J Technol Transfer (2008) 33:91–103
DOI 10.1007/s10961-007-9063-x

The strategic value of new university technology and its impact on exclusivity of licensing transactions: An empirical study

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Published online: 26 October 2007

Abstract Commercialization of new university technology within the new product development process is an important tool by which established firms can expand their innovative capabilities. The strategic importance of the university technology to the firm, however, can vary considerably. An exclusivity agreement is a useful tool to protect the firm's investment and help ensure that value is appropriated through the commercialization process. An empirical study of 66 technology transfer projects in the information and communications technology industry reveals that licensing transactions are usually secured by some form of exclusivity agreements when the product innovation enabled by the new university technology is new-to-the-firm or new-to-the-market and the firm's perception of the strategic value of the new technologies is high.

Keywords Strategic value · Technology transfer · University technology · Licensing · Exclusivity · Core competence

JEL Classifications O31 · O32 · O33 · O34 · L24 · L63

1 Introduction

University-industry linkages occur in a wide variety of forms and appear to be an increasingly important phenomenon that has received widespread attention (Bonaccorsi

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and Piccaluga 1994). Universities can be important sources of new technological knowledge for firms and have the benefit of not being in direct competition with industry (Grigg 1994). Because of their respective science bases, new university technologies are likely to be radical in nature, therefore making them quite valuable (Betz 1994). Acquiring and commercializing new university technologies, therefore, can be an important means of staying current with technological advances in an environment of rapid technological change (Dosi 1982; Tushman and Anderson 1986; Granstrand et al. 1997). As such, the adoption of new university technology by established firms for use in their product innovation is an important component of technology strategy (Thursby and Thursby 2003).

The objectives of this empirical study were to understand how firms perceive the strategic value of new technologies transferred from universities for use in their product innovations and to understand how this perspective influences the establishment of exclusivity agreements for their research relationships. This is of practical importance to managers in firms who are faced with the decision of whether to enter into or deepen a research relationship with a university in order to develop and acquire a new technology. It is also important to managers of university technology transfer offices who need to balance the often conflicting demands of generating adequate returns on research investments and satisfying the competitive needs of industry partners.

Past research on external technology acquisition has indicated that external sources of technology are attractive to firms when they are more economical to acquire than to develop internally, when firms do not have the internal capacity to develop them, or when time to market pressures prohibit internal development (Arora and Gambardella 1990; Pennings and Harianto 1992; Kurokawa 1997; Tidd and Trewhella 1997). External technology sourcing through inter-firm relationships has therefore been an important area of research and has received much attention (Atuahene-Gima 1993; Steensma and Corley 2000).

In this study, we examine firm perceptions of the strategic value of an acquired new university technology and its impact on exclusivity agreements. Firms that enter into research relationships with universities to develop and acquire new technologies are motivated by the benefits or strategic value that the new technology is perceived to bring to the firm. Managers must weigh this value against the cost of acquiring the technology through such relationships. These investment costs include direct expenses (equipment, meetings, travel, etc.,) as well as time and resources for research and the management of the research relationship. Partnering with a university to develop the new technology also exposes the firm to risks, such as leaking of information through publications, disclosing of technical information to other industry players and having the technology available to other firms. These factors act against the firm's ability to appropriate the benefits of the new technology (Teece 1986). To mitigate against such risks, firms often pursue exclusivity agreements with their university partners in the hope of protecting their investments and increasing the probability of appropriating the benefits anticipated.

From the perspective of the technology transfer office manager, however, exclusivity agreements limit the opportunities to commercialize a new technology. Success is reliant on the execution capabilities of the single licensee. This reduces the probability of successful outcome and return on investment. To compensate, TTO managers would want to select only licensees that have strong potential for success and a strong desire to succeed in the commercialization process. The above tension can be accommodated when the new technology has a high strategic value to the firm, thus ensuring adequate investment support and management attention on the part of the firm, and at the same time increased likelihood of successful commercialization and therefore licensing returns for the TTO.

2 Framework

This study aims to examine the characteristics or attributes of strategic value in terms of the resource-based view and a core competence framework. These attributes can then be used in a management tool for both firms and TTOs to aid the decision making process surrounding exclusivity agreements. When the new technology and its organizational context exhibit attributes that are strongly aligned with the firm's core competencies, it may provide a strong rationale for seeking an exclusivity agreement.

The core competence concept is rooted in the resource-based view of the firm, which considers firms as bundles of resources that yield competitive advantage. It maintains that superior returns are generated from internal resources and capabilities that are valuable, rare, difficult to imitate, and without substitute (Wernerfelt 1984; Aaker 1989; Barney 1991; Barney 1992, p. 44; Peteraf 1993). These potentially create resource barriers that other firms find too costly to imitate and can therefore become sources of competitive advantage (Wernerfelt 1984; Barney 1994, p. 119).

A competence is "a set of differentiated skills, complementary assets, and routines that provide the basis for a firm's competitive capacities and sustainable advantage in a particular business" (Teece, Pisano et al. 1990, p. 28). Competencies are viewed as bundles of skills and technologies rather than a single discrete skill or technology that enables a company to deliver value by providing a particular benefit to the customer. Thus, they represent the synthesis of a variety of skills, technologies, and knowledge streams (Prahalad and Hamel 1990; Hamel 1991; Hamel and Prahalad 1994).

In order to be core, competencies must meet at least three distinguishing criteria (Prahalad and Hamel 1990). First, they should provide customer-perceived value by delivering a significant contribution to the perceived customer benefits of the end products and contribute to the competitiveness of a range of products or services. Second, they should exhibit extendibility by being used in a wide range of products and services and providing potential access to a wide variety of markets. Thus, they are the gateways to tomorrow's markets. Third, core competencies should be difficult for competitors to imitate, and will be so if they are a complex harmonization of individual technologies and production skills (Prahalad and Hamel 1990; Hamel and Prahalad 1994). Thus, they should be distinctive relative to competitors' competencies (Gorman and Thomas 1997). Core competencies are more durable and last longer than individual products or services, do not diminish with use, but are enhanced as they are applied and shared (Prahalad and Hamel 1990; Hamel 1991; Hamel and Prahalad 1994). Thus they are enduring sources of competitive advantage.

Building core competencies may be viewed as an investment mode of R&D that may include the selective external acquisition of technologies that feed into core competencies (Dierickx and Cool 1989; Coombs 1996). These help strengthen existing capability by improving or replacing existing technologies, or by helping to build new strategic capabilities. "Strategic" or "key" technologies, are those that are proprietary to some degree and which firms seek to control internally. They differentiate firms from their competition by enabling firms to provide greater value to their customers (Whelan 1989; Welch and Nayak 1992; Przybylowicz and Faulkner 1993, p. 33; Tidd and Trewhella 1997, p. 370). Synergy between the new technology and existing internal strategic capabilities would suggest that the new technology lies at the core of the firm's capability and is therefore of high value to the firm.

From the firm's perspective, an exclusivity agreement is a useful tool to ensure that value is appropriated through the commercialization process. Exclusivity helps to protect

the firm's investment in the technology by denying access to the technology by the firm's competitors. Exclusivity increases the rareness of the technology, thereby helping to create a high appropriability regime (Teece 1986). Exclusivity is also important when firms perceive the need to have internal control over the new technology.

The forgoing can be expressed in hypothesis form as follows:

Hypothesis 1 The greater the perceived strategic value of the new university technology the more likely the firm will secure some form of exclusive license agreement.

The newness of the product innovation enabled by the new university technology may also affect whether the firm will secure some form of exclusivity. When the new technology results in a product which is either new-to-the-firm or new-to-the-market, thereby establishing a completely new product platform family or product line, it is likely that firms will secure an exclusivity agreement to protect their investment, thus:

Hypothesis 2 The greater the newness of the product innovation, resulting from the new university technology, the more likely the firm will secure some form of exclusive license agreement.

3 Method

3.1 Sampling method and return rate

The unit of analysis is the new product development project involving a new university technology. The information and communication technology industry is characterized by a high rate of technological change and was chosen as the context for our study. The sample was taken from the Canadian industry which is representative of the global sector. A total of 342 possible cases of industry-university collaboration involving 150 firms were initially identified from the Natural Sciences and Engineering Research Council collaborative R&D grant awards listing for 1990–1998 and information from thirteen university science and technology networks and research centers of excellence. A short telephone interview with the appropriate senior manager at each firm was then used to screen whether a collaboration activity did exist and whether it, or a similar activity, resulted in a new university technology being adopted by the firm for use in product innovation. We also collected provisional data and invited participation in a web-based survey. The screening process yielded 75 projects suitable for our research and for which the interviewees consented to further participate. Formal survey invitations were emailed and follow-up calls were made to increase returns. Data collection was drawn to a close at the end of 7 weeks. Sixty-seven survey responses were received achieving an 89.3% response rate (67 out of 75). One response did not fit the research model and one had missing data resulting in 65 useable responses. Two non-responses were associated with second projects from respondents who had already submitted a response to one project. Four did not respond despite repeated calls and reminders. Only two of the eight non-responding executives declined to participate citing insufficient time. *t*-tests on firm size and R&D expenditure between the responding and non-responding groups were not significant, indicating an absence of respondent bias on these factors. The data covered a time period from 1991 to 2000.

3.2 Instrument and measures

Self-assessment measures are a commonly used form of performance assessment in strategy research since senior executives are typically the respondents with the greatest knowledge of their own business and performance (Gatignon and Xuereb 1997). Perceptions, rather than objectively measured factors, often determine strategy policy (Bourgeois 1980; Lowe and Taylor 1998). Several studies have demonstrated the convergent validity of such scales (Venkatraman and Ramanujam 1986; Gatignon and Xuereb 1997). Incomplete recall was minimized since most of the respondents were at the level of President, CEO, Chief Technology Officer or Vice-President/Director of R&D/Engineering. We also ensured that they had been involved in, and were knowledgeable about, the technology acquisition. During the screening interviews we asked the participants to briefly describe the technology acquisition project so as to enhance recall and limit retrospective rationalization.

Likert-type scales were used to capture subjective responses and seven response alternatives were chosen in order to enhance internal reliability (Cox 1980). This is the modal number of response alternatives for scales reviewed by Peter (1979) and has been used in recent management research (Zander and Kogut 1995; Steensma and Corley 2000). Question items were constructed to minimize socially desirable responses. Scale anchors were chosen to focus attention on a concrete event, making bias and impression management less likely (Miller et al. 1997).

Table 5 shows seven perceptual measures that tapped into the concept of strategic value, three measures which tapped into the concept of product newness and three measures which tapped into the concept of exclusivity as discussed in the framework. Respondents were asked to indicate their responses on a scale of 1—does not describe this new university technology at all to 7—describes this new university technology (or our new product) exactly. The term "customers" and "key technologies" were noted to mean the buyers of the firm's products and technologies that are proprietary to some degree and which the firm seeks to control; and which differentiate the firm from its competition by enabling it to provide greater value to it's customers. To match the perceptual measures during factor analysis, the dichotomous exclusivity measure was coded 0 for no exclusivity in the licensing agreement and 7 for some form of exclusivity in the licensing agreement.

The instrument was pre-tested to help identify potential sources of ambiguity, ensure ease of completion and determine the length of time to complete the questionnaire. Pretesting was conducted by management professors, graduate students and industry executives. After completing the refining process, an on-line pilot test of the web-based questionnaire was carried out to ensure that responses were correctly captured for analysis.

4 Results

Exclusivity rights agreements were in place for 32 (48%) of the 66 technology transfer projects studied as shown in Table 1. The chi-square goodness of fit statistic was not significant indicating the distribution result does not differ significantly from chance.

Data was also collected to determine the domains to which the exclusivity applied and whether any limitations were placed on exclusivity. Table 2 shows that there were limitations placed on the time domain relating to exclusivity agreements with 22 (67%) of agreements being unlimited in time compared to 10 (33%) of agreements which were limited, representing an odds ratio for unlimited-to-limited of 2.2. The chi-square goodness

Table 1 Frequency of exclusive rights agreements

Type of exclusive rights to technology	No *N* (%)	Yes *N* (%)	Total *N* (%)
Any exclusive rights	34 (52)	32 (48)	66 (100)

Table 2 Limitation to exclusive rights to use the university technology

Domain of exclusivity	Limited/Specific *N* (%)	Unlimited/Any *N* (%)	Total N (%)	χ^2 (*p*)	df	Ratio unlimited/limited
Limited duration of time	10 (15)	22 (33)	32 (100)	4.5 (.034)	1	2.20
Type of product application	11 (17)	19 (29)	30 (94)	2.13 (.144)	1	1.73
Market or industry sector	13 (20)	17 (26)	30 (94)	.533 (.465)	1	1.31

of fit test indicated the distribution was statistically significant. For some agreements, there were limitations placed on the type of product application with 11 (35%) limited and 19 (59%) unlimited. Similarly, for 13 (41%) projects limitations were placed on the market or industry sector. The distribution results for product and market limitations were not statistically significant.

Table 3 shows the distribution of projects by technology type and the crosstabulation with exclusivity of licensing agreement. The projects were categorized within nine main technology types. The top category, software, accounted for 28 (42%) of all projects. The top five categories accounted for 57 (86%) of total projects and included VLSI with 8 (12%), Digital Signal Processing with 7 (11%) and Communications and Instrumentation each with 6 projects (9%).

Table 4 shows the distribution of projects ranked by number of projects per university. The top three universities, University of Waterloo, Carleton University and University of Toronto, accounted for 22 or one-third of all projects.

Table 3 Crosstabulation of technology type and exclusivity of agreement

Technology type	Exclusivity of agreement		Total
	Non-exclusive	Exclusive	
Software	15	11	26
VLSI	5	3	8
Digital signal Processing	4	3	7
Communications	2	4	6
Instrumentation	4	2	6
Radio frequency	3	1	4
Electronics	0	3	3
Sensors	0	3	3
Optoelectronics	1	2	3
Total	34	32	66

Table 4 Distribution of projects by university

University	Frequency	Percent	Cumulative percent
University of Waterloo	9	13.6	13.6
Carleton University	7	10.6	24.2
University of Toronto	6	9.1	33.3
University of British Columbia	4	6.1	39.4
Simon Fraser University	4	6.1	45.5
York University	3	4.5	50.0
University of Manitoba	3	4.5	54.5
University of Saskatchewan	3	4.5	59.1
University of Montreal	3	4.5	63.6
University of Alberta	3	4.5	68.2
(Not Answered)	2	3.0	71.2
Queens University	2	3.0	74.2
Dalhousie University	2	3.0	77.3
McGill University	2	3.0	80.3
University of Geneva	2	3.0	83.3
Sub-total	55		83.3
Others (one per university)	11	16.5	100.0
Total	66		

Following data collection, we applied confirmatory factor analysis with varimax rotation resulting in three factors Perceived Strategic Value (PSV), Product Innovation Newness (NEW) and License Exclusivity (EXCL) with loading coefficients for each measure item as shown in Table 5. The items are shown ranked according to their mean values and grouped on each factor. The standardized mean (standard deviation) of the factors were 4.70 (1.54), 4.11 (1.78) and 4.31 (1.86) respectively. The coefficient alphas for the factors, based on the standardized items, were 0.89, 0.72 and 0.66 respectively, indicating the items combined reliably into the scales (Nunnally 1978). Yes/No responses for the individual items were derived from the 7-point Likert-type scales as follows: % Yes = the proportion of responses with scores greater than 4; % No = the proportion of responses with scores less than 4. The remaining percentage out of 100 represents responses with an indifference score of 4. Analysis of the histograms, skewness and kurtosis indicated that assumptions of normality were not unreasonable for PSV and NEW. The scale EXCL showed some kurtosis but was not considered severe enough to deter from further analysis. Two variables that tapped the strengthening and inimitability attributes loaded onto all three factors fairly equally and were excluded from further analysis. Their descriptive statistics are shown for general information.

A regression analysis of the predictor variables PSV and NEW on the dependant variable EXCL was then performed as shown in Table 6. Firm size (FSIZE) and R&D intensity (RD) variables were initially included as control variables but later removed since their coefficients were very insignificant indicating they were not good predictors. The resulting model was significant at the .000 level indicating a good fit with the data. The adjusted R square was 0.247 indicating 25% of the variance was explained by the model. The predictor coefficient PSV was significant at the .014 level and NEW was significant at

Table 5 Measure items, descriptive statistics and item factor loadings for PSV, NEW and EXCL

Conceptual attribute	Measure item	Mean (SD)	Rank	% Agree (Disagree)	N	PSV Mean = 4.70 SD = 1.54 α = .89 Loading	NEW Mean = 4.11 SD = 1.78 α = .72 Loading	EXCL Mean = 4.31 SD = 1.86 α = .74 Loading
Durable	This new university technology will be useful for a significant period of time.	5.09 (1.80)	1	67 (20)	66	.711		
Valuable	This new university technology will increase the value our customers perceive of our products.	5.02 (1.82)	2	73 (18)	66	.766		
Synergistic	This new university technology has exceptional synergy with our existing strategic capabilities.	4.80 (1.90)	3	65 (24)	66	.746		
Strengthening	This new university technology will improve one of our existing key technologies.	4.58 (1.91)	5	61 (26)	66	.715		
Consistent	We will continue to invest in this new university technology for a significant period of time.	4.53 (2.26)	6	56 (32)	66	.695		
Building	This new university technology will help build a new strategic capability.	4.48 (1.90)	8	52 (28)	65	.643		
Extendable	This new university technology is likely to be deployed across a range of our products.	4.47 (2.11)	9	59 (36)	66	.798		
New-to-firm	Our new product marks the beginning of a new platform family / product line	4.51 (2.4)	7	46 (34)	65		.689	

Table 5 continued

Conceptual attribute	Measure item	Mean (SD)	Rank	% Agree (Disagree)	N	PSV Mean = 4.70 SD = 1.54 α = .89 Loading	NEW Mean = 4.11 SD = 1.78 α = .72 Loading	EXCL Mean = 4.31 SD = 1.86 α = .74 Loading
New-to-market	Our new product is unlike anything seen in the marketplace before	3.95 (2.18)	11	48 (40)	65		.777	
Future potential	This new university technology is likely to become a key technology some time in the future.	3.95 (2.13)	12	40 (40)	65		.766	
Rare	We would have a distinct advantage if our competitors did not have access to this new university technology.	4.68 (1.87)	4	42 (23)	66			.671
Internal Control	Controlling this new university technology will be very important to our competitiveness.	4.33 (2.03)	10	52 (33)	66			.678
Exclusivity	We received exclusive rights to this new university technology	3.91 (3.02)	14	32 (34)	66			.842
Inimitability	This new university technology is very difficult to duplicate by our competitors.	3.91 (1.62)	13	38 (51)	65			
Strengthening	This new university technology is likely to replace one of our existing key technologies.	1.95 (1.56)	15	8 (88)	65			

Table 6 Regression model for exclusivity EXCL and predictors PSV and NEW

	Unstandardized coefficient	Standardized coefficient	t	Sig.	F	Adjusted R square
(Constant)	2.568		1.74	.087		
PSV	.168	.322	2.54	.014		
NEW	.293	.276	2.17	.034		
Model				.000	11.3	.247

the .034 level indicating that they should both be included in the model. The regression equation in standardized and non-standardized form is:

$$\text{EXCL} = 2.568 + 0.168 \cdot \text{PSV} + 0.293\ \text{NEW}\ (\text{non-standardized form})$$

$$\text{EXCL} = 0.322 \cdot \text{PSV} + 0.276\ \text{NEW}\ (\text{standardized form})$$

The above result provides support for rejecting the null hypothesis and accepting the alternative hypothesis that the greater the perceived strategic value of the new university technology and the greater the newness of the product innovation the more likely the firm will secure some form of exclusive license agreement.

5 Conclusion

This study has shown that firms are more likely to pursue and secure some form of exclusive licensing agreement when they perceive a high degree of strategic value in the new university technology used in their product innovation. Likewise, when the product innovation based on the new university technology is perceived to be new-to-the-firm or new-to-the-market, this study shows that firms are more likely to pursue exclusive licensing agreements.

The perceived strategic value can be measured along a number of different dimensions such as: The perceived customer value of the new product, the improvement the new technology brings to current capabilities, the usefulness of the new technology over time, the roadmap for investing in the technology, the application of the technology to a range of products, the synergy between the new technology and existing capabilities, and the contribution of the new technology to building new strategic capabilities.

5.1 Implications for management

Exclusivity is perceived to be an important mechanism for protecting the firm's investment in the development of the new technology and the new product and is seen as a means of controlling the technology and denying the firm's competitors access to the new technology. Negotiating and agreeing the terms of an exclusivity agreement, however, can be a lengthy process requiring considerable effort and resources on the part of both the firm and the university. One central question that managers within the firm need to answer is: Is an exclusivity agreement worth pursuing? This study helps managers to answer that question by providing some insight into how the strategic value of a new technology might be evaluated. Management could use the above concepts to evaluate internally how important the new university technology is to the competitive advantage of the firm. One way to do

this would be to answer questions about the impact of the new technology in terms of the concepts of strategic advantage and product newness examined in this study.

For example, managers could consider the contribution of the new technology to the perceived value of the new product by answering questions such as:

- To what extent will this new technology increase the value our customers perceive of our products?
- Does this new technology enable a product that marks the beginning of a new platform family or product line?
- Is the new product using this technology unlike anything seen in the marketplace before?
- Will we be able to deploy this new technology across a range of our products?

Similarly, managers should be challenged to review the relationship between the new technology and the company's technological capabilities as well as the future potential of the new technology through questions such as:

- Does this new technology have exceptional synergy with our existing strategic capabilities? Or
- Will this new technology help us build a new strategic capability?
- Will this new technology improve one of our existing strategic technologies? Or
- Is this new technology likely to become a strategic technology some time in the future?
- Will this new technology be useful for a significant period of time? And
- Are we prepared to invest in this new technology for a significant period of time?

Finally, managers should consider the impact of the new technology on their competitive advantage in the marketplace by answering questions such as:

- Would preventing our competitors from having access to this new technology provide us with a distinct advantage?
- Will controlling this new technology be very important to our competitiveness?

Compiling the above items into a short 5 min questionnaire will provide a useful tool for evaluating those characteristics and help develop a clearer picture of the perceived strategic value of the new technology and hence the desirability of pursuing an exclusivity agreement. Questions could be presented in either a yes/no format or as 5 response scale ranging from strongly disagree to strongly agree. When answered by a number of knowledgeable personnel in the organization (for example, managers, directors, and chief officers responsible for research and development, product development and marketing), the resulting scores could be averaged to provide an overall organizational perspective. If the new technology scores highly, then the firm might consider investing the effort and resources to negotiate an exclusivity agreement. Furthermore, such an internal self-evaluation could prove useful in supporting the firm's position during negotiations with the university. Conversely, if the self-evaluation score is low, this would indicate that it may not be in the firm's best interest to pursue an exclusivity agreement.

5.2 Implications for the university technology transfer office

Universities are concerned with commercializing their new technologies. Technology Transfer Offices (TTO) need to consider how best to generate a return on the research investment for their new technologies. The innovation process, however, is a complex one

and successful outcome is never guaranteed. Therefore, TTOs ideally would want to license their new technologies to as many industry partners as possible in order to maximize the potential return through licensing fees. Licensing a particular new technology to a wide range of licensees also increases the probability of a successful commercialization outcome as more firms engage in the innovation process.

Exclusivity agreements by their very nature limit the opportunities to commercialize a new technology. The successful outcome is then reliant on the execution capabilities of the licensee. This reduces the probability of successful outcome and return on investment. Before offering an exclusive license agreement, TTOs would therefore want to be increase their confidence that the licensee has a strong potential for success and a strong desire to succeed in the commercialization process.

One way to determine this would be to evaluate the strategic value of the new technology to the firm. TTO's could develop a self-evaluation template based on the above questions and request that firms seeking exclusive agreements complete it. The results could be used as one basis for establishing suitability for an exclusive agreement. By doing this, TTOs would also assist firms in obtaining insight as to the importance of the new technology to their own internal agenda.

Acknowledgement The authors gratefully acknowledge the financial support provided for this research by the Natural Sciences and Engineering Research Council, the government of the Province of Ontario the University of Waterloo and the NSERC/SSHRC/CIBC/Nortel Chair in Management of Technological Change.

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