Technology Licensing and the Performance of Firms in US Information and Communication Technology Industry: The Case of Licensees

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Abstract

This paper empirically investigates the effects of technology licensing on the licensee firm's performance with the help of a unique data set of observed licensing transactions in Information and Communication Technology (ICT) industry. We examine how intensity of licensing participation as a licensee affects the firm's performance. This study also analyzes how relationship between the licensor and the licensee in a deal along with characteristics of participants and their industry influences the performance of the licensee firm. The findings suggest that frequent participation in technology licensing increase licensee firm's sales growth. Also, transaction cost considerations and technology spillovers are important explanatory factors that influence licensee firms' performance in licensing.

Keywords: Licensing, ICT, Firm performance

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1. Introduction

Strategic technological alliances between companies, where the adoption and adaptation of technological innovation play an important role, have become the key to the competitive strategy of firms in high technology environment. Especially, in the context of the contemporary economic and business surroundings featuring more rapid technology change, strengthened intellectual property protection, and intensive international collaboration through outsourcing and open innovation, technology licensing has arguably become a more visible type of strategic technological alliances. Thompson Financial's SDC (Securities Data Company) database used in this study lists more than 21,000 publicly announced licensing agreements worldwide between 1990 and 2004 across all sectors.

Like many other types of strategic alliances and partnering, key questions in technology licensing may be (a) why companies enter into licensing contracts, (b) whom do they choose as their licensing partners and (c) what's the impact of licensing on participants' performance. As for the first two questions (a) and (b), owing to the voluminous inquiry, we are gaining an understanding of technology holders' licensing incentives. Prior literature in industrial organization and strategic management has addressed several factors that may induce firms to license their proprietary technologies to others, such as additional revenues or income [1], access to complementary resources and capabilities [2], enhancing demand [3], facilitating collusion [4], preserving a market position or acquiring one [5], firm and industry characteristics [6], and strategic drivers [7]. Former studies also examine factors influencing licensing agreements [8] [9]. As for the partner choice, Eswaran and Rockett demonstrate the inclination of incumbent firms' to avoid licensing their technology to potential entrants and the strategic incentive to license a weak rival to crowd the market and deter entry by a stronger competitor [10] [11]. Kim studies the validity of potential factors that might affect technology holders' choice of foreign licensing partners [12].

However, as for the last question (c), it is rather hard to find large sample studies that examine the ex-post impact of technology licensing on participant firms. Analyses have been done on other types of strategic alliances such as joint ventures, research consortia, and research partnership. For example, McConnell and Nantell find that parent companies' share prices increase when they announce joint ventures [13]. The impact of Japanese government-sponsored research consortia on the research productivity of participants is observed in Branstetter and Sakakibara [14]. Caloghirou, et al. investigate research partnership performance as perceived by individual partners using qualitative survey data [15]. Stuart examines the relationship between interorganizational alliances and the performance of firms measured by sales growth [16]. Studies have also been conducted on performance of technology licensing and technology transfer within the context of the university and public research organization [17] [18] [19].

Although the evidences support that strategic alliances engender high firm performance, studies that mainly focus on the link between technology licensing and firm performance are rare. Further, how relationship between partners in a licensing deal affects the performance of participants remains an unexplored area of research. This paper studies effects of technology licensing on performance of companies who obtained technology through licensing alliances.

We first investigate how intensity of licensing participation as a licensee affects the firm's performance. We deal with endogeneity problem in estimating the model by employing the method of two-stage least squares (2SLS). Then we analyze how relationship between the licensor and the licensee in a deal along with characteristics of participants and their industry influences the performance of the licensee firm. Empirical analyses are done with the help of a unique data set of observed licensing transactions worldwide. Especially, we examine licensing transactions occurred in information and communication technology (ICT) sector: an industry that has grown in economic and business importance over the last few decades.

This study extends the literature in the following respects. Most of studies deal with the firms' incentives to license, not the ex-post impact of licensing. Further, the licensing literature has mainly dealt with the supply side of technology licensing (e.g. licensors), and the demand side of technology licensing (e.g. licensees) has been somewhat missing. Understanding the impact of firms' involvement in technology licensing deals on the firm performance in ICT sector will be of interest to both academics and practitioners.

The organization of the rest of the paper is as follows. Section 2 describes the data. The model is specified in Section 3. Section 4 discusses the results. Section 5 concludes.

2. Data

This study employs a relatively homogeneous data set, focusing information and communication technology sector. Limiting the analysis to a relatively homogeneous technological sector eliminates possible variation of firm performance across different technological industries (i.e. biotechnology, advanced materials). We broadly defined ICT sector as electronic & equipment, computer & data processing services, computer & office equipment, and communication industry.

ICT is a great deal of attention. It has penetrated throughout the economy during the past 2-3 decades and has thus dramatically altered the basic meaning of high technology [20] [21]. ICT has characteristics of the "general purpose technology" and "infrastructural technology" of our time and has provided the critical spillovers to the other economic and industry sectors. Thus, in today's world, the level of ICT readiness is essential for firms to compete and grow.

The information about licensing activities of companies is drawn from the SDC (Securities Data Company) by Thomson Financial. This database records all publicly announced alliance deals worldwide tracked down in the Security Exchange Commission filings, newswires, press, trade magazines, professional journals, and the like. SDC provides information on contract type (i.e. technology licensing, marketing agreement, manufacturing agreement, joint venture, joint development or production, etc.), identities of participant firms (name, nation, SIC code of the primary business line, etc.), description of the deal, the date of agreement. The SDC also identifies different kinds of licensing agreements (exclusive, non-exclusive, cross-licensing) and the roles of the participants in them (licensor, licensee).

For this study, we employ two different sets of sample below.

(1) SAMPLE 1: In order to explore the relationship between intensity of licensing participation as a licensee and the firm's performance, we draw sample firms from CompuStat (publicly traded companies in the United States) by Standard & Poor. CompuStat was used to

extract financial information. Among firms in CompuStat, we choose ICT firms that reported uninterrupted series of values for necessary information in all seven years from 1999 to 2005. There are 983 such firms (each firm is the unit of observation) and these are included in the final sample.

(2) SAMPLE 2: In estimating how the relationship between licensor and licensee in a deal affects the performance of the participating licensee firm, we focus on only licensee firms who engaged in licensing deals. Given that the empirical analysis below requires the identification of a licensor and a licensee, we were obliged to eliminate agreements for which we could not identify at least two participants. From SDC database, we choose licensing deals occurred during the period 1999-2004 that meet the following conditions: (i) we can identify who is licensee and licensor in a deal, (ii) the licensee firm in a deal is operated in ICT industry and (iii) both licensee and its licensor firm in a deal is identified in CompuStat. We found 349 such deals[1] and each *deal* is the unit of observation. We identify 201 unique licensee firms participating in above 349 licensing deals.
Table 1 shows the frequency distribution of the sample by industry.

Table 1. Frequency distribution of sample and licensee firms, by industry

Technology cluster	Industry[a]	<Sample 1> Number of sample firms	<Sample 1> Number (%) of licensee[b] firms among sample	<Sample 2> Number of licensee firms
ICT	Computer & office equipment	156	52 (33.3 %)	43
	Electronic & equipment	282	88 (31.2 %)	66
	Communication	143	27 (18.9 %)	19
	Computer & data processing services	402	109 (27.1 %)	73
Total		983	276 (28.1 %)	201

Notes: [a] The industry definitions follow the Standard Industrial Classifications (SIC); [b] Sum of exclusive and nonexclusive licenses. It includes cross licenses.

3. Model Specification

This study uses sales growth as a measurement of firm performance because we believe that the sales amount is more direct indicator reflecting firms' activities than other accounting-based performance measures.

3.1 Analysis 1

For the analysis of the impact of licensing participation as a licensee on firm performance, let:

$$S_{i,t+1} = S_{i,t}^{\alpha} \exp(\beta L_{i,t} + \pi' x_{i,t}) e \tag{1}$$

[1] We ignore few deals that multiple licensors license to the same licensee firm in a deal.

where $S_{i,t}$ is the sales of the licensee firm *i* at year *t* (*t* = 1999-2004), $L_{i,t}$ is the intensity of participation in inter-firm technology licensing as a licensee, and $x_{i,t}$ is a covariate matrix. Here, the coefficient of $L_{i,t}$ is of main interest. Log transformation of above function (1) gives us:

$$\log(S_{i,t+1}) = \alpha \log(S_{i,t}) + \beta L_{i,t} + \pi' x_{i,t} + e_{i,t+1} \tag{2}$$

We assume error term, $e_{i,t+1}$, consists of unmeasured firm effects and random i.i.d. error. Thus,

$$e_{i,t+1} = \eta_i + u_{i,t+1} \tag{3}$$

where η_i is an unmeasured firm specific effect like superior quality of the management, and $u_{i,t+1}$ is an i.i.d. error term.

Here, the presence of η_i suggests the possible endogeneity problem, i.e. the intensity of participation, $L_{i,t}$, may not be exogenous. Firms who anticipate sales growth may seek out technology through licensing deals to accommodate the growth in some way. Moreover, because of the management's superior ability to negotiate with partners effectively, some firms are likely to engage in a much larger number of technology licensing contracts in a given time period than average. All of these arguments raise the typical issue of causation. That is, if we find that sales growth is positively correlated with the intensity of participation in licensing agreements as a licensee, it may be that the causality runs from sales growth to technology licensing rather than the other way around.

In order to deal with this problem, this analysis employs the method of two-stage least squares (2SLS). For that, we first need to find instruments for the intensity of participation in technology licensing, $L_{i,t}$. We propose that firms who were participated in licensing as licensees frequently in the past are more likely to become licensees now regardless of their true management quality. Thus, $L_{i,t}$ can be described by the following:

$$\overline{L_{i,t}} = b_0 + b_1 L_{i,t-g} + b_2 L_{i,t-g-1} + b_3 L_{i,t-g-2} + \pi' x_{i,t} + v_{i,t} \tag{4}$$

In (4), we obtain a predicted value of $L_{i,t}$, $\overline{L_{i,t}}$, by using *g*-lagged values of $L_{i,t}$ as instruments, where *g* is a lag long enough to be exogenous with respect to η_i. $\overline{L_{i,t}}$ is used as the estimate of the first stage of 2SLS. We use SAMPLE 1 for the Analysis 1.

3.2 Analysis 2

To find out how relationship between licensing partners in a deal influences performance of the licensee firm, we estimate the equation (5) below using OLS.

$$\log(S_{j,t+1}) = \gamma \log(S_{j,t}) + \pi' x_{j,t} + e_{j,t+1} \tag{5}$$

where $S_{j,t}$ is the sales of the participating licensee firm in a deal *j* at year *t*. We assume

$$e_{j,t+1} = \eta_j + u_{j,t+1} \tag{6}$$

where η_j is an unobserved effect, and $u_{j,t+1}$ is an i.i.d. error. Note that, in Analysis 2, t is measured with respect to the year when the deal is made. That is, year $t+1$ indicates $t+1$ years after the deal is made. SAMPLE 2 is employed for the Analysis 2.

Dependent variable

SALES = the log of sales amount of firm *i* (licensee firm in a deal *j*)[2] at year $t+1$. $i=1,...,983$; $j=1,\dots,349$.

Independent variables

(A) Firm characteristics

Lag of SALES = the log of sales amount of firm *i* (licensee firm in a deal *j*) at year *t*.
LICENCE = the number of participation in technology licensing of firm *i* as a licensee at year *t*. We use 6, 7 and 8 year lagged ***LICENSE*** as instruments in the first stage regression.
CAPITAL/ASSET = the log of capital expenditures over total invested asset of firm *i* (licensee firm in a deal *j*) at year *t*.
Capital-intensive firms may show high performance considering that those activities are usually associated with higher value-added and more positive sales outcomes. We, thus, control for such possibility. An expected sign is positive.
R&D/SALE = the R&D intensity of firm *i* (licensee firm in a deal *j*) at period *t*.
The higher level of R&D investment is usually associated with the higher probability of invention and/or innovation. Thus, R&D intensive companies may have better technologies and complementary assets available than others and this can help firm grows. The positive sign is anticipated.
PRELICENSE = the average number of licenses granted by the firm *i* (licensee firm in a deal *j*) during the pre-sample period (1990-1998).
Pre-sample activity provides a good approximation for the unobserved heterogeneity, η_j in (6), while continuing to allow for dynamic feedback through weakly exogenous explanatory variables. Following Blundell, Griffith and Reenen, a possible measure of the firm's fixed effect in our model is the average number of licenses bought by firms [22] [23]. This variable captures the fact that firms who sometimes obtained many technology licenses may be qualitatively different from those who did a few or none.

(B) Relationship between partners

TECHPROXIMITY = the degree of similarity in the technological profile of licensee firm and its partner licensor firm in a deal *j* at year *t*.
Firms with similar technological profiles will incur lower transaction costs of licensing such as gathering information about prospective licensors, negotiating, writing contracts and enforcing

[2] For Analysis 2, 'licensee firm in a deal *j*' is used instead of 'firm *i*' (Analysis 1) in defining variables.

them due to similar capabilities [24]. In addition, the strong potential for technological spillovers will exist between firms that are operating in the similar technological areas. All of these will lead to increase in the performance of the participant licensee company. A positive sign is predicted.
MARKETPROXIMITY [3] = 1 if licensee firm and its licensor firm in a deal *j* at year *t* share same SIC code at two-digit level, and 0 otherwise.
Firms operating in similar industries may be organized along similar lines, making the technology adoption less costly in terms of being familiar with markets, processes and supply chains. Moreover, higher business similarity between partners allows firms to scrutinize with greater confidence their partners' opportunistic behavior [25] [26]. Thus, market proximity between firms will engender high sales growth of participants. An expected sign is positive.
FAMILIARITY = 1 if licensee firm and its licensor firm in a deal *j* have met each other before in a licensing deal during five previous years prior to year *t*, and 0 otherwise.
Familiarity between supplier and customer through prior deals typically lowers the transaction costs of licensing. Gulati argues that trust through prior deals displaces a lot of transaction costs [27]. Thus, familiarity between the transacting parties raises firm performance. An anticipated sign is positive.

(C) Industry characteristics

GROWTH = the percentage change in total sales of the primary industry of firm *i* (licensee firm in a deal *j*) at year *t*.
Firms will have a better chance to grow in rapidly growing industries. An expected sign is positive.
MARKET SIZE = the amount of total sales of the principal industry of firm *i* (licensee firm in a deal *j*) at year *t*.
Considering larger markets usually provide high potential for firms to grow, it will be easier for firms to raise their sales in bigger markets. A positive sign is anticipated.
CONCENTRATION = the collective market share of the four leading firms in the primary operating industry of firm *i* (licensee firm in a deal *j*) at year *t*.
Low concentration implies that the firms already have many competitors in their primary product market. Thus, it will be harder for firms to capture of an additional market shares. A positive sign is anticipated.

Year dummy variables are included to control for potential year-specific macroeconomic effects. See Appendix for more details regarding the construction of variables. Descriptive statistics are presented in **Table 2**.

Table 2. Descriptive statistics

Variables	<Analysis 1> Mean (Std. Dev.)	<Analysis 2> Mean (Std. Dev.)
Lag of SALES	1.975 (1.154)	1.817 (1.092)
LICENCE	.114 (.293)	

[3] Richards and Carolis have also used same definition to measure market proximity [28].

CAPITAL/ASSET	.058 (.062)	.061 (.059)
R&D/SALE	.209 (1.609)	.207 (1.661)
PRELICENSE	.173 (.062)	.192 (.058)
TECHPROXIMITY		.187 (.278)
MARKETPROXIMITY		.212 (.262)
FAMILIARITY		.369 (.095)
GROWTH	13.853 (4.897)	12.987 (4.829)
MARKET SIZE	201198.2 (79881.7)	197863.7 (75802.3)
CONCENTRATION	31.822 (11.465)	30.961 (10.864)

4. Results and Discussion

Table 3 presents the estimation results for the Analysis 1. The findings show that a positive and statistically significant relationship between the intensity of participation in technology licensing as a licensee (***LICENCE***) and sales growth of the licensee firm.

Technology licensing represents present opportunities to enter new market segments and to service new customers. Licensee firms who, even though cannot innovate, can produce products and enter the market in order to make additional revenues once they obtain technologies from one of the incumbent technology owners. The results confirm that firms' technology adoption through licensing raise the sales revenue of firms.

Table 3. Results (licensing participation and firm performance)

Variables	<Analysis 1> 2SLS
Lag of SALES	.529** (.259)
LICENCE	.226** * (.078)
CAPITAL/ASSET	.456 (.377)
R&D/SALE	.051* (.03)
PRELICENSE	1.742*** (.665)
GROWTH	.081* (.048)
MARKET SIZE	6.16e-04** (3.14e-04)
CONCENTRATION	-.063 (.059)
N	983
R^2	.592

Notes: 1. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level; Standard errors are in parentheses.

2. Dependent variable is ***SALES***. Coefficients of year dummies are not presented here.

The results for the Analysis 2 is shown in **Table 4**. The signs of the coefficients are generally as we expected except ***MARKETPROXIMITY***. The results show ***TECHPROXIMITY*** and ***FAMILIARITY*** are statistically significant. Thus, the findings indicate that the higher technological proximity and familiarity between partners through prior agreements are positively and significantly associated with the higher level of firm performance.

Table 4. Results (licensing partner characteristics and firm performance)

Variables	<Analysis 2> OLS	
Lag of SALES	.483**	(.245)
CAPITAL/ASSET	.295	(.379)
R&D/SALE	.095**	(0072)
PRELICENSE	1.478***	(.474)
TECHPROXIMITY	.681**	(.322)
MARKETPROXIMITY	.497	(.513)
FAMILIARITY	.552***	(.123)
GROWTH	.065*	(.037)
MARKET SIZE	3.92e-04*	(2.36 e-04)
CONCENTRATION	-.174	(2.114)
N	349	
R^2	.478	

Notes: 1. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level; Standard errors are in parentheses.
2. Dependent variable is ***SALES***. Coefficients of year dummies are not presented here.

Transaction costs theory in the network literature provides another perspective to licensing. According to transaction costs theory, terms and types of alliances depend on the level of uncertainty and opportunism surrounding the transaction [29]. The greater the level of uncertainty and opportunism, the more controls would be placed on a transaction. Entrepreneurs, thus, will try different ways to organize a transaction and choose the least costly and most efficient organizational design.

Similar technological specializations with the licensor decrease the learning cost of new technology to the licensee firm. For example, the transferred technology is easier to master by the licensee, requires fewer modifications by the licensee, and can be implemented faster. Also, technology proximity between participants fostered technological spillovers. Familiarity between supplier and customer through prior deals lowers the transaction costs of licensing as well. Repeated contracts with same partner will build confidence in each partner for the other and solve the problem of moral hazard and asymmetric information occurred in exchanging knowledge through arm's length transactions like licensing. Thus, high technology proximity and familiarity between the transacting parties engender high sales growth of the licensee companies.

One of the unexpected findings is that market proximity. The coefficient of ***MARKETPROXIMITY*** is statistically insignificant. We expected a positive relationship between market proximity and the performance of the company. Licensing can generate the negative *rent dissipation effect* (*competition effect*) on the profits of the firm, which refers to the profit erosion due to an increased competition at the market [30]. Companies, who cannot innovate, may able to produce products and compete with the licensor if they receive the rights to use the technology from one of the technology owners. When both licensee and licensor firms produce and sell products at the market, they will compete fiercely each other if their major lines of business coincide. Although similar market profiles lowers the transaction costs of licensing, market similarity between licensee and its licensor firm may affect the performance of the licensee firm adversely at the same time due to a negative competition effect.

R&D intensity and Pre-licensing experience of the firm help firms grow. In addition, firms operating in a fast growing industry and a large market size demonstrate high sales growth.

5. Concluding Remarks

Given that there is extensive evidence of the increasing use of licensing in technology-intensive industries, the important of a technology licensing alliance seems certain to increase. This paper empirically explores the ex-post effects of technology licensing on firm's performance. We investigate whether the intensity of licensing participation as well as the relationship between partners in a licensing deal affect the licensee firm's performance. A unique data set of observed licensing agreements in information and communication technology industry is employed for the analyses.

In order to examine the impact of licensing intensity as a licensee on firm performance, we use 2SLS model instrumenting the firms' participation in licensing to get a clean interpretation. We find that frequent participation in technology licensing increase licensee firm's sales growth. Thus, aggressive management strategy of collaborating with others and adopting proprietary technologies externally through licensing alliances would be beneficial to companies. The results suggest that a technology licensing can be a powerful weapon in the strategic manager's arsenal of options.

In addition, the findings show that licensing partner characteristics have a key impact on firm performance. That is, technology proximity and familiarity between partners in a licensing deal lead to high sales growth of participating companies. This results implies that transaction cost considerations and technology spillovers are important explanatory factors that influence firms' performance in technology licensing. Our analysis suggests that the company managers should pay attention to choosing optimal partners to generate high performance when they enter into licensing agreements.

One of the limitations of this study lies in the exclusion of many other potential factors that might affect the firm performance in a technology licensing alliance. Even though we find that participation in technology licensing agreements increase firms' sales growth, the amount of sales growth may also depend on other factors. The next step would be to look at how various types of organizational and operational characteristics of participants as well as a set of variables describing market environment and industrial ecosystem affect the performance of firm in technology licensing. Such an extension will require a different empirical model and an additional data altogether.

Appendix

PRELICENSE. The average number of licenses granted by the firm during 1990-1998 = $\frac{\sum_{1990}^{1998} Y_{it}}{9}$.

TECHPROXIMITY. We borrow from Jaffe and Branstetter and Sakakibara to calculate the technological proximity of two firms as an angle between the firms' patent class portfolios [31]

[14]. We obtain the patenting histories of companies from the NBER patent database.
TECHPROXIMITY $\in [0,1]$. Higher values represent more similar technology portfolios.
MARKETPROXIMITY. The SDC database provides this information.
GROWTH. Percent change in value of shipments of an industry.
MARKET SIZE. Value of shipments of an industry (millions of dollars).
CONCENTRATION. The 4-firm concentration ratio is used (U.S. Census Bureau).

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