Impacts of international and domestic R&D alliances on return on assets: Some counterintuitive evidences

Hélène Delerue, Dr.
Professor, Researcher at the MATEB
Département Management et Technologie
École des sciences de la gestion
Université du Québec à Montréal
315 Ste. Catherine East
Montreal (QC) Canada H2X 3X2
Tel.: (514) 987-3000, x 1583
Fax.: (514) 987-3343
Email: vidot-delerue.helene@uqam.ca

Albert Lejeune, Ph.D.
Professor, Researcher at the MATEB
Département Management et Technologie
École des sciences de la gestion
Université du Québec à Montréal
315 Ste. Catherine East
Montreal (QC) Canada H2X 3X2
Tel.: (514) 987-3000, x 4844
Fax.: (514) 987-3343
Email: lejeune.albert@uqam.ca

Data collection and analysis were undertaken thanks to the Quebec FQRSC Research Team Grant # 65679854 (2006-2010)

Impacts of international and domestic R&D alliances on return on assets: Some counterintuitive evidences

ABSTRACT

This study investigates the impacts of domestic and international R&D alliances on the return on assets. The hypothesis is tested using data from US biotechnology firms. This paper presents and tests a model in which firms leverage their development activities through domestic and international R&D alliances. Our analysis reveals a counterintuitive result: While the relationship between the intensity of domestic R&D alliances and ROA is negative, the intensity of international R&D alliances is positively related to firm returns.

Key words: domestic R&D alliance, International R&D alliance, company financial performance, biotechnology

1. Introduction

R&D strategic alliances have become a key strategic tool for the firm in the new competitive environment. Through R&D collaboration, firms may access unique technologies that are not yet available in-house. Even if R&D activities are less internationalized than production or marketing activities, they have nevertheless grown significantly over the past 15 years (OECD, 2000). Globally dispersed R&D operations may provide the firms a competitive advantage that cannot be reached in the situation where R&D operations are centralized in a single country (Brouthers et al., 2001; Kuemmerle, 1999).

Nevertheless, when alliances are extensively used, evidence suggests that many of them doesn't reach expectations or fail (Kogut, 1989). The alliance performance has predominantly been seen as a result of either (1) conditions surrounding their formation (e.g. Park & Ungson, 1997) or (2) collaborative processes and partners interactions (e.g. Ring & Van de Ven, 1994; Deeds & Rothaermel, 2003).

Nonetheless, empirical work investigating the performance of alliances is scarce, largely because of methodological barriers (Gulati, 1998; Hoang & Rothaermel, 2005). The specific literature shows that the longevity of alliances has been used as a proxy for their performance (Barkema et al., 1997), perceptual measures obtained from one of the partners in a given alliance (Parkhe, 1993) or the reaction of the stock market to alliance announcements (Anand & Khanna, 2000). Other studies have investigated interfirms cooperation and its performance implications (Hagedoorn & Schakenraad, 1994; Combs & Ketchen, 1999; Baum et al, 2000).

Consequently, the understanding the R&D alliances impacts is key for the decision-makers. In this study, by comparing domestic and international R&D alliances, we sought to link the intensity of R&D collaborative activity in biotechnology and pharmaceutical industry to the return on assets. Domestic R&D alliances are not managed like international alliances (Lichtenthaler & Lichtenthaler, 2004); moreover, their motivations are often different (Gassel

& Pascha, 2000) in a context of cross-border activities where additional factors have to be taken into account (Osborn & Hagedoorn, 1997):

Our analysis of the impacts of R&D alliances is conducted at the intra-industry level. In the results interpretation, we avoided two kind of bias: differential industry technological opportunities and inter-industry market-structure effects. But the precision gain obtained by focusing on a single industry generates the hazard for this industry of being atypical (Berg & Friedman, 1977).

In a first part of the paper, R&D alliances characteristics are presented. Then we describe the statistically testable hypotheses that relate firm's rates of return to a set of variables, including R&D alliances activities. Then we follow with the methodology, the results and the discussion.

2. Domestic and international R&D alliance activities

R&D alliance is defined as any activity "which seek to leverage the resources and competencies of partners in order to exchange or develop technology" (Li & Zong, 2003, p. 101). In the biopharma industry, the rising number of this type of cooperation is mainly due to the evolving nature of the innovation process i.e. growing complexity, higher risks and costs of innovation (Hagedoorn, 1993; Robinson & Stuart, 2003). In biopharma field, alliances are widely used at all stages of the drug development process, but are mostly prevalent in the pre-clinical testing phase (Robinson & Stuart, 2003): more than 50%. The benefits of these alliances are self justified: R&D alliances allow the co-financing of the R&D efforts, the reducing of uncertainty and costs, the sharing of skills and the inflow of internal resources or assets in the innovation process (Hagedoorn, 1993). In the biopharmaceutical industry, they represent a viable way for biopharmaceutical companies to gain access to the complementary assets required to increase their rate of new products development (Deeds & Hill., 1996).

Indeed, the faster a firm develops new products and brings them to market, the more likely it is to capture the first mover advantages.

Empirical research has reported that leading firms engage in an increasing number of R&D alliances (Lichtenthaler & Lichtenthaler, 2004; Deeds & Rotherhamel, 2003). Baum et al (2000) show that in the case of a biotechnology start-up, the number of alliances they have contracted influence their rate of innovation and more specifically their number of patents. Through alliances, companies acquire new skills, have access to new markets and improve their overall performance (Hagedoorn & Schakenraad, 1994).

Hence, it is expected that a high intensity of R&D domestic alliance is transformed into an increased return on assets.

Hypothesis 1

There is a positive link between the intensity of domestic R&D alliance and the return on assets.

An increasing number of R&D alliances are international, involving partners from several countries and even continents (OECD, 2000). An international alliance is a collaborative relationship between a local entity and an overseas counterpart encompassing agreements to co-operate in joint activities such as development, research or technology innovation (Saffu & Mamman, 2000). In order for the firms to maximise their distinct competitive advantages, their best strategic option is to look for the best resources available worldwide. Nevertheless, international alliances bring new challenges not found within domestic alliances (Sirmon & Lane, 2004). They are riskier than domestic R&D alliances, given the cultural differences between partners (Barkema & Vermeulen, 1997; Sirmon & Lane, 2004). International alliances “reside at the confluence of different cultures, including national, corporate and occupational” (Salk & Shenkar, 2001, p. 163). The cultural distance raises partners’ business uncertainty, intellectual property protection problems (Yang et al., 2004), and information

costs, and increases partners' needs for efficient coordination and control mechanisms (Merchant, 2005). International R&D alliances are hence very complex to manage successfully, partly due to the matching difficulty of the goals and aspirations of autonomous organizations, headquartered in two or more countries (Nielsen, 2007).

Consequently, international alliances are frequently plagued with high degrees of instability and poor performance (Beamish & Delois, 1997). Moreover, some authors suggest that international alliances are not intended to fulfill standard financial objectives such as profit generation (Nielsen, 2007). Geringer and Hebert (1991) argue that international alliances may be considered successful by one or all of the parents despite poor financial results, suggesting that the performance of the alliance have to be distinguished from the impact of the alliance on financial company performance.

Hence, it is expected that a high intensity of R&D international alliance is transformed into a decreased return on assets.

Hypothesis 2

There is a negative link between the intensity of international R&D alliance and the return on assets.

3. The return on asset

The return on assets (ROA) is used in this study as a financial performance measure (De Carolis, 2003). The ROA is a measure of the efficiency of business operations (Hill *et al.*, 1992). ROA is dependent upon a number of factors suggested by both theory and previous empirical work, such as the characteristics of relationships and the relational structure (Rowley et al., 2000); the interfirm assets specificity (Dyer, 1996), the size of the firm (Hall & Weiss, 1967), the R&D intensity (Berg & Friedman, 1977), the total of sales (Roberts, 1999). Hall and Weiss (1967) found a positive rate of return effect due to the firm size. Roberts' study (1999) of firms in the U.S. pharmaceutical industry found that the innovative

propensity of a firm (defined as the average proportion of sales derived from new products) positively influences the degree to which above average profits (ROA) persists over time.

The rate of return has also been associated with firm market power and barriers to entry (Demsetz & Villalonga, 2001), the role of information-based trading (Easley et al. 2002), the advertising intensity, the financial structure.

In this study, we introduce in the model the R&D expenditures and the size of the firm. The size variable may serves as a proxy for the market power and the barriers to entry (Hall & Weiss, 1967; Berg & Friedman, 1977). The other variables are omitted. First, some of them are only relevant when analysing dyadic or a particular alliance relationship. Second, "advertising expenditure" is not relevant in the biotechnology industry case, because other industries instead of final consumers, are buying most of the biotechnology industry output.

4. Research Methods

4.1. Data and sample

The research setting is the US biotechnology industry. This term describes the industry composed of biotechnology companies focusing on the discovery of new drugs. The number of US biotechnology firms has grown by 12% since 1998, up to 1573 in 2006.

The data were obtained from *Compustat*. A systematic random sample of 400 firms was obtained from this data base. The present study analyses this sample. The various interorganizational agreements are taken from *BioScan*, press articles and firms web sites. The availability of appropriate data restricted the analysis to a sample of 312 enterprises.

4.2. Measures

Descriptions of the measures used for the independent and dependent variables are given below.

Return on asset

Return on assets measures a company's earnings in relation to all of the resources it had at its disposal. Return on assets is measured using the data from *Compustat*.

Intensity of R&D collaboration activity

We measure intensity of collaboration activity by the number of R&D alliances a biotechnology firm has entered into with an incumbent firm or another biotechnology firm. We distinguish domestic collaborations (when the partner is American) from international collaboration (when the partner is from a foreign country).

The measure is defined as

$$\text{R\&D alliances}_{it} = \frac{\sum_t number\ of\ R\ \&\ D\ alliances\ of\ type\ i\ in\ year\ t}{Number\ of\ firms\ in\ the\ data\ file\ in\ year\ t}$$

Where i = 1, 2 (1 = domestic alliance; 2 = international alliance)

Research and Development. Firm expenditures on research and development were measured using the data from *Compustat*. Past R&D expenditures may be expected to impact upon current profits. The measured rate of return on assets will depend on past R&D investments (Berg & Friedman, 1977). R&D expenditure was chosen in preference to R&D intensity given that the amount of sales is equal to 0 for a majority of firms.

Size of the firm. According to Hall and Weiss (1967) "A definition (of size) expressed in asset terms is superior to a "sales" or "employment" concept of size because it is the difficulty of financing large lumps of assets that limits entry to certain fields ». Consequently, we include in the model the size-of-firm variable in logarithmic form (log (total of assets).

We tested two models. The first model of the cross sectional variation in rate-of-return is the following:

$$ROA_t = \beta_0 + \beta_1\ RDE_{t-1} + \beta_2\ LogA_t + \beta_3 \sum_{t=1996}^{2005} ALL_{1t} + \beta_4 \sum_{t=1996}^{2005} ALL_{2t} + \varepsilon_t \quad \textit{(model 1)}$$

Where,
ROA = Return on asset
RDE = R&D expenditures
A = Total of assets

ALL1 = incidence of domestic R&D alliances
ALL2 = incidence of international R&D alliances

Nevertheless, past R&D expenditures may be expected to impact upon current profits. Time-series estimates were computed for the effects of past R&D on current profitability. The method used to estimate the w_k coefficients is based on a second-order polynomial according to the Among lag procedure.

Hence, the second model is the following:

$$ROA_t = \beta_0 + \beta_1 \sum_{k=1}^{r} w_r RDE_{,t-r} + \beta_2 LogA_t + \beta_3 \sum_{t=1996}^{t} ALL_{1t} + \beta_4 \sum_{t=1996}^{t} ALL_{2t} + \varepsilon_t \quad \textit{(model 2)}$$

Where,
ROA = Return on asset

$\sum_{k=0}^{r} w_r RDE_{,t-r}$ where RDE = R&D expenditures and w_k, weights from a polynomial distributed lag, *k* is the number of periods covered by the lag function, w_r the coefficients of the lag structure: w_1, w_2, …, w_k. Thus there are k coefficients to be determined.
A = Total of assets
ALL1 = incidence of domestic R&D alliances
ALL2 = incidence of international R&D alliances

In this case:

$$W_r = \alpha_0 r^2 + \alpha_1 r + \alpha_2. \geq 0$$

This restriction is imposed because it is assumed that beyond some time periods k, R&D expenses variations no longer will affect and at worse will not reduce current return on assets.

This can be broken down as follows:

$$w0 = \alpha_0 0^2 + \alpha_1 0^2 + \alpha_2 = \alpha_2 \geq 0$$

$$w_1 = \alpha_0 1^2 + \alpha_1 1^2 + \alpha_2 = (\alpha_0 + \alpha_1 + \alpha_2) \geq 0$$

$$w2 = \alpha_0 2^2 + \alpha_1 2 + \alpha_2 = (4\,\alpha_0 + 2\,\alpha_1 + \alpha_2) \geq 0$$

$$w3 = \alpha_0 3^2 + \alpha_1 3 + \alpha_2 = (9\,\alpha_0 + 3\,\alpha_1 + \alpha_2) \geq 0$$

each w_r coefficients then replaced in by the corresponding polynomial equation.

$$\sum_{k=0}^{r} w_r RDE_{,t-r} = \sum_{k=0}^{r} (\alpha_0 r^2 + \alpha_1 r + \alpha_2) RDE_{t—r}$$

$$= \alpha_0 \sum_{k=0}^{r} r^2 RDE_{t-r} + \alpha_1 \sum_{k=0}^{r} r RDE_{t-r} + \alpha_2 \sum_{k=0}^{r} RDE_{t.-r}$$

For $0 \leq r \leq 3$ the final model 2 is :

$$ROA_t = \beta_0 + \beta_1 (\alpha_0 (RDE_{t-1} + 4\,RDE_{t-2} + 9\,RDE_{t-3}) + \alpha_1 (RDE_{t-1} + 2RDE_{t-2} + 3RDE_{t-3}) + \alpha_2 (RDE_t + RDE_{t-1} + RDE_{t-2} + RDE_{t-3}) + \beta_2 \text{ Log } A_t + \beta_3 \sum_t ALL_{1t} + \beta_4 \sum_t ALL_{2t} + \varepsilon_t$$

Our arguments indicate that the coefficients of equation should be:

$\beta_1 > 0$; $\beta_2 > 0$; $\beta_3 > 0$; $\beta_4 < 0$

The main implications for this study concern the sign of β_3 and the sign of β_4. Firms engaging in intensive domestic R&D collaborations will have a higher return on assets than international R&D alliances.

As the sample is cross-sectional and gathers firms with various sizes, we decided to correct risks of heteroscedasticity by using a weighted least square estimation (WLS): an efficient estimator in presence of heteroscedasticity.

5. Results and analysis

The regression results are presented in Table 1 *(model 1)* and in Table 2 *(model 2).* Table 3 presents main descriptive statistics and elasticities.

For model 1, the appropriate data available are restricting the analysis to a sample of 312 enterprises. Fewer observations on R&D expenditures restricted the sample size for model 2.

Table 1
Cross Sections of the Rate of Return in biotechnology *(model 1)*

Year	N	β_1 R&D expenditure	β_2 Size	β_3 R&D domestic alliance	B_4 R&D international alliance	Ajusted-R^2 F
2005	312	-.616*** (-4.376)	.880*** (6.336)	-.230* (-2.302)	.190^{+} (1.825)	.349 9.300***

$ROA_t = \beta_0 + \beta_1 RDE_{t-1} + \beta_2 \text{Log} A_t + \beta_3 \sum_t ALL_{1t} + \beta_4 \sum_t ALL_{2t} + \varepsilon$

Dependent variable: Compustat's return on asset (ROA)
( ) = t Statistic, *** $p < .001$, ** $p < .001$ * $p < .05$, $^{+}p < .10$

The results from model 1 do not supported our hypotheses. The coefficient β_3 is significantly negative *($p = .025$)* and the coefficient β_4 is significantly positive *($p = .073$).*

More surprisingly, R&D expenditure (in t-1) is negatively associated with company performance *(β_1 = -.616, p = .000)*. This result does not confirm those of previous studies (Berg & Friedman, 1977).

Table 2
Cross Sections of the Rate of Return in biotechnology and polynomial lag model *(model 2)*

Year	N	β_1 Lagged R&D expenditure	β_2 Log assets	β_3 R&D domestic alliance	β_4 R&D international alliance	Ajusted-R^2 F
2006	140	.202* (2.737)	.601*** (7.049)	-.245** (3.272)	.047 (.632)	.420 26.158***
2005	103	-.161 (-13.21)	.703*** (5.688)	-.198** (-2.196)	.102 (1.077)	.326 13.323***
2004	82	-.245*** (-2.218)	.880*** (7.442)	-.119* (-1.329)	.049 (.530)	.496 20.938***

$$ROA_t = \beta_0 + \beta_1 (w_{t-1} RDE_{,t-r} + w_{t-2} RDE_{t-2} + w_{t-3} RDE_{t-3}) + \beta_2 LogA_t + \beta_3 \sum_t ALL_{1t} + \beta_4 \sum_t ALL_{2t} + \varepsilon_t$$

The w_{t-1} 's were estimated from a polynomial distributed lag, on R&D data over three years.
Dependent variable: Compustat's return on asset (ROA)
( ) = t Statistic ; *p <.001, ** p < .001 * p< .05*

Table 3
Mean Values and elasticities (e)

Year	|ROA|	R&D	$e_{ROA/RDE}$	log A	$e_{ROA/A}$	|All1|	$e_{ROA/All1}$	|All2|	$e_{ROA/All2}$
2006	58,52	201,50	-0,05	2,00	0,01	5,70	-0,02	2,86	0,00
2005	101,76	132,45	0,12	1,95	0,01	5,92	-3,40	3,05	3,41
2004	76,11	147,89	0,10	1,88	0,01	5,66	-1,60	2,73	1,37

$$e_{ROA/RDE} = \frac{\frac{dROA}{ROA}}{\frac{dRDE}{RDE}} = \beta_1 \frac{\overline{ROA}}{\overline{RDE}}; \quad e_{ROA/A} = \frac{\frac{dROA}{dA}\frac{dA}{d\log A}}{ROA} = \beta_2 \frac{1}{\overline{ROA}}; \quad e_{ROA/All1} = \frac{\frac{dROA}{ROA}}{\frac{dAll1}{All1}} = \beta_3 \frac{\overline{ROA}}{\overline{All1}}$$

$$e_{ROA/All2} = \frac{\frac{dROA}{ROA}}{\frac{dAll2}{All2}} = \beta_4 \frac{\overline{ROA}}{\overline{All2}}$$

The results from model 2 are also not supported. The coefficient β_3 is significantly negative and the coefficient β_4 is positive. Engaging in national alliances would lower a firm's rate of

return by more than 2 percentage points. Nevertheless, the positive effect is not statically significant for the international alliances.

The increasing coefficient on the R&D intensity variable may reflect higher returns to past R&D in the later years, compared with expenditures made in the 2004.

In elasticity terms, one percent of change in the R&D expenditures leads to a 0.04 percent increase in the rate of return in 2006. One percent increase in assets raises the rate of return of .01 percent.

As with previous studies, our result shows a positive return on assets effect from the size of the firm. Hall & Weiss (1967) explain it in terms of a significant capital requirements barrier. An alternative interpretation is that scale economies allow giant firms to be more efficient. Nevertheless, the falling coefficient on the asset variable may reflect lower returns in 2006, compared with increases of assets in 2004.

5. Discussion

Our results show that, contrary as we expected, as firm increased their R&D domestic alliances, they tended to reduce their performance. Engaging in intensive R&D domestic alliances would lower a firm's return on assets. This result is in accordance with those of Berg and Friedman's study (1977). In their regression model, the coefficient β (for the dummy variable Joint Venture) is negative. The authors concluded that joint venture may be a response to low past profitability. They also consider that the size of the coefficient β may reflect the fact that the managers of firms that engage in joint venture are more risks adverse than others. These results are counterintuitive but not surprising. The relationship between alliances and company performance is very complex. It has been shown that alliances do not conduct to an increase of new products development. The relation could be initially positive but at some point may exhibit diminishing returns or even negative returns (Deeds and Hill. 1996;. de Mesa Vasquez et al, 2006). In a multi-alliances situation, managers have to focus

more on the aggregate success of alliances, in addition to single alliance performance (Fricke and Shenhar, 2000). Alliances are complex organisational arrangements which involve risks. The risks of R&D alliances are related to the incompleteness of contract (Grossman & Hart, 1986), the potential opportunistic partner's behaviour (Williamson, 1975), and hence the potential expropriation by the other partner (Heiman & Nickerson, 2004). Consequently, the greater the number of alliances, the more likely the negative effects could outweigh the positive one (de Mesa Vasquez et al., 2006).

The other interesting result of this study is the positive impact of international R&D alliances on company performance. According to Kuemmerle (1999) firms internationalize their R&D facilities in order to take advantage of host country scientific inputs and or respond to local host country needs that require a modification of the firm's product or service. Kurokawa et al., (2007) demonstrate that the more active in international R&D alliances is a company, the higher is the technology-related knowledge flow. An alternative interpretation stems from the fact that domestic R&D alliances (in our sample) are mainly contracted with pharmaceutical firms. Hence, in our study, the international R&D alliances mainly implicate firms of the same size. Pothukuchi et al. (2002, p. 258) found that the "negative effect from partner dissimilarity on IJV performance originates more from differences in organizational culture than from differences in national culture". Sirmon and Lane (2004) suggest that differences between professional cultures will be the most disruptive to the alliance's value-creating activities. They argue that R&D alliances between US pharmaceutical and biotechnology firms are asymmetric. The asymmetries resulting from "differences in beliefs and norms matter more as they become more relevant to the value-creating activities of the alliance" (Sirmon & Lane, 2004, p. 316).

The negative relation between "R&D expenditures" and "return on asset" may result from the model design. Given that in R&D, the steps necessary to achieve the outcome often are highly

uncertain (Rothaermel, 2001). In the case of the drug development process in the biotechnology industry, it can take up to 15 years to bring a biotechnology molecule to the market (Giovannetti & Morrison 2000). Consequently, the positive effect of R&D expenditure has repercussion on long term.

References

Anand, B. and Khanna, T. (2000). Do firms learn to create value? The case of alliances, *Strategic Management Journal*, 21, 295-315.

Barkema, H. G. and Vermeulen, F. (1997). What differences in the cultural backgrounds of partners are detrimental for international joint ventures?, *Journal of International Business Studies*, 28, 845–864.

Barkema, H. G., Shenkar, O., Vermeulen, F. and Bell, J. H. J. (1997). Working abroad, working with others: How firms learn to operate international joint ventures. *Academy of Management Journal***,** 40, 426-442.

Baum , J.A.C., Calabrese, T. and Silverman, BS. (2000). Don't go it alone: alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, 21/3, 267–294.

Beamish, P. W. and Delois, A. (1997). Joint ventures in LDC's: Partner selection and performance, *Management International Review*, 34/special issue, 60–74.

Berg, S. V. and Friedman, P. (1977). Joint Ventures, Competition, and Technological Complementarities: Evidence from Chemicals, *Southern Economic Journal*, 43/3, 1330-1337.

Brouthers, K.D., Brouthers, L.E. and Werner, S. (2001). RandD mode choices in central and Eastern Europe, *Journal of Business Research*, 52/1, 83–91.

Combs, J.G. and Ketchen, Jr. (1999). Explaining interfirm cooperation and performance: toward a reconciliation of predictions from the resource-based view and organizational economics, *Strategic Management Journal*, 20**,** 867–888**.**

De Carolis, D. M. (2003). Competencies and Imitability in the Pharmaceutical Industry: An Analysis of Their Relationship with Firm Performance, *Journal of Management*, 29/1, 27–50.

Deeds, D.L. and Hill, C.W.L. (1996). Strategic alliances and the rate of new product development: an empirical study of entrepreneurial biotechnology, *Journal of Business Venturing*, 11/1, 41-55.

Deeds, D. L. and Rothaermel, F. T. (2003). Honeymoons and Liabilities: The Relationship between Age and Performance in Research and Development Alliances, *Journal of Product Innovation Management*, 20/6, 468 – 484.

de Mesa Vázquez Gutiérrez, E., Jiménez, J. A. and Mascareñas, J. (2006). Strategic alliances as a mechanism for wealth creation in the biopharmaceutical industry: An empirical analysis of the Spanish case, *Journal of Commercial Biotechnology*, 12/3, 229-237.

Demsetz, H. and Villalonga, B. (2001). Ownership structure and corporate performance, *Journal of Corporate Finance*, 7, 209–233.

Dyer, J.H. (1996). Specialized supplier networks as a source of competitive advantage: Evidence from the auto industry. *Strategic Management Journal*, 17/4, 271-291.

Easley, D. and Hvidkjaer, S. and O'Hara, M. (2002). Is Information Risk a Determinant of Asset Returns?, *The Journal of Finance*, LVII/5, 2185-2221.

Fricke, S.E. and Shenhar, A.J. (2000). Managing multiple engineering projects in a manufacturing support environment, *IEEE Transactions on Engineering Management*, 47/2, 258–268.

Gassel, K. and Pascha, W. (2000). Milking partners or symbiotic know-how enhancement? International versus national alliances in Japan's biotech industry, *International Business Review*, 9/5, 625-640.

Geringer, M. and Hébert, L. (1991). Measuring Performance of International Joint Ventures, *Journal of International Business Studies*, 22, 249-264.

Giovannetti, G. T., & Morrisson, S. W. 2000. *Convergence:The biotechnology industry report.* Palo Alto, CA: Ernst & Young.

Grossman, S. J. and O. D. Hart (1986). The Cost and Benefit of Ownership: A Theory of Lateral and Vertical Integration, *Journal of Political Economy*, 94, 691-719.

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

Hagedoorn, J. (1993). Understanding the rationale of strategic technology partnering: interorganizational modes of cooperation and sectoral differences, *Strategic Management Journal*, 14, 371–385.

Hagedoorn, J. and Schakenraad, J. (1994). The Effect of Strategic Technology Alliances on Company Performance, *Strategic Management Journal*, 15/4, 291-309.

Hall, M. and Weiss, L. (1967). Firm Size and Profitability, *The Review of Economics and Statistics*, 49/3, 319-331.

Heiman, B. and Nickerson, J. (2004). Empirical evidence regarding the tension between knowledge sharing and knowledge expropriation in collaborations, *Managerial and Decision Economics*, 25/6-7: 401-420.

Hill, C.W.L., Hitt, M. A. and Hoskisson, R. E. (1992). Cooperative versus Competitive Structures in Related and Unrelated Diversified Firms, *Organization Science*, 3/4, 501-521.

Hoang, H. and 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.

Kogut, B. (1989). The stability of joint ventures: Reciprocity and competitive rivalry. *Journal of Industrial Economics*, *38/*2, 183-198.

Kuemmerle, W. (1999). The drivers of foreign direct investment into research and development: an empirical investigation, *Journal of International Business Studies*, 30, 1, 1-25.

Kurokawa, S., Iwata, S. and Roberts, E. B. (2007) Global RandD activities of Japanese MNCs in the US: A triangulation approach, *Research Policy*, 36, 3–36.

Li, J. and Zhong, J. (2003). Explaining the Growth of International R&D Alliances in China, *Managerial and Decision Economics*, 24, 101–115.

Lichtenthaler, U. and Lichtenthaler, E. (2004). Alliance functions: implications of the international multi-R&D-alliance perspective, *Technovation*, 24, 541–552.

Merchant, H. (2005). The structure–performance relationship in international joint ventures: a comparative analysis, *Journal of World Business*, 40, 41–56.

Nielsen, B. B. (2007). Determining international strategic alliance performance: A multidimensional approach, *International Business Review*, 16/3, 337-361.

OECD science, technology and industry outlook (2000). Paris: Organisation for Economic Co-operation and Development.

Osborn, R. and Hagedoorn, J. (1997). The institutionalisation and evolutionary dynamics of inter-organizational alliances and networks, *Academy of Management Journal*, 40, 261–278.

Park, S.H. and 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. (1993). Strategic alliance structuring: A game theoretic and transaction cost examination of interfirm cooperation, *Academy of Management Journal*, 36, 794-829.

Pothukuchi, V., Damanpour, F., Choi, J., Chen, C.C. and Park, S.H. (2002). 'National and organizational culture differences and international joint venture performance, *Journal of International Business Studies*, 33, 243–265.

Ring, P. S. and Van de Ven, A. H. (1994). Developmental processes of cooperative interorganizational relationships, *Academy of Management Review*, 19, 90-118.

Roberts, P.W. (1999). Product Innovation, Product-Market Competition and Persistent Profitability in the U.S. Pharmaceutical Industry, *Strategic Management Journal*, 20, 655–670.

Robinson, D.T. and Stuart, T.E. (2003). Contractual, Relational, and Property Rights-based Control in Biotech Strategic Alliances, Working paper.

Rowley, T., Behrens, D. and Krackhardt, D. (2000). Redundant governance structures: an analysis of structural and relational embeddedness in the steel and semiconductor industries, *Strategic Management Journal*, 21, 369–386.

Rothaermel, F. T. (2001). Complementary assets, strategic alliances, and the incumbent's advantage: An empirical study of industry and firm effects in the biopharmaceutical industry., *Research Policy*, 30, 1235-1251.

Saffu, K. and Mamman, A. (2000). Contradictions in international tertiary strategic alliances: the case from down under, *International Journal of Public Sector Management*, 13/6, 508-518.

Salk, J.E. and Shenkar, O. (2001). Social identify in an international joint venture: an exploratory case study, *Organization Science*, 12, 161–178.

Sirmon, D. G. and Lane, P. J. (2004). A model of cultural differences and international alliance performance, *Journal of International Business Studies*, 35/4, 306–319.

Williamson, O. E. (1975). *Markets and Hierarchies: Analyses and Antitrust Implications*, New York: The Free Press.

Yang, D., Sonmez, M. and Bosworth, D. (2004). Intellectual property Abuses: How should Multinationals responds?, Long Range Planning, 37, 459-475.