is more irreversible within joint ventures than in contractual agreements and so the partner firms have incentives to monitor each other's technology alliance activities for actions that undermine the focal alliance (Gimeno, 2004; Harrigan, 2003 [1985]; Steensma & Corley, 2000). Alliances with novel partners are exploration devices that are more likely to induce changes in a firm's technological activities than repeat alliances with current or prior partners (Beckman et al., 2004; Lavie & Rosenkopf, 2006). Thus, novel partners may shift a firm's technological focus away from that in the firm's current alliances, which is likely to reduce the value of those alliances, especially for the firm's partners. Furthermore, the reliability and priorities of novel partners are often difficult to evaluate (Goerzen, 2007; Gulati & Gargiulo, 1999; Larson, 1992; Uzzi, 1997). It is therefore difficult to assess if novel partners have intentions to free ride on investments made within the firm's current alliances, which would also reduce the value of the latter. Consequently, as compared with repeat partners, novel partners are a greater threat to the value of especially a firm's more hierarchical alliances. Both the firm and especially its joint venture partners will try to minimize such potential threats and so the focal firm's ability to select novel technology alliance partners will be constrained.

Finally, because alliance formation is a joint action of two firms, the interests of potential partners that are novel to the focal firm also play a role. Novel partner candidates will estimate the benefits they derive from an alliance with a given firm. Because they have limited prior information on a firm's reliability and priorities, they will rely on proxy indicators to determine the likelihood that the firm will behave cooperatively. One such a proxy is the extent to which the focal firm is already committed to and dependent on its current partners. If the focal firm is strongly tied to its current partners, it will be less able, and less motivated, to serve the interests of any novel partner than if it is more loosely tied to its current partners (Gimeno, 2004; Harrigan, 2003 [1985]). Because joint ventures represent stronger alliances between partner firms than contractual agreements, novel partner candidates should thus be less motivated to partner with a firm exclusively engaged in joint ventures than with one exclusively engaged in contractual agreements.

Hypothesis 3: The larger the proportion of joint ventures in a firm's set of technology alliances, the smaller that firm's propensity for novel technology alliance partners.

The above arguments suggest that technology alliance governance influences a firm's innovativeness in two distinct ways. More hierarchical governance directly increases innovativeness (H1), but at the same time, it reduces the firm's propensity for novel partners (H3), which in turn impedes its innovativeness (H2). Because the state of the technological environment determines the performance of a firm's technology alliances (Afuah, 2000; Goerzen, 2007; Nicholls-Nixon & Woo, 2003; Steensma & Corley, 2000), technological dynamism is likely to moderate the direct and indirect effects of technology alliance governance on a firm's innovativeness. When technological dynamism is substantial, extant technologies will speed to obsolescence, leading to concomitant changes in technological and partnering opportunities (Davis, Eisenhardt, & Bingham, 2009). Technological dynamism will affect the performance of technology alliances by reducing the fit between the partners' knowledge bases

(Afuah, 2000; Mitchell & Singh, 1996). Moreover, beyond affecting the technological fit between firms, changes in the technological environment may also cause the firms' interests and incentives to diverge (Hagedoorn, 1993).

By implication, the innovative benefits of joint ventures over contractual agreements will change in dynamic environments. Though joint ventures achieve greater incentive alignment, coordination, and monitoring and control as compared with contractual agreements, these benefits become superfluous when the fit between the partners decreases and their interests diverge due to exogenous changes in the technological environment. Also, technological dynamism generates new partnering opportunities and so it increases firms' motivation to seek out novel partners. But by hypothesis 3, a firm governing its technology alliances through joint ventures rather than contractual agreements will be less able to engage with novel partners. Therefore, the governance of a firm's technology alliances will determine that firm's partner selection behavior in response to exogenous changes in the importance of novel partners.

Hypothesis 4: Technological dynamism negatively moderates (i.e., weakens) the positive relationship between the proportion of joint ventures in a firm's set of technology alliances and that firm's innovativeness.

Hypothesis 5: Technological dynamism positively moderates (i.e., strengthens) the negative relationship between the proportion of joint ventures in a firm's set of technology alliances and that firm's propensity for novel technology alliance partners.

METHODS

I used data on the performance and innovativeness of firms engaged in IT-related technology alliances during 1978-1999. I focused on firms' activities in a single industry because this reduced concerns of industry heterogeneity, increasing the precision of the estimates for the hypothesized relations. The final panel consisted of 1,275 firm-year records.

Dependent Variables

Innovativeness_{i(t+1)} was measured as the natural logarithm of the count of citations that firm *i* received to its stock of IT patents in year *t+1* (Dutta & Weiss, 1997; Jaffe & Trajtenberg, 2002). I used patent data because they are the most consistent indicators of firms' innovative activities over time (Jaffe & Trajtenberg, 2002). A firm whose patents receive many citations is considered technologically innovative (Dutta & Weiss, 1997), which is reflected in its growth potential, among others (Hall et al., 2005).

Novel Partner Share_{i(t+1)} was defined as the proportion of firm *i*'s technology alliances formed in year *t+1* that involved a novel partner. Specifically, I divided the number of technology alliances with novel partners that firm *i* formed in year *t+1* by all the technology alliances it formed in the same year. Consistent with Beckman et al. (2004: 264) and Lavie and Rosenkopf (2006: 807-808), I defined a partner as novel when firm *i* had no joint technology alliances with that partner from 1975 to year *t*.

Independent Variables

$JV\ Share_{it}$ was defined as the proportion of firm i 's technology alliances formed between year $t-2$ and year t that were joint ventures. I used a three-year window because the average technology alliance with traceable duration lasted three years.

$Tech\ Dynamism_t$ was the extent to which counts of patents assigned in the 39 IT patent classes (Hall et al., 2002: 452-453) during the prior three-year period were poor predictors of within-class counts in year t (Dess & Beard, 1984; Sharfman & Dean, 1991; Wang & Chen, 2010). First, I compiled a dataset with the 39 IT patent classes as rows and the annual counts of assigned patents in columns. Second, I regressed the within-class patent volume in year t on the average within-class patent volume from year $t-3$ to year $t-1$. Finally, I used the yearly adjusted R^2 -values to calculate the coefficient of alienation for year t as $\sqrt{1-R^2}$, which indexed $Tech\ Dynamism_t$.

Analysis

I estimated the equations for Innovativeness and Novel Partner Share as a function of JV Share and Tech Dynamism using three-stage least squares (3SLS; Zellner & Theil, 1962). In both equations, I controlled for firm size, age, and profitability. In the Innovation equation, I also controlled for a firm's number of technology alliances and its R&D intensity, while in the Novel Partner Share equation, I controlled for a firm's alliance experience and the extent to which others in the industry also partnered with novel partners in a given year. I also included temporal fixed effects to control for unobserved time-varying influences on firms' innovativeness and partner selection that would systematically affect all firms in the sample.

Key to identifying consistent coefficients for JV Share was the assumption that there were no uncontrolled firm-level factors that correlated with both JV Share and the dependent variables. Endogeneity tests failed to reject the null hypothesis of consistent estimates for JV Share and so JV Share appeared uncorrelated with the structural error terms. Thus, I treated it as exogenous to the system of simultaneous equations.

RESULTS

Results support Hypotheses 1 and 2: a one-standard deviation increase in a firm's JV Share produces a 14% increase in its innovativeness and a one-standard deviation increase in a firm's Novel Partner Share produces an 8% increase in its innovativeness. In support of Hypothesis 3, a firm whose reliance on joint ventures is one standard deviation above the mean has a 13% (i.e., 0.13) lower propensity for novel partners as compared with an otherwise identical firm that has contractual agreements only. This effect is substantial considering that an average firm had a propensity for novel partners of around 40% (i.e., 0.4). Hypothesis 4 also finds support: a firm with only contractual agreements facing Tech Dynamism at one standard deviation above the mean has an innovativeness multiplier of 3.65, while an otherwise identical firm with only joint ventures has an innovativeness multiplier of only 1.29. Finally, in support of Hypothesis 5, if Tech Dynamism is one standard deviation above the mean, then a firm whose reliance on joint ventures is one standard deviation above the mean has a 19% (i.e., 0.19) lower propensity for novel partners than an otherwise identical firm with only contractual agreements that faces Tech Dynamism at one standard deviation below the mean.

DISCUSSION AND CONCLUSION

This paper sought to assess the direct and indirect effects of governance across a firm's set of technology alliances on firm innovativeness. Modeling both the direct and indirect mechanisms connecting technology alliance governance to a firm's innovativeness, this paper extends extant theory on the performance implications of alliance governance. Drawing from transaction cost economics, knowledge-based, and control perspectives, the direct and well-established mechanism relates to the benefits of hierarchical governance for incentive alignment, coordination, and monitoring and control (Oxley & Wada, 2009). Yet, the indirect and previously unexplored mechanism concerns the difficulty for firms with more hierarchical technology alliances to engage with novel partners, which indirectly decreases the performance of such firms. Opposite effects of alliance governance on partner selection and performance is consistent with Williamson's (1991: 277-281) insight that governance decisions have conflicting implications for autonomous versus coordinated adaptation. My analyses indicated that the sample firms required autonomy to engage with novel partners, but at the same time, they required interdependence to coordinate technology exchanges within their technology alliances – to extract innovative benefits from such alliances. Convergent with Williamson (1991), therefore, the implication is that alliance governance may be at once a source of opportunity and constraint, which has significant consequences for both firm behavior and performance.

The empirical support for the direct and indirect governance effects may explain why firms' alliance governance decisions tend to differ across industries. In dynamic environments, novel partner opportunities are omnipresent and so the indirect partner-selection mechanism connecting alliance governance to innovativeness is disproportionately important. However, in more stable environments, novel partner opportunities occur irregularly and so the indirect mechanism is less relevant as compared with the direct one. This may be part of the reason why firms in dynamic environments broadly prefer contractual agreements to joint ventures, while those in stable environments tend to prefer joint ventures instead (Hagedoorn, 2002).

More broadly, by suggesting and showing how the governance of a firm's alliances affects that firm's partner selection behavior and its innovativeness, this paper answers the recent call for research that bridges the behavioral and performance implications of interfirm alliances (Gulati, 2007; Wassmer, 2010). Though prior research has extensively studied the alliance-related antecedents of either a firm's behavior (Dushnitsky & Lavie, 2010) or its performance (Hagedoorn & Schakenraad, 1994), integrative accounts of the interconnected consequences of interfirm alliances for firm behavior and performance are rare. Nevertheless, such accounts are essential to develop a more integrative understanding of the complex, multi-dimensional implications of alliance strategy. As illustrated by the results, such an understanding is especially imperative when behavioral and performance implications diverge, forcing decision makers to consider fundamental trade-offs.

To the extent that consistent data on alliance termination are available, future research might investigate the concurrent effects of alliance governance on a firm's propensity for novel partners and its likelihood of terminating alliances with its current partners. Moreover, this paper offers limited empirical insights into more time-invariant industry characteristics that might explain the cross-industry variance in firms' alliance governance decisions (Hagedoorn, 2002).

Overall, this paper advances research on the relationship between alliance governance and firm performance by showing that some of the characteristics of hierarchical alliance governance that increase a firm's innovativeness simultaneously hamper the firm's ability to engage with novel alliance partners. Therefore, because hierarchical alliance governance can be a

source of inertia in partner selection, less hierarchical governance may be beneficial when novel partners are crucial for a firm's performance. The arguments and evidence in this paper hopefully offer an impetus for further exploration of these mechanisms.

REFERENCES AVAILABLE FROM THE AUTHOR