Original Article

Learning in collaborative R&D: When multinationality matters

Received 15 January 2009; revised 20 June 2010; accepted 17 September 2010

Oana Branzei[a], Masao Nakamura[b,*] and Ilan Vertinsky[b]
[a]Richard Ivey School of Business, The University of Western Ontario, London, Ontario, Canada N6A 3K7.
E-mail: obranzei@ivey.uwo.ca
[b]Sauder School of Business, University of British Columbia, 2053 Main Mall, Vancouver BC, Canada V6T 1Z2.
E-mails: masao.nakamura@sauder.ubc.ca; ilan.vertinsky@commerce.ubc.ca
*Corresponding author.

Abstract We explore when and why MNCs invest more in collaborative R&D than domestic firms. The received wisdom in R&D research is that firms invest more in R&D when strong capabilities lead them to expect higher returns. Yet the stronger firms' capabilities get, the greater their incentives to specialise and the lesser their incentives to collaborate. Prior research resolved this paradox by concluding that firms with strong capabilities do their own R&D, while those with weak capabilities partner with others. However, some firms choose to invest in collaborative R&D despite having strong capabilities. We discuss a multinationality-asymmetry: MNCs and domestic firms invest differentially in collaborative R&D depending on their approach to learning. Using a random sample of manufacturing firms in Japan, we hypothesise and find that MNCs invest less than domestic firms in collaborative R&D when they learn anticipatorily, more when they learn experientially, and equally when they learn vicariously. These differences are significant when and only when firms are motivated to (re)build capabilities.
Asian Business & Management advance online publication, 15 December 2010; doi:10.1057/abm.2010.34

Keywords: collaborative R&D; multinationality; motivation; forward-looking learning; experiential learning; vicarious learning

Collaborative R&D

Recent R&D research has questioned the causality of R&D investments and R&D returns and concluded that 'it is *not* that firms obtain higher returns by investing more in R&D; it is that some firms have higher returns to R&D, thus

they invest more' (Knott, 2008, p. 2054). Rational firms invest more in their own R&D when their capabilities allow them to derive greater returns by leveraging such R&D investments across different assets or activities, and less when their lack of capabilities limits possible returns. Furthermore, firms with higher R&D specialisation can expect greater benefits from such assets or activities than firms with lower R&D specialisation (Knott *et al*, 2009). Firms' own R&D is hard to duplicate because it 'entails alterations and enhancements to existing firm assets, production processes and products' (Helfat, 1994, p. 173). Greater specialisation lowers firms' incentives and/or increases disincentives to engage in collaborative R&D. Thus, specialisation explains and sustains heterogeneity (Knott, 2008).

Despite theoretical and empirical support for the R&D specialisation argument, firms' own R&D has been declining (Tao and Wu, 1997), while the share of co-operative R&D continues to increase (Bleeke and Ernst, 1993; Rood, 2000). This shift has become so noticeable that the definition of what an organisation represents has progressively moved away from single-product firms to 'the network of firms that co-operate to design the whole product, manufacture its components, assemble and market it' (Brusoni *et al*, 2001, pp. 597–598). R&D increasingly takes place within complex innovation systems that bring together corporations, universities, research institutes, R&D consortia, industry associations and professional groups (Rappa and Debackere, 1992; Van de Ven, 1993).

This study extends arguments on the causal prediction of R&D investments by focusing on collaborative R&D (Ring and Van de Ven, 1992; Nakamura and Xie, 1998). There are two distinct reasons why firms would rely on collaborative R&D: necessity and opportunity. Necessity is the longer-standing argument: 'At any time there will be certain kinds of R&D projects that a firm can carry out with some confidence and success, and a wide range of other projects that, while other firms might be able to do them, this firm cannot, with any real confidence' (Nelson, 1991, p. 68). The R&D specialisation argument indirectly supports this position by suggesting that firms lacking fundamental capabilities compensate by absorbing others' knowledge (Knott, 2008).

Although more recent, an opportunity argument has been gathering both theoretical and empirical support (Cantwell, 1992, 1993), especially for multinationals (Florida, 1997). Firms deliberately seek geographically distributed knowledge (Lindqvist *et al*, 2000) to overcome limitations in their knowledge sets (Branzei, 2005) or spill-over pools (Frost, 2001). Multinationality gives firms broader access to a more diverse and valuable knowledge base, either through strategically placed subsidiaries (Hedlund and Rolander, 1990; Hedlund, 1994; Frost, 2001; Frost *et al*, 2002) or through alliances with knowledgeable local partners (for example, universities and research centres, Almeida, 1996).

Both the necessity and the opportunity arguments share an important boundary condition: a lack of specialisation or inferior capabilities constrain

subsequent returns from future R&D investments. This assumption is correct in stable or mature industries and at low degrees of technological uncertainty – settings where the R&D specialisation argument has received strong empirical support. However, this assumption is questionable in rapidly changing environments, where collaborative R&D may offer a pathway to greater future returns (Branzei and Vertinsky, 2006).

Our study explicitly engages this boundary condition by exploring antecedents to investments in collaborative R&D when firms deliberately work with, and learn from, others (Branzei, 2005), irrespective of their *ex ante* capabilities or expected returns to R&D activities (Knott, 2008). The thrust of our study is that motivation and multinationality influence investments in collaborative R&D. We argue for two quasi-moderation effects: motivation and multinationality each have a direct effect and a moderating effect on collaborative R&D.

Learning in Collaborative R&D

Prior literature examines three distinct types of learning: anticipatory, experiential and vicarious. Anticipatory or forward-looking learning projects future actions and examines possible causes and effects as the environment changes (often unpredictably) (Gavetti and Levinthal, 2000). Simulating causal relationships helps firms identify and evaluate path-breaking alternatives before they experience them directly (Holland *et al*, 1986; Simon, 1991). We proxy anticipatory learning in R&D by firms' leadership in basic research, as this helps firms become more competent at R&D and helps protect their R&D from leakage (Knott, 2008, p. 2062). Experiential or backward-looking learning relies on trial-and-error from one-step changes in current alternatives (Cyert and March, 1963). Firms can also learn vicariously by monitoring others' successes and failures (Manz and Sims, 1981; Darr and Kurtzburg, 2000).

Figure 1 introduces our theoretical model. In the next section, we set up this model by first explaining how firms' motivation to (re)build capabilities stimulates investments in collaborative R&D (Hypothesis 1a). Consistent with the growing literature on R&D-driven internationalisation, we expect multinationality to strengthen the positive effect of motivation on collaborative R&D by broadening access to heterogeneous knowledge sets and/or providing additional partner matches (Hypothesis 1b).

We then explain how multinationality conditions the effects of anticipatory, experiential and vicarious learning on collaborative R&D. We hypothesise and find that MNCs are more likely than domestic firms to invest in collaborative R&D at low levels of anticipatory learning, and less likely at high levels

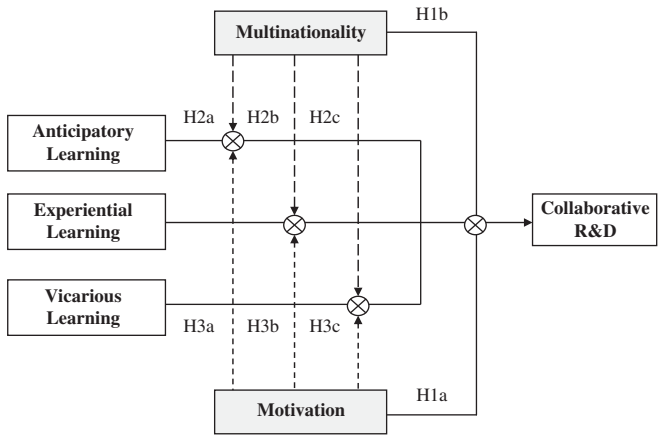

Figure 1: Relational contingencies to learning in collaborative R&D.

(Hypothesis 2a), because leaders in basic research both profit and protect their superior R&D (Knott, 2008), and MNCs have stronger incentives and opportunities for both. In contrast, MNCs are less likely to invest in collaborative R&D at low levels of experiential learning and more likely to do so at high levels of experiential learning (Hypothesis 2b), because experiential learning enhances absorptive capacity (Zahra and George, 2002) and MNCs have more opportunities and stronger incentives to leverage their absorptive capacity across geographically dispersed knowledge pools (Frost, 2001). MNCs and domestic firms should be equally likely (or unlikely) to invest in collaborative R&D at any given level of vicarious learning (Hypothesis 2c), because other firms' lessons transfer only indirectly and imperfectly to bystanders.

Last, we argue and show that the multinationality contingent effects of learning on collaborative R&D depend on firms' motivation. The differential effects of anticipatory (Hypothesis 3a), experiential (Hypothesis 3b) or vicarious learning (Hypothesis 3c) hold only when firms have high levels of motivation.

Taken together, these findings suggest that a specialisation argument holds for collaborative R&D when and only when firms are motivated to (re)build capabilities. When motivation is high, multinationality directs investments asymmetrically: MNCs invest more in collaborative R&D at low levels of anticipatory learning and high levels of experiential learning, whereas domestic firms invest more in collaborative R&D at high levels of anticipatory and low levels of experiential learning.

Hypotheses

Motivation

Prior studies have shown that collaboration helps partners gain knowledge (Ingram and Baum, 1997; Gulati *et al*, 2002) and/or capabilities (Branzei, 2005). We focus on firms' motivation to (re)build internal capabilities (Zahra and George, 2002). The notion that firms seek and assimilate new skills from alliance partners (Cohen and Levinthal, 1990) is now foundational in R&D research, and more broadly in inter-firm knowledge transfer (Simonin, 1997; Branzei, 2005). The link between motivation and expected returns to R&D is also well-established (Almeida, 1996).

The link between firms' motivation to build internal capabilities and their investments in collaborative R&D has not yet been studied. Although often assumed, such motivation is not always necessary: some firms invest in collaborative R&D simply to economise on R&D costs (Steensma and Corley, 2000) or to exploit the skills or resources of their partners, without expectation that they would or could build new capabilities in the process (Brusoni *et al*, 2001). Conversely, some firms may set ambitious capability-building targets but proceed cautiously, with incremental rather than large commitments.

We argue that motivation is important because collaborative R&D partners need to exchange and evaluate complex and sticky knowledge. Figuring out what knowledge is useful typically requires a high degree of joint sense-making, feedback and iterative processing (Szulanski, 1996). Learning theories have proven that firms acquire new skills faster and more completely when they share a similar knowledge base with partners – that is when the firm and its partners have similar cultural norms (Lane and Lubatkin, 1998) or similar strategies (Darr and Kurtzburg, 2000). Greater motivation helps partners plan for, and actively manage, different expectations and processes. This enables more timely and more accurate assessment of partners' knowledge complementarities (Branzei, 2005), improving firms' incentives to engage in collaborative R&D.

Hypothesis 1a: Firms with a higher motivation to (re)build internal capabilities will invest more in collaborative R&D.

Multinationality

There are several reasons to expect that the positive link between motivation and investments in collaborative R&D may be stronger for MNCs than domestic firms, because foreign operations are important sources of new ideas and capabilities (Hakanson and Nobel, 1993). First, MNCs have more options

to access, assimilate and apply new knowledge (Cantwell, 1993; Almeida, 1996). MNCs can access more (Frost, 2001) and/or more heterogeneous (Rosenkopf and Nerkar, 2001) knowledge pools; they also hear more about opportunities (Hakansson and Henders, 1992). Second, motivated MNCs gain timely access to the specialised knowledge bases of local partners, in part because they pursue local talent more aggressively than domestic firms (Almeida, 1996).

Hypothesis 1b: Multinationality moderates the positive relationship between motivation to (re)build internal capabilities and investment in collaborative R&D, such that at any given level of motivation MNCs will invest more than domestic firms in collaborative R&D.

Multinationality-asymmetries

Anticipatory learning

In general, firms that are more proficient at anticipatory learning tend to invest less in collaborative R&D. The better a firm becomes at basic research, the more difficult it becomes to find suitable collaborators – the collaborator pool shrinks as the capabilities of the focal firm evolve (Knott, 2008). Furthermore, as firms develop advanced knowledge in basic research, they become more cautious about opportunistic behaviour in alliance partners, as promising results are very difficult to protect at this early stage and the more the firm knows, the more tempted its partners might be to take advantage of these early discoveries. Simply put, laggards will rationally invest more in collaborative R&D and leaders will rationally invest less.

Anticipatory learning is more important in complex, turbulent environments and in environments where firms face multiple alternatives (Gavetti and Levinthal, 2000). It is also resource-intensive – anticipatory learning requires high levels of attention and exposure to foresee and evaluate these alternatives. MNCs have richer attention resources, which help them explore future possibilities. They also have access to broader, more diverse networks and thus have multiple options to form collaborations with partners with non-overlapping skill sets (Barkema and Vermeulen, 1998; Hansen, 1999; Ahuja, 2000; Lim, 2000). At low levels of anticipatory learning, there is little to lose, because firms lag behind their competitors in basic R&D. However, MNCs may stand to gain more than domestic firms because their global networks offer richer, more diverse and/or more accessible knowledge sets. At high levels of anticipatory learning, however, partners not only have little to add to what firms already know, but may diffuse and dilute firms' lead. As global networks erode such leads more rapidly than local networks, the disincentives are greater for MNCs.

Hypothesis 2a: Multinationality strengthens the negative relationship between anticipatory learning and investment in collaborative R&D, such that MNCs will invest less than domestic firms in collaborative R&D when they are leaders in basic research and will invest more than domestic firms in collaborative R&D when they are laggards in basic research.

Experiential learning

Firms can also learn experientially by incrementally revising their existing routines. These gradual refinements occur gradually, through repeated trial-and-error (Zollo and Winter, 1999). Experiential learning updates the most recent or most similar competences available: firms recall and revise their latest decision, or the decision that was closest in content, context or location to the current situation (Cyert and March, 1963; Nelson and Winter, 1982).

Prior literature generally views collaborative R&D and experiential learning as substitutes: that is firms do one or the other. Firms that cannot learn experientially have incentives to engage in collaborative R&D so they can update routines and processes that may have outlived their usefulness (Barkema and Vermeulen, 1998). Firms that have come to rely on experiential learning often have difficulty establishing the close, transparent and redundant knowledge–transfer relationship required for collaborative R&D.

MNCs may be more likely to engage in both experiential learning and collaborative R&D for two reasons. First, MNCs often rely on collaborative R&D precisely because it is harder to develop and maintain the close and redundant local ties that enable domestic firms to learn experientially in the first place. Second, more diverse global networks help MNCs locate and access knowledge sets that are sufficiently proximate to theirs and thus afford reliable knowledge transfers (Pisano, 1994; Lyles and Salk, 1996; Lane and Lubatkin, 1998; Ahuja, 2000). MNCs may even deliberately internationalise (Almeida, 1996) or form cross-border alliances (Branzei, 2005) to gain access to such knowledge sets.

Hypothesis 2b: Multinationality weakens the negative relationship between experiential learning and investment in collaborative R&D, such that MNCs will invest more than domestic firms in collaborative R&D at high levels of experiential learning, and will invest less than domestic firms in collaborative R&D at low levels of experiential learning.

Vicarious learning

Firms can also learn vicariously by observing the actions of similar organisations (Haunschild and Miner, 1997). Firms typically attend to organisations that are credible, competent and successful (Manz and Sims, 1981). They also rely on the cumulative experience of their industry and spill-overs. Firms

typically benefit equally from vicarious learning under one of two conditions: the knowledge is abundant and relevant, and firms have similar capabilities to interpret the knowledge (Knott *et al*, 2009).

Firms invest in collaborative R&D to supplement vicarious learning. Because vicarious learning is equally useful (or not) to all firms, MNCs and domestic firms should invest equally in collaborative R&D – that is, we should observe a multinationality symmetry across levels of vicarious learning.

Hypothesis 2c: The relationship between vicarious learning and investment in collaborative R&D is not contingent on multinationality, such that MNCs and domestic firms will invest equally in collaborative R&D at any given level of vicarious learning.

The Motivation Contingency to Multinationality-Asymmetries

This multinationality-asymmetry does not apply to all firms. Global networks may provide MNCs with relatively greater access to new opportunities (Dyer and Singh, 1998; Gulati, 1998), but do not guarantee that MNCs will take better advantage of these opportunities. Qualitative studies that take a close look at the processes of knowledge-transfer within global networks suggest that collaborations across different national and institutional cultures, languages and geographical locations add significant complications to knowledge transfers (Hedlund and Ridderstrale, 1995). Global networks offer MNCs broader access to innovative opportunities, but also make the extraction and assimilation of useful ideas more difficult.

Local networks provide more complete and trustworthy information, allowing domestic firms to fine-tune prior capabilities, but do not ensure incremental improvements. We argue that MNCs and domestic firms who learn anticipatorily and experientially invest asymmetrically in collaborative R&D only when they are motivated to (re)build internal capabilities. At low levels of motivation, the unique benefits of global and local networks often remain unharnessed.

Our arguments for multinationality-asymmetries assume that the main motivation for collaborative R&D is to (re)build capabilities. However, R&D may be driven by other goals, independent of the firm's learning approach, including 'learning economies' (Katz, 1986), risk-sharing (Chan and Heide, 1993), status and legitimacy (Baum and Oliver, 1991), even financial gains (Ingram and Inman, 1996). Once we control for these alternative explanations, we should observe no significant relationship between learning approaches and investments in collaborative R&D at low levels of motivation. Furthermore, unless MNCs and domestic firms differ systematically in their propensity or ability to achieve these goals, we should no longer observe multinationality-asymmetry at low levels of motivation.

Hypothesis 2a predicted that the negative relationship between anticipatory learning and investments in collaborative R&D is contingent on multinationality, such that MNCs invest less than domestic firms when they stay ahead of their peers in basic R&D (because they need to work harder to protect their lead) and more than domestic firms when they lag behind peers (because they have greater opportunities to recover the handicap). Multinationality influences the magnitude of these disincentives or incentives only when firms are motivated to (re)build capabilities. When firms are driven by cost efficiencies, risk-sharing, status or financial gains, the disincentives to leaders as well as incentives to laggards are muted. Thus, when motivation is absent, we expect no significant difference between MNCs and domestic firms.

Hypothesis 3a: Anticipatory learning has an asymmetric impact on collaborative R&D for MNCs versus domestic firms when and only when firms have a high level of motivation to (re)build internal capabilities.

Hypothesis 2b predicted that domestic firms either learn experientially or engage in collaborative R&D, whereas MNCs rely on some of both, as they can more easily access (but only partially utilise) complex, tacit and embedded knowledge across different geographies (Cantwell, 1993; Almeida and Kogut, 1999; Frost, 2001). For MNCs, the function of foreign subsidiaries has been gradually expanded to include access and multiple systems of innovation (Jaffe *et al*, 1993). However, greater participation in these global knowledge 'pockets' is not always nor necessarily related to experiential learning (Hakanson and Nobel, 1993), nor even, more broadly, to knowledge transfers (Westney, 1996; Belderbos, 2003). When MNCs tap into different national systems of innovation without a motivation to (re)build capabilities, they are unlikely to find the rich repetitive experiences that can supplement experiential learning. Without such motivation, we do not expect multinationality-asymmetry.

Hypothesis 3b: Experiential learning has an asymmetric impact on collaborative R&D for MNCs versus domestic firms when and only when firms have a high level of motivation to (re)build internal capabilities.

Our last argument, that MNCs and domestic firms make similar investments in collaborative R&D when they learn vicariously, also presumes that firms are motivated to (re)build capabilities. If firms have other priorities, for example, to gain from others' pain, they may initiate or terminate collaborative R&D to take advantage of others' successes or failures.

Hypothesis 3c: Vicarious learning has a symmetric impact on collaborative R&D for MNCs versus domestic firms when and only when firms have a high level of motivation to (re)build internal capabilities.

Methods

Context

We focused on Japan for two main reasons. First, Japanese firms are often credited for their superior R&D capabilities (Cheng and Bolon, 1993; Reger, 1999; Belderbos, 2003). Although Japanese firms have traditionally invested in R&D at home, following a specialisation model (Kenney and Florida, 1994), their investments in overseas manufacturing affiliates and research labs have been increasing (Odagiri and Yasuda, 1996; Belderbos, 2001, 2003). Second, there is substantial geographic variance in R&D among Japanese firms. Some still concentrate R&D locally (for example Nippon Steel; Gassmann and von Zedtwitz, 1999), while others reach out for host-country networks through foreign affiliates (for example Sony; Reger, 1999).

Design

Our research design combined a randomised survey with two waves of secondary data collection. We first sampled 1160 large Japanese manufacturing firms from the first section of the Tokyo Stock Exchange. Responses were received from 215 firms, for a response rate of 18.53 per cent. The questionnaire, jointly developed by a team of Japanese and non-Japanese researchers and then translated into Japanese following the back-translation method (Brislin, 1983), was administered in the native language of the respondents.

We collected secondary data from the *Japan Company Handbook* (*JCH*) to match the survey responses with complete financial records. The secondary data from the *JCH* included prior (1999–2000) and current (2000–2001) performance, R&D expenditures and firm characteristics (size, age, product diversification, internal fragmentation and overseas operations). Another secondary data collection helped identify which firms were part of one of the six *keiretsu* groups (Mitsui, Mitsubishi, Sumitomo, Fuyo, Sanwa and DKB). We obtained complete financial performance data and *keiretsu* membership records for 169 firms, 110 MNCs and 59 domestic. Both MNCs and domestic firms were large manufacturing firms listed in the first section of the Tokyo Stock Exchange. Domestic firms operated exclusively within Japan. MNCs had global operations.

Sample

In our random sample, MNCs and domestic firms did not differ in size, age and current-year performance (see Appendix). MNCs were significantly less

likely than domestic firms to invest in collaborative R&D (16 per cent versus 22 per cent, $P = 0.030$). R&D also varied by multinationality: MNCs invested twice as much in R&D for the year ending March 2001, and their R&D intensity was double that of domestic firms. Annual changes in R&D expenditures were much smaller for MNCs (3 per cent) compared to domestic firms (26 per cent).

The average MNC in our sample had been founded on average 63 years before, and had been listed on Japanese and international stock exchanges for about 41 years. In 2000–2001, it earned net profits of ¥13.4 billion, employed 21 041 workers (about half of whom held jobs at the parent's site) and had 60 subsidiaries. It spent on average 3.9 per cent of consolidated revenues on R&D activities (about ¥34.4 billion); an average of 16.2 per cent of its average annual budget went towards collaborative R&D.

The average domestic firm in our sample had been founded 60 years before, and had been listed on Japanese and international stock exchanges for about 36.7 years. In 2000–2001, it earned net profits of ¥8.2 billion, employed 6136 workers (about two-thirds of whom held jobs at the parent's site) and had 15 subsidiaries. It spent on average 0.5 per cent of consolidated revenues on R&D activities (about ¥10.9 billion); an average of 21.9 per cent of its annual budget went towards collaborative R&D.

Measures

Criterion

Our criterion, *investment in collaborative R&D*, was measured using the self-reported fraction of each company's total R&D budget spent on R&D activities conducted jointly with other firms. Responses were recorded on a 10-interval scale with 10-percentile increments (0–100 per cent).

Predictors

Anticipatory learning was operationalised using the self-reported position in basic research for each firm relative to its competitors. The response scale had five anchors: 1, much more than the industry level; 2, somewhat more than the industry level; 3, about the industry level; 4, somewhat below the industry level; and 5, much below the industry level. We recoded the responses such that leaders in basic research had higher scores on anticipatory learning and laggards in basic research had lower scores on anticipatory learning.

Experiential learning was operationalised using the self-reported answers to the following statement: 'Your company tolerates failures in R&D even though

they are costly'. The response scale included five categories: 1, very much so; 2, generally yes; 3, neutral; 4, does not tolerate failures well; 5, failures are punished. We recoded the responses such that firms which encouraged trial-and-error had higher scores on experiential learning.

Vicarious learning was operationalised using the self-reported answers to the statement 'Your company considers it prudent to follow up risky innovations of others and learn from their experiences' on a five point Likert-type scale with anchors from 1, strongly disagree, to 5, strongly agree.

Quasi-moderators

Multinationality was operationalised using the type of firm: MNC or domestic.

Motivation was operationalised using a three-item scale: (1) 'Your company conducts joint R&D because it is a way to learn from other firms'; (2) 'Your company conducts joint R&D because it helps learn about the capabilities and strategies of other firms'; and (3) 'Your company conducts joint R&D because it helps coordinate your company's activities with other companies' activities. The items were measured using a five-point Likert-type scale with anchors from 1 (strongly agree) to 5 (strongly disagree). Cronbach's α for the three-item scale was 0.65. We used factor analysis (principal components with Varimax rotation) to separate *Motivation* from *R&D Complementarity*, a two-item factor: (1) 'Your company conducts joint R&D to take advantage of complementary skills of your partner firms'; (2) 'Your company conducts joint R&D because it helps share costs and risks, measured on the same scale'. Motivation explained 35.98 per cent of the variance; R&D Complementarity explained another 23.98 per cent. Item loadings for Motivation ranged between 0.609 and 0.830, with the highest cross-loading of 0.221. Item loadings for R&D Complementarity were 0.677 and 0.865, with the highest cross-loadings of 0.358. Both factors were robust to alternative extraction and rotation methods and were measured using factors scores.

Covariates

R&D Characteristics

In addition to *R&D Complementarity*, we included self-reported measures of *R&D Competitiveness* and *R&D Advantage* as well as measures of *R&D Intensity*, *Annual R&D Budget* and $\Delta R\&D$ – all derived using secondary data from the *JCH*. *R&D Competitiveness* was measured using self-reported answers to the statement 'The top management of your company recognises R&D as the major source of competitiveness' on a five-point Likert-type scale with anchors from 1 (strongly disagree) to 5 (strongly agree). *R&D Advantage* was

measured using self-reported answers to the statement 'There is a great deal of advantage in being the first mover in R&D in your business', using the same scale. *R&D Intensity* is a well-established proxy for absorptive capacity (firms' ability to absorb, assimilate and integrate new knowledge; Cohen and Levinthal, 1990). We measured *R&D Intensity* as R&D investments divided by total revenues, both obtained from the *JCH*. *Annual R&D Budget* was also measured using the total R&D expenditures reported by each firm for fiscal year 2000–2001. *ΔR&D* reflected the change in the annual R&D budget over the prior year. Both measures relied on secondary data from the *JCH*.

Firm characteristics

We also controlled for several firm characteristics obtained from the *JCH*. *Age (Founding)* offered a proxy for firm's experience. We subtracted the year of founding from 2000, the year when we collected the survey data. *Age (Listing)* offered a proxy for firm visibility and was similarly computed. *Age (Average Employee)* controlled for the propensity to innovate, because younger workforces may be more creative. *Size* (number of employees for the parent firm), *Sales* (revenues) and *Net Profits* were obtained from the *JCH* for the fiscal year April 2000 to March 2001. *ROA* and *ROE* for the April 1999 to March 2000 period were also included as covariates.

Geography

The model also included covariates for *Revenue Concentration* (the ratio of Parent Revenues to Total Revenues), *Workforce Concentration* (the ratio of Parent Workforce to Total Workforce), *Subsidiaries* (Number of Subsidiaries), *Diversification, Overseas Sales Ratio* and *Foreign Ownership*, all obtained or derived from the *JCH*.

Embeddedness

Because collaboration patterns depend on institutional norms and fields (DiMaggio and Powell, 1991; Odagiri and Yasuda, 1996), we controlled for each firm's embeddedness by its *R&D Cluster Membership* ('In your opinion your company is located in a region(s) which enjoys strong R&D activities and R&D networking activities') and its *R&D Community Membership* ('Do your company's R&D activities take advantage of the R&D community and network – such as technology-based firms and R&D centres – in your local area?'). Self-reported answers on *R&D Cluster Membership* and *R&D Community Membership* were recorded on a five-point scale with anchors: 1, very much so; 2, much so; 3, to some extent so; 4, only marginally so; and 5, not at all, and then reverse-coded so that higher scores on both items reflected a higher degree of

embeddedness. We included a dummy variable for *Keiretsu Membership*, which took a value of 1, if the firm participated in one of the six groups. We also included *Group Membership*, a count variable that used the number of bank endorsements as a proxy for each firm's ties to financial institutions.

Respondent characteristics
We used several covariates to control for respondent characteristics, because professional experience and organisational roles may influence how respondents perceive and interpret information. We included *Organisational Tenure* (the number of years each respondent has worked for the current firm), *Prior Experience* (the number of previous employers), *R&D Division* (whether or not the respondent was directly affiliated with the R&D unit) and dummy variables for *Middle, Upper and Senior Management* to identify a respondent's managerial position.

Analyses

We used analyses of covariance to identify differences between the 110 MNCs and 59 domestic firms in our Japanese sample (see Appendix). All the hypotheses were tested using fully specified multivariate analyses of variance. The reported results test the hypothesised effects on investments in collaborative R&D controlling for whom firms collaborate with (suppliers versus customers)[1]; all findings were robust to the inclusion or exclusion of these two variables. The model included direct and interaction effects of anticipatory, experiential and vicarious learning, multinationality and motivation. It also specified (unreported) direct effects and fully crossed interaction effects of all these variables with R&D Complementarity; our findings were robust to the addition or omission of these effects. All interacting variables were dichotomised. For motivation and R&D Complementarity, we used the standardised mean of the factor scores as the reference point. We used arbitrary cut-off points for anticipatory, experiential and vicarious learning to divide responses roughly in half; the findings were replicated by sensitivity analyses of cut-off points.

Results

Table 1 summarises the zero-order correlations for MNCs and domestic firms. Motivation has a positive correlation with investment in collaborative R&D – strong and significant for domestic firms, but non-significant for MNCs. In line with our predictions, we observe a stronger negative correlation between anticipatory learning and investment in collaborative R&D for MNCs

Table 1: Zero-order correlations

	MNCs					*Domestic firms*				
	1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
1. Collaborative R&D										
2. Anticipatory Learning	**−0.203**	—	—	—	—	−0.045	—	—	—	—
3. Experiential Learning	0.045	**0.189**	—	—	—	−0.108	**0.363**	—	—	—
4. Vicarious Learning	−0.042	−0.003	**0.198**	—	—	−0.044	0.131	0.038	—	—
5. Motivation	0.045	−0.105	0.056	0.088	—	**0.370**	−0.110	0.103	0.181	—
Covariates										
R&D characteristics										
R&D Complementarity	0.020	**−0.192**	−0.126	0.095	**0.319**	0.165	0.073	0.109	0.032	0.008
R&D Competitiveness	0.088	0.092	−0.069	0.151	−0.063	0.084	0.250	**0.342**	0.109	0.111
R&D Advantage	0.058	−0.041	0.098	0.182	−0.065	0.006	0.171	**0.290**	0.000	0.174
Annual R&D Budget	−0.130	0.171	0.078	**−0.203**	0.121	0.015	0.007	0.145	−0.028	−0.045
R&D Intensity	0.046	−0.041	0.038	−0.070	0.017	−0.002	0.115	−0.046	−0.211	−0.129
ΔR&D	−0.011	0.007	−0.180	0.067	0.095	0.021	−0.013	0.107	0.169	0.133
Firm characteristics										
Age (Founding)	0.007	0.097	0.185	−0.108	−0.081	0.016	−0.081	0.006	−0.009	0.035
Age (Listing)	0.104	0.095	0.010	−0.111	0.060	0.157	−0.128	−0.021	0.114	0.046
Age (Average Employee)	0.102	0.021	0.039	0.027	−0.101	0.200	**−0.266**	−0.242	0.116	0.190
Size	−0.121	0.128	0.043	**−0.199**	0.121	−0.060	0.195	0.002	0.059	−0.226
Sales	−0.132	0.138	0.068	−0.188	0.128	−0.066	0.204	−0.010	0.024	−0.178
Net Profit	−0.031	**0.229**	0.096	−0.160	0.076	−0.054	**0.340**	0.026	0.012	−0.081
ROA	−0.069	−0.009	0.035	−0.113	−0.063	−0.116	0.122	0.124	−0.237	−0.139
ROE	−0.180	0.105	−0.058	−0.110	0.022	0.077	0.116	−0.104	−0.111	−0.230

Table 1 *continued*

	MNCs					*Domestic firms*				
	1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
Geography										
Workforce Concentration	0.186	0.085	0.137	0.127	−0.083	0.164	0.139	0.056	−0.118	0.228
Revenue Concentration	**0.262**	−0.**247**	−0.182	0.048	−0.109	0.125	0.117	0.173	−0.015	0.240
Subsidiaries	−0.085	0.070	0.018	−0.**238**	0.083	−0.093	−0.045	0.035	0.104	−0.253
Diversification	**0.247**	−0.088	0.001	−0.119	0.111	−0.094	−0.103	0.126	0.210	0.155
Overseas sales Ratio	−0.051	−0.162	−0.136	−0.012	0.017	—	—	—	—	—
Foreign Ownership	−0.141	0.075	0.138	−0.170	0.085	−0.056	−0.149	−0.075	−0.184	−0.243
Embeddedness										
R&D Cluster Membership	0.046	**0.301**	0.057	−**0.199**	−**0.215**	0.129	0.184	0.238	0.155	0.174
R&D Community Membership	0.145	**0.199**	0.090	−0.028	−0.010	0.135	0.134	0.213	−0.184	−0.059
Keiretsu Membership	0.012	−0.008	−0.056	−0.136	**0.220**	−0.110	−0.238	−0.075	0.164	−0.189
Financial Group Membership	−0.024	−0.118	−0.147	0.110	−0.105	−0.122	−0.052	−0.016	0.044	−0.151
Respondent characteristics										
Organisational Tenure	−0.015	0.014	0.101	0.168	0.171	0.090	−0.254	0.012	−0.021	0.003
Prior Experience	0.064	−0.052	0.021	−0.041	0.174	0.140	0.005	0.188	0.096	0.258
R&D Division	−0.083	−0.120	−0.113	−0.058	−0.103	0.096	−0.034	0.023	0.047	0.080
Middle Mgmt. Dummy	−0.094	−0.018	−0.083	−0.113	0.152	−0.124	−0.085	−0.144	−0.075	0.047
Upper Mgmt. Dummy	0.151	−0.080	0.007	0.148	−0.066	0.215	0.042	0.044	0.057	−0.008
Senior Mgmt. Dummy	−0.028	0.075	0.043	−0.079	−0.120	−0.077	−0.069	−0.002	0.153	0.124

Correlations significant at $P<0.05$ appear in bold.

(−0.203, $P<0.05$) than domestic firms (−0.045, NS). We also observe a stronger negative correlation between experiential learning and investments in collaborative R&D for domestic firms (−0.108, NS) than MNCs. The correlation between vicarious learning and investment in collaborative R&D is negative and similar for both MNCs and domestic firms.

Motivation had the predicted positive effect on investment in collaborative R&D. For MNCs, motivation marginally increased investment in collaborative R&D (20.9 per cent versus 14.4 per cent, $P=0.10$). For domestic firms, motivation triggered a four-fold increase in joint R&D investments (40 per cent versus 10 per cent, $P=0.048$). Hypothesis 1a is supported (Table 2). This effect was robust to controlling for firms' *ex ante* capabilities for, and returns to, R&D. This insight is important, as it suggests a future-oriented causality for the R&D return–R&D investment relationship (Knott, 2008): firms do not invest in collaborative R&D because they expect to achieve greater returns

Table 2: Effects on collaborative R&D

Variables	*Effects*
Predictors	
Anticipatory Learning	0.099*
Experiential Learning	0.015*
Vicarious Learning	0.059*
Moderators	
Motivation *(Hypothesis 1a)*	0.015*
Multinationality	0.374
Multinationality*Motivation *(Hypothesis 1b)*	0.508
Two-way interactions	
Multinationality*Anticipatory learning *(Hypothesis 2a)*	0.000*
Multinationality*Experiential learning *(Hypothesis 2b)*	0.020*
Multinationality*Vicarious learning *(Hypothesis 2c)*	0.436
Three-way interactions	
Motivation*Multinationality*Anticipatory learning *(Hypothesis 3a)*	0.034*
Motivation*Multinationality*Experiential learning *(Hypothesis 3b)*	0.004*
Motivation*Multinationality*Vicarious learning *(Hypothesis 3c)*	0.094*
R^2	*0.571*
Adj. R^2	*217*

All control variables are entered as covariates. The reported model includes (unreported) direct and moderation effects of complementarity; all results are robust to their inclusion or exclusion.
*$P<0.05$.

together than alone; they invest in collaborative R&D because they foresee learning opportunities which may help them do better in the future.

Hypothesis 1b was not borne out by the data. Although the pattern of correlations in Table 1 suggested that motivation may have a stronger effect on collaborative R&D for domestic firms, the two-way interaction between motivation and multinationality was non-significant in the fully crossed model. Taken together, these findings suggest that the direct positive effect of motivation on investment in collaborative R&D is not contingent on multinationality.

Anticipatory learning

Hypothesis 2a predicted a steeper negatively sloped relationship between anticipatory learning and investment in collaborative R&D for MNCs than domestic firms. Figure 2 confirms this prediction, lending support to Hypothesis 2a. MNCs invest more in collaborative R&D at low levels of anticipatory learning (when they lag behind peers in basic research) and invest less in collaborative R&D at high levels (when they are ahead of peers in basic research). Notably, MNCs are more opportunistic collaborators than domestic firms at low levels of anticipatory learning and more cautious at high levels.

Figure 2 also uncovers an unexpected finding: domestic firms that lead in basic research are more (not less) likely to invest in collaborative R&D. This may be a sample-specific anomaly. Japanese firms may feel a responsibility to share basic research, at least among other members of their keiretsu and/or R&D clusters. Although our model controls for these alternative explanations, it is plausible that leaders in basic research may feel a greater debt to promote collective learning. Perhaps close monitoring and overlapping ties offer greater protection to leaders, especially when they behave altruistically. Furthermore, domestic laggards in basic research are also less (not more) likely to invest in collaborative R&D. Given high transparency among Japanese firms, firms which lag behind peers may have fewer opportunities for collaboration; or they may deliberately forego for equity reasons (not wanting to take advantage of others' lead, although it might be economically rational to do so).

Hypothesis 3a further qualified the moderation effect proposed by Hypothesis 2a by contrasting firms with low and high motivation to (re)build capabilities. Our prediction was straightforward: we expected the predicted differences in anticipatory learning to hold only at high levels of motivation. The three-way interaction effect is significant. The graphs shown in Figure 2 show differences between MNCs and domestic firms at low levels of motivation, but reconfirm a steeper negative slope for MNCs at high levels of motivation.

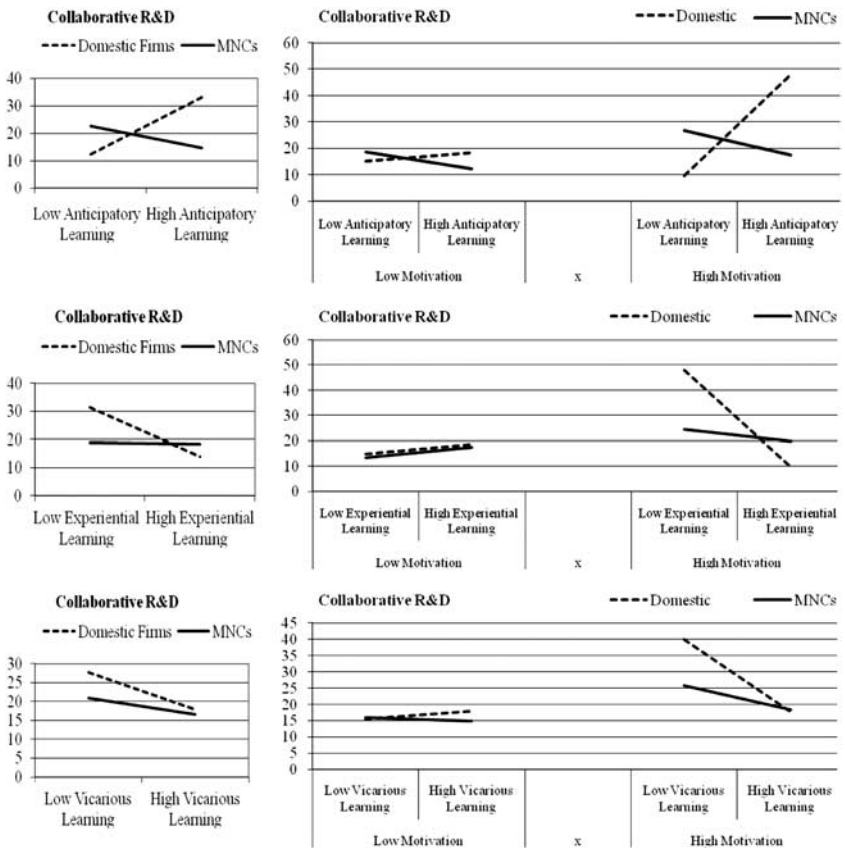

Figure 2: Learning in collaborative R&D: Multinationality and motivation.

Experiential learning

Hypothesis 2b predicted a flatter negatively sloped relationship between experiential learning and investment in collaborative R&D for MNCs than for domestic firms. Table 2 reports a significant two-way interaction, lending support to Hypothesis 2b. For domestic firms, experiential learning and collaborative R&D may work as substitutes: they either do one or the other. MNCs do some of both, at any given level of experiential learning. As shown in Figure 2, the relationship has the expected negative slope: MNCs invest more in collaborative R&D at low levels of experiential learning and less in collaborative R&D at high levels of experiential learning. The slope is also flatter for MNCs than domestic firms. This finding offers an important insight:

firms that rely on experiential learning are less likely to invest in collaborative R&D. This is not surprising: experiential learning requires well-honed routines and micro-processes, whereas collaborative R&D calls for exploration and quick adaptation (Branzei, 2005). Yet some firms are ambidextrous: MNCs are more likely than domestic firms to show such ambidexterity.

Hypothesis 3b further qualified the moderation effect proposed by Hypothesis 2b by contrasting firms with low and high motivation to (re)build capabilities. Our prediction was straightforward: we expected the predicted differences in experiential learning to hold only at high levels of motivation. The three-way interaction effect is significant. The graphs shown in Figure 2 show differences between MNCs and domestic firms at low levels of motivation, and reconfirm a flatter negative slope for MNCs at high levels of motivation.

Vicarious learning

Hypothesis 3c argued against a multinationality-asymmetry when firms can learn vicariously. The interaction effect of vicarious learning and multinationality is non-significant (Table 2), lending support to Hypothesis 3a: MNCs and domestic firms make similar investments in collaborative R&D at any given level of vicarious learning. Figure 2 further shows that both MNCs and domestic firms make smaller investments in collaborative R&D as their level of vicarious learning increases. This empirical regularity suggests that vicarious learning may substitute for collaborative R&D in both local and global networks; this raises several new questions about the interchangeability of processes and/or the outcomes of vicarious learning versus collaborative R&D.

Hypothesis 3c further explained that the symmetry proposed by Hypothesis 2b should hold when firms have high levels of motivation to (re)build capabilities, but may not necessarily hold without such motivation. This three-way interaction effect was significant, lending support to Hypothesis 3c. The graphs shown in Figure 2 confirm that greater vicarious learning reduces R&D collaboration to a similar extent for MNCs and domestic firms when they are motivated to (re)build capabilities. However, we observe the opposite trend in the absence of such motivation: investments in collaborative R&D are constant (that is, insensitive to the level of vicarious learning) for MNCs, and they increase slightly for domestic firms, suggesting that opportunities to learn vicariously may in fact increase domestic firms' investment in collaborative R&D for other reasons (that is, cost- or risk-sharing).

Discussion

Taken together, our findings show hardly any differences between MNCs and domestic firms lacking motivation to (re)build capabilities. Both made very

similar investments in R&D, which varied little by either learning approach (anticipatory, experiential or vicarious) or proficiency (low versus high). Multinationality matters only when firms are motivated to (re)build capabilities. Given such motivation, MNCs and domestic firms exhibited opposite patterns of investment in collaborative R&D for both forward- and backward-looking learning. MNCs invested half as much as domestic firms when they were ahead of rivals in basic research, but twice as much when they lagged behind. MNCs invested twice as much as domestic firms at high levels of experiential learning, but only half as much at low levels. Vicarious learning was not contingent on multinationality: both MNCs and domestic firms invested much less when they could learn vicariously than when they could not, and the difference between MNCs and domestic firms was not significant.

Limitations

Our findings are subject to several important limitations. First, our data and design limits the generalisability of our findings to a single country (Japan), a single industry (manufacturing), and a narrow time window (1999–2001). We chose Japan because of its variability in R&D; we also feel that its growing emphasis on collaborative R&D during the period of study made it an optimal setting for exploring our theoretical argument. At the same time, several of our findings may be context-specific. For example, leaders in basic R&D behave more altruistically, while laggards in basic R&D behave more equitably than profit-maximising arguments would predict. Replications in other settings and/or different time periods may help explain these anomalous but intriguing findings.

Second, our criterion and predictors were collected at one point in time, with the same instrument, raising some concerns about common method bias. We took several steps to mitigate these concerns, including careful design of the questionnaire and separate collection of secondary data whenever possible. We would welcome future replication using different sources of data or at least different respondents. Longitudinal studies that examine the relationship between learning and investments in collaborative R&D over time would be particularly beneficial, because they could control for fixed effects as well as take a closer look at the causality between learning and collaborative R&D.

Conclusion

This study argues that multinationality matters when firms invest in collaborative R&D – but it matters only when firms are motivated to (re)build

capabilities. At high levels of motivation, we predict and find opposite effects of forward- and backward-looking learning for MNCs and domestic firms. The differences are substantial: MNCs collaborated only half as much as domestic firms at high levels of forward-looking learning (leadership in basic research), but twice as much at low levels. They invested twice as much as domestic firms in collaborative R&D at high levels of backward-looking learning (experiential learning by trial-and-error), but only half as much at low levels. This multinationality-asymmetry helps extend received knowledge on R&D by explaining how access to global versus local knowledge networks can (dis)incentivise firms' investments in collaborative R&D.

Acknowledgements

A prior version of the article was presented at the 2008 Association of Japanese Business Studies (AJBS) conference in Milan, where it received a Best Paper Award. The authors thank the conference participants, two anonymous ABM reviewers and special issue editors Elizabeth L. Rose and John Volkmar for their helpful comments and suggestions. Financial support for this project was provided by the Social Science and Humanities Research Council, the Sauder School of Business at the University of British Columbia and the Richard Ivey School of Business at The University of Western Ontario.

About the Authors

Oana Branzei is David G. Burgoyne Faculty Fellow, Building Sustainable Value Research Fellow and Assistant Professor of Strategy at the Richard Ivey School of Business, University of Western Ontario. She teaches Strategy and Sustainability in the HBA, MBA, EMBA and PhD programs and researches the relational origins of competitive advantage and the formation of path-breaking capabilities and strategies. Her most recent papers have appeared in the *Journal of International Business Studies* 41(5), 2010; *Organisation* 17(5), 2010; and the *Journal of Business Ethics* (forthcoming).

Masao Nakamura is Professor and Konwakai Japan Research Chair in the Sauder School of Business and Institute of Asian Research of the University of British Columbia. His recent publications appear in the *Asia Pacific Journal of Management* (forthcoming), *Corporate Social Responsibility and Environmental Management* (2010) and the *Journal of Asian Business* (forthcoming). His book *Changing Corporate Governance Practices in China and Japan: Adaptations of Anglo-American Practices*, was published by Palgrave Macmillan in 2008.

Ilan Vertinsky is Vinod Sood Professor of International Business Studies, Strategy and operations logistics. He is also a member of the Institutes of Asian Research and Resources, Environment and Sustainability, and director of the Center of International Business Studies at the University of British Columbia. His most recent publications appeared in *Small Business Economics* (Web, October 2009); *Public Money and Management* (2009); *Strategic Organisation* (2008) and the *Journal of Business Venturing* (2008).

Note

1 Collaborative projects with suppliers were operationalised as self-reported answers to the following question: 'How frequently do your supplier firms participate in your company's R&D projects in the area of new product development?' Responses were recorded on a 10-interval scale with 10 per cent increments from 0 per cent (never) to 100 per cent (all projects). An identical format was followed for assessing R&D collaborations with customers. Both variables were measured using self-reported answers to the following statement: 'please indicate by a circle on the given line the fractions of R&D projects that represent joint R&D activities between your company and other companies (suppliers and customers)'.

References

Ahuja, G. (2000) Collaboration networks, structural holes and innovation. *Administrative Science Quarterly* 45(3): 425–455.

Almeida, P. (1996) Knowledge sourcing by foreign multinationals: Patent citation analysis in the US semiconductor industry. *Strategic Management Journal* 17: 155–165.

Almeida, P. and Kogut, B. (1999) Localisation of knowledge and the mobility of engineers in regional networks. *Management Science* 45: 905–917.

Barkema, H.G. and Vermeulen, F. (1998) International expansion through start-up or acquisition. *Academy of Management Journal* 41(1): 7–26.

Baum, J.A.C. and Oliver, C. (1991) Institutional linkages and organisational mortality. *Administrative Science Quarterly* 36: 187–218.

Belderbos, R.A. (2001) Overseas innovation by Japanese firms: An analysis of patent and subsidiary data. *Research Policy* 30(2): 313–332.

Belderbos, R. (2003) Entry mode, organisational learning and R&D in foreign affiliates: Evidence from Japanese firms. *Strategic Management Journal* 24(3): 235–259.

Bleeke, J. and Ernst, D. (1993) *Collaborating to Compete*. Toronto: John Wiley.

Branzei, O. (2005) Product innovation in heterogeneous R&D networks. Unpublished Dissertation, University of British Columbia.

Branzei, O. and Vertinsky, I. (2006) Innovation pathways to product innovation capabilities in SMEs. *Journal of Business Venturing* 21(1): 75–105.

Brislin, R.W. (1983) Cross-cultural research in psychology. *Annual Review of Psychology* 34: 363–400.

Brusoni, S., Prencipe, A. and Pavitt, K. (2001) Knowledge specialisation, organisational coupling and the boundaries of the firm. *Administrative Science Quarterly* 46: 597–621.

Cantwell, J. (1992) The theory of technological competition and its application to international production. In: D.G. McFeteridge (ed.) *Foreign Investment, Technology and Economic Growth*. Calgary, Canada: University of Calgary Press, pp. 33–67.

Cantwell, J. (1993) The internalisation of technological competence and its implications for competitiveness. In: O. Grandstrand, H. Hakanson and S. Sjolander (eds.) *Technology Management and International Business*. Chichester, UK: Wiley, pp. 137–162.

Chan, P.S. and Heide, D. (1993) Strategic alliances in technology. *SAM Advanced Management Journal* 58(4): 9–17.

Cheng, J.L.C. and Bolon, D.S. (1993) The management of multinational R&D. *Journal of International Business Studies* 24(1): 1–18.

Cohen, W.M. and Levinthal, D.A. (1990) Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35: 128–152.

Cyert, R.M. and March, J.G. (1963) *A Behavioural Theory of the Firm*. Englewood Cliffs, NJ: Prentice-Hall.

Darr, E. and Kurtzburg, T. (2000) Selecting knowledge transfer partners: An investigation of strategic similarity and difference. *Organisational Behavior and Human Decision Processes* 64: 28–44.

DiMaggio, P.J. and Powell, W.W. (1991) The iron cage revisited: Institutional isomorphism and collective rationality in organization fields. In: P.J. DiMaggio and W.W. Powell (eds.) *The New Institutionalism in Organizational Analysis*. Chicago, IL: University of Chicago Press, pp. 63–81.

Dyer, J.H. and Singh, H. (1998) The relational view: Cooperative strategy and sources of inter-organisational competitive advantage. *Academy of Management Review* 23(4): 660–679.

Florida, R. (1997) The globalisation of R&D: Results of a survey of foreign-affiliated R&D laboratories in the USA. *Research Policy* 26: 85–103.

Frost, T.S. (2001) The geographic sources of foreign subsidiaries' innovation. *Strategic Management Journal* 22: 101–123.

Frost, T.S., Birkinshaw, J.M. and Ensign, P.C. (2002) Centers of excellence in multinational corporations. *Strategic Management Journal* 23: 997–1018.

Gassmann, O. and von Zedtwitz, M. (1999) New concepts and trends in international R&D organisation. *Research Policy* 28(2–3): 231–250.

Gavetti, G. and Levinthal, D. (2000) Looking forward and looking backward: Cognitive and experiential search. *Administrative Science Quarterly* 45: 113–137.

Gulati, R. (1998) Alliances and networks. *Strategic Management Journal* 19: 293–317.

Gulati, R., Dialdin, D.A. and Wang, L. (2002) Organisational networks. In: J.A.C. Baum (ed.) *Companion to Organisations*. Oxford: Publishers, pp. 281–303.

Hakanson, L. and Nobel, R. (1993) Determinants of foreign R&D in Swedish multinationals. *Research Policy* 22: 397–411.

Hakansson, H. and Henders, B. (1992) International co-operative relationships in technological development. In: M. Forsgren and J. Johanson (eds.) *Managing Networks in International Business*. Amsterdam, the Netherlands: Gordon & Breach.

Hansen, M.T. (1999) The search-transfer problem: The role of weak ties in sharing knowledge across organisational sub-units. *Administrative Science Quarterly* 44: 82–111.

Haunschild, P.R. and Miner, A.S. (1997) Modes of inter-organisational imitation: The effects of outcome salience and uncertainty. *Administrative Science Quarterly* 42: 472–500.

Hedlund, G. (1994) A model of knowledge management and the N-form corporation. *Strategic Management Journal* 15: 73–90.

Hedlund, G. and Ridderstrale, J. (1995) International development projects: Key to competitiveness, impossible or mismanaged? *International Studies of Management and Organisation* 25(1–2): 158–184.

Hedlund, G. and Rolander, D. (1990) Action in hierarchies: New approaches to managing the MNC. In: C.A. Bartlett, Y. Doz and G. Hedlund (eds.) *Managing the Global Firm*. New York: Routledge.

Helfat, C.E. (1994) Firm-specificity in corporate applied R&D. *Organisation Science* 5(2): 173–184.

Holland, J., Holyoak, K., Nisbett, R. and Thagard, P. (1986) *Induction: Processes of Inference, Learning and Discovery*. Cambridge, MA: MIT.

Ingram, P. and Baum, J.A. (1997) Opportunity and constraint: Organisations' learning from the operating and competitive experience of industries. *Strategic Management Journal* 18: 75–98.

Ingram, P. and Inman, C. (1996) Institutions, inter-group competition and the evolution of hotel populations around Niagara Falls. *Administrative Science Quarterly* 41: 629–658.

Jaffe, A., Trajtenberg, M. and Henderson, R. (1993) Geographical localisation of knowledge spill-overs by patent citations. *Quarterly Journal of Economics* 108(3): 577–598.

Katz, M. (1986) An analysis of cooperative research and development. *Rand Journal of Economics* 17(4): 527–543.

Kenney, M. and Florida, R. (1994) The organisation and geography of Japanese R&D: Results from a survey of Japanese electronics and biotechnology firms. *Research Policy* 23: 305–323.

Knott, A.M. (2008) R&D/returns causality: Absorptive capacity or organisational IQ. *Management Science* 54(12): 2054–2067.

Knott, A.M., Posen, H.E. and Wu, B. (2009) Spill-over asymmetry and why it matters. *Management Science* 55(3): 372–388.

Lane, P.J. and Lubatkin, M. (1998) Relative absorptive capacity and inter-organisational learning. *Strategic Management Journal* 19: 461–477.

Lim, K. (2000) The many faces of absorptive capacity: Spill-overs of copper interconnect technology for semiconductor chips. Cambridge: MIT, mimeo.

Lindqvist, M., Solvell, O. and Zander, I. (2000) Technological advantage in the international firm. *Management International Review* 40(1): 95–126.

Lyles, M.A. and Salk, J.E. (1996) Knowledge acquisition from foreign parents in international joint ventures: An empirical examination in the Hungarian context. *Journal of International Business Studies* 27(5): 877–903.

Manz, C.C. and Sims, H.P. (1981) Vicarious learning: The influence of modelling on organisational behaviour. *Academy of Management Review* 6(1): 105–113.

Nakamura, M. and Xie, J. (1998) Nonverifiability, noncontractibility and ownership determination models in foreign direct investment, with an application to foreign operation in Japan. *International Journal of Industrial Organisation* 16: 571–599.

Nelson, R. and Winter, S. (1982) *An Evolutionary Theory of Economic Change*. Cambridge: Harvard University Press.

Nelson, R.R. (1991) Why do firms differ, and how does it matter? *Strategic Management Journal* 12: 61–74.

Odagiri, H. and Yasuda, H. (1996) The determinants of overseas R&D by Japanese firms. *Research Policy* 25: 1056–1079.

Pisano, G.P. (1994) Knowledge, integration and the locus of learning: An empirical analysis of process development. *Strategic Management Journal* 15: 85–100.

Rappa, M. and Debackere, K. (1992) Technological communities and the diffusion of knowledge. *R&D Management* 22: 209–220.

Reger, G. (1999) How R&D is co-ordinated in Japanese and European multinationals. *R&D Management* 29(1): 71–88.

Ring, P. and Van de Ven, A. (1992) Structuring co-operative relationships between organisations. *Strategic Management Journal* 13(7): 483–504.

Rood, S. (2000) *Government Laboratory Technology Transfer: Process and Impact*. Burlington, VT: Ashgate.

Rosenkopf, L. and Nerkar, A. (2001) Beyond local search: Boundary-spanning, exploration and impact in the optical disk industry. *Strategic Management Journal* 22: 287–306.
Simon, H.A. (1991) Bounded rationality and organisational learning. *Organisation Science* 2(1): 125–134.
Simonin, B.L. (1997) The importance of collaborative know-how. *Academy of Management Journal* 40(5): 1150–1174.
Steensma, H.K. and Corley, K.G. (2000) On the performance of technology-sourcing partnerships: The interaction between partner interdependence and technology attributes. *Academy of Management Journal* 43(6): 1045–1067.
Szulanski, G. (1996) Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal* 17: 27–43.
Tao, Z. and Wu, C. (1997) On the organisation of co-operative research and development. *International Journal of Industrial Organisation* 15: 573–596.
Van de Ven, A.H. (1993) A community perspective on the emergence of innovations. *Journal of Engineering and Technology Management* 10: 23–51.
Westney, D.E. (1996) Japanese multinationals in North America. In: L. Eden (ed.) *Multinationals in North America*. Calgary, Canada: University of Calgary Press, pp. 53–275.
Zahra, S.A. and George, G. (2002) Absorptive capacity: A review, reconceptualisation and extension. *Academy of Management Review* 27(2): 185–203.
Zollo, M. and Winter, S. (1999) Deliberate learning and the evolution of dynamic capabilities. *Organisation Science* 3(3): 339–351.

APPENDIX

See Table A1.

Table A1: Sample characteristics and comparison of MNCs and domestic firms in Japan

Variables	*MNCs*		*Domestic firms*		*Comparison*	
	Mean	*SD*	*Mean*	*SD*	*F*	*Sig.*
Criterion						
Collaborative R&D	16.250	1.539	21.964	2.097	4.825	0.030
Predictors						
Anticipatory Learning	2.760	0.087	2.804	0.118	0.090	0.765
Experiential Learning	3.394	0.089	3.232	0.121	1.173	0.280
Vicarious Learning	3.692	0.066	3.643	0.090	0.198	0.657
Moderator						
Motivation	3.449	0.064	3.437	0.087	0.012	0.912
Covariates						
R&D Characteristics						
R&D Complementarity	4.129	0.069	4.017	0.094	0.920	0.339
R&D Competitiveness	4.211	0.077	4.104	0.109	0.634	0.427
R&D Advantage	4.105	0.073	3.979	0.103	0.994	0.320
Annual R&D Budget	34355.421	7764.043	1752.563	10922.677	5.919	0.016
R&D Intensity	3.910	0.387	1.378	0.545	14.369	0.000
ΔR&D	−3.016	5.906	−25.922	8.309	5.049	0.026
Firm Characteristics						
Age (Founding)	62.863	1.955	59.708	2.751	0.874	0.351
Age (Listing)	41.242	1.561	36.688	2.196	2.859	0.093

Table A1 *continued*

Variables	*MNCs*		*Domestic firms*		*Comparison*	
	Mean	*SD*	*Mean*	*SD*	*F*	*Sig.*
Age (Average Employee)	38.632	0.394	39.015	0.554	0.317	0.574
Size	21041.621	4361.731	6520.750	6136.208	3.720	0.056
Sales	761806.316	172946.920	557143.750	243306.671	0.470	0.494
Net Profit	13365.895	5800.079	15766.250	8159.718	0.057	0.811
ROA 2000	1.747	0.365	0.395	0.514	4.605	0.034
ROE 2000	1.013	6.266	−13.903	8.815	1.902	0.170
Geography						
Workforce Concentration	0.469	0.020	0.688	0.029	38.321	0.000
Revenue Concentration	0.777	0.061	0.822	0.086	0.187	0.666
Subsidiaries	60.495	11.026	15.271	15.511	5.647	0.019
Diversification	2.484	0.109	1.949	.153	8.138	0.005
Foreign Ownership	10.336	1.213	9.935	1.707	0.037	0.849
Embeddedness						
R&D Cluster Membership	2.863	0.100	2.854	0.140	0.003	0.958
R&D Community Membership	2.432	0.096	2.292	0.135	0.714	0.399
Keiretsu Membership	0.253	0.039	0.063	0.055	7.833	0.006
Financial Group Memberships	4.811	0.128	5.229	0.181	3.565	0.061
Respondent Characteristics						
Organisational Tenure	16.968	0.612	13.396	0.862	11.422	0.001
Prior Experience	2.589	0.322	2.792	0.452	0.133	0.716
R&D Division	0.579	0.050	0.646	0.071	0.589	0.444
Middle Mgmt. Dummy	0.326	0.048	0.313	0.068	0.028	0.869
Upper Mgmt. Dummy	0.495	0.051	0.417	0.072	0.774	0.381
Senior Mgmt. Dummy	0.137	0.035	0.125	0.049	0.038	0.845

