Technology Licensing and Licensee Firms′ Profits : Empirical Examination

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〈 목 차 〉

Summary : This study empirically examines the relationship between technology licensing and licetnsee firms′ profitability. A significant positive effect of licensing on profitability is generally demonstrated in both the short run and the long run. Further, the magnitude of positive effect is bigger in the long run than that in the short run. The paper suggests that, for firms, aggressive management strategy of collaborating with technology holders through licensing agreements is beneficial. It also argues that transferred technology requires time to be implemented, modified and mastered better by companies.

Key Words : Licensing, Technology, Profitability, Licensee, Strategic Technological Alliances

1. Introduction

Strategic technological alliances, where the adaptation of technological advances takes a central role, have become increasingly important for the competitive strategy of firms in high technology industries. Especially, in the context of the contemporary

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economic environment featuring more rapid technology change, strengthened intellectual property protection, and intensive international competition through outsourcing and collaborating, technology licensing has become one of the most commonly observed strategic technology partnering. In fact, there is an extensive evidence of intensive use of licensing in high technology industry. For instance, a recent study by Arora, Fosfuri and Gambardella (2001) shows that over 15,000 technology licensing transactions occurred with a total value of over $320 billion, implying an average of nearly 1,150 transactions worth $25 billion per year occurred worldwide in the period 1985~1997.

Reflecting an increasing importance of licensing, it has been the subject of industrial economics and management studies. In the context of technology licensing, like many other types of strategic alliances, key questions may be why companies enter into licensing contracts and what's the effects of it on participants' performance. Owing to the voluminous theoretical inquiry, we are gaining an understanding of technology holders' licensing incentives. Since Arrow (1962) has acknowledged the profits a patent holder can obtain from licensing, scholars such as Kamien and Tauman (1986) and Katz and Shapiro (1985, 1986) establish the game-theoretic framework for the analysis of the patent holder's licensing strategy focusing, for example, on the optimal number of licenses for a single technology holder sells. In Gallini (1984), licensing can be used strategically to limit potential entry and reduce competition while Shepard (1987) observes that licensing can also be used to enhance demand by creating a supply. A study by Arora and fosfuri (2003) shows that how competitions among multiple technology holders create strategic incentives to license when product is differentiated among technology owners.

In light of the ex-post impact of technology licensing, however, it is rather hard to find large sample studies that confirm technology licensing is beneficial to participant firms. Analyses have been done on other types of strategic alliances such as joint ventures and research consortia. For instance, McConnell and Nantell (1985) find that parent companies' share prices increase when they announce joint ventures. Stuart 2000) examines the relationship between interorganizational alliances and the performance of firms measured by sales growth. The impact of Japanese governmentsponsored research consortia on the research productivity of participants is observed in Branstetter and Sakakibara (2002). They find that there is a positive association between the intensity of participation in research consortia and the number of patents generated by member firms. Caloghirou, Hondroyiannis and Vonortas (2003) investigate research partnership performance as perceived by individual partners using qualitative survey data.

Although the evidences support that strategic alliances engender high firm performance, empirical studies that mainly focus on the relationship between technology licensing and the firm performance are rare. This analysis extends the literature in following respects. 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 missing. Further, most of studies focus on the technology holders' determinants of technology licensing, not the ex-post impact of it.

This paper empirically examines the effects of technology on licensee firms' profits with the help of a large data set of observed licensing transactions worldwide. A significant positive effect of technology licensing on profitability is generally demonstrated in both the short run and the long run. Further, the magnitude of the positive effect is bigger in the long run than in the short run.

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 main results. Section 5 finally, concludes.

2. Data

This study uses the Securities Data Company (SDC) database of Thomson Financial to locate participating firms (licensors and licensees) in technology licensing deals. SDC database records all publicly announced strategic alliances 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. licensing agreement, joint marketing and manufacturing agreement, joint venture, joint development or production, etc.), description of the deal, the date of agreement, and identities of participant firms (i.e. Standard Industrial Classification (SIC) code of primary business, name, nation, parent companies, etc.).

SDC database has many advantages for our analysis. First, this is the largest database on licensing agreements. Second, it identifies all licensing participants and provides the detailed supplementary information on them. Finally, it provides a link to the original source of information and date of licensing agreements. For the analysis, we read through the description of every agreement to ensure that each deal was related to technology transfer or exchange in the licensing agreement. Licensing deals referring to termination of licensing agreements and litigation settlements of past licensing deals are not counted.

The final sample of firms for this study is drawn from CompuStat by Standard & Poor (publicly traded companies in the United States). We concentrate our analysis on the five industry[1] sectors for the time period 1993~1999. The financial information on the independent variables comes from CompuStat and we choose only firms that reported uninterrupted (nonzero) series of values for all necessary information. There are 3,104 such firms and these are used as a final sample for the analysis.

<Table 1> Frequency distribution of licensee[a] firms in sample, by sector

Industry	*Description*	*Number of licensee firms in sample*	*Number of total firms in sample*
SIC 28	Chemicals and Pharmaceuticals	234	598
SIC 35	Industrial Machinery & Equipment	201	431
SIC 36	Electronic & Other Electronic Equipment	283	629
SIC 37	Transport	41	159
SIC 73	Business Services	224	1,287
Total		983 firms	3,104 firms

Notes : [a] License includes non-exclusive, exclusive, and cross-licenses.

1) SDC database reports that these industries are the most active technology receiving sectors.

<Table 1> demonstrates the number of firms that have bought at least one license during the period 1990~1998[2] in our sample. Electronics (SIC 36) and chemicals (SIC 28) are the most active buyers of technology through licensing deals. They are trailed by business services industry (SIC 73).

3. Model Specification

In panel (cross-section time series) data used in this study, unobserved 'heterogeneity' is presumed commonly present. One possible way to accommodate unobserved heterogeneity is to include 'fixed' or 'random' effects into the model. A necessary assumption for random effects specification is that unobserved firm-specific effects are uncorrelated with included variables. Hausman test, however, allows us to reject the null hypothesis of no serial correlation at 5% significance. Thus, we employ fixed effects OLS for the analysis.

The model is tested over five industry sectors separately as well as the entire sample of the total industry.

Dependent Variable

(INCOME/ASSET)$_{i,t}$ = net income over total invested asset of firm i in year t, t = 1993~1999.

Since the main purpose of this study is to find out the effect of technology licensing on profitability, this study chooses the net income as a measurement of firm performance. I also expect that the net income is more direct indicator reflecting firms' activities than other accounting-based performance measures, and profitability is the most important concern among managers.

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2) SDC database provides us licensing information for the time period 1985~2002. We use only subset of it for this analysis.

Independent Variables

$LICENSE_{i,1}$ = 1, if firm *i* bought at least one license during *t-1*,
= 0, otherwise.

$LICENSE_{i,2}$ = 1, if firm *i* bought at least one license during previous two years prior the year *t-1*,
= 0, otherwise.

$LICENSE_{i,1}$ is used as a proxy to the short term effect of buying technology licenses on profitability while $LICENSE_{i,2}$ is used as a proxy to the long term effect. As Anand and Khanna (2000) stress, technology licensing is one of only a few significant methods of technology transfer between firms. The biggest benefit for firms to enter into technology licensing is the ability of obtaining up-to-date technology without a high risk of developing technology on their own. For instance, in certain industries such as pharmaceuticals, the costs of fielding products is so high (clinical trial costs may run into the hundreds of millions of dollars) that small firms often cannot even attempt to make necessary technology available without assistance from larger established companies. Technology outsourcing through licensing then can be an integral part of competitive strategy for them. Companies may also have a chance to imitate or utilize licensed technology without paying properly given the nature of knowledge itself imperfect appropriability (Arrow 1962). In addition to the chance to acquire technology, strategic technology alliances like licensing represents present opportunities to enter new markets and to service new customers (Mitchell and Singh, 1992). This suggests that net income flow may be affected by licensing contracts since firms can facilitate entry into new market niches after technology transfer (Kogut, 1988). Thus, if companies are able to acquire the latest and profitable technology and to gain new business, there will be a positive association between technology licensing and profitability. I predict positive signs of their coefficients.

Control Variables

$LOGSALE_{i,t}$ = log of sales amount (millions of dollars) of firm *i* in year *t*.

Sales amount is used as a proxy for firm size. Large firm may be more profitable thanks to its strong market power, economies of scale, and sophisticated management practices. This study, thus, controls for the possibility that large firms might be more likely profitable in nature than small firms.

(R&/SALE)$_{i,3t}$ = $\frac{1}{3}\sum_{k=1}^{3}(R\&D/SALE)_{i,t-k}$ = average research and development (R&D) intensity during the three years preceding t.

(CAPITAL/ASSET)$_{i,3t}$ = $\frac{1}{3}\sum_{k=1}^{3}(CAPITAL/ASSET)_{i,t-k}$ = average capital investment over assets during the three years preceding t.

R&D intensity and capital investment are measured as averages of the three years prior to the examined period to avoid abrupt short cycle fluctuations. R&D and capital intensive firms are more profitable considering that those activities are usually associated with higher value-added and more profitable outcomes. We, thus, control for the possibility that R&D and capital intensive firms might be more likely profitable.

GROWTH$_{I,t}$ = growth rate of primary industry I of firm i = percent change of GDP, $\left(\frac{GDP_t - GDP_{t-1}}{GDP_{t-1}}\right)\times 100$, where GDP is real Gross Domestic Product in 1996 dollars (billions of dollars) (Bureau of Economic Analysis, USA)

If companies are operating in high growing industry, their net incomes may be also growing anyway even without licensing. This variable controls for such possibility.

<Table 2> shows the descriptive statistics of variables, and the correlation matrix is presented in <Table 3>.

<Table 2> Descriptive statistics of variables (total industry[a] sample)

Variables	*Mean*	*Std. Dev*
$(INCOME/ASSET)_{i,t}$	.047	.175
$LICENSE_{i,1}$	.0617	.1662
$LICENSE_{i,2}$	.2112	.1884
$LOGSALE_{i,t}$	3.13	3.82
$(R\&D/SALE)_{i,3t}$	.0426	.1305
$(CAPITAL/ASSET)_{i,3t}$	.0754	.2703
$GROWTH_{i,t}$	4.98	7.26

Notes : [a] Sum of all industry including SIC 28, SIC 35, SIC 36, SIC 37, and SIC 73.

<Table 3> Correlation matrix

Variables	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*
1. $(INCOME/ASSET)_{i,t}$	–						
2. LICENSEi.1	.41 (.0000)	–					
3. $LICENSE_{i,2}$	.63 (.0000)	.64 (.0059)	–				
4. $LOGSALE_{i,t}$	.22 (.0000)	.185 (.0033)	.201 (.0025)	–			
5. $(R\&D/SALE)_{i,3t}$	.28 (.0002)	.16 (.0019)	.18 (.0011)	-.01 (.0307)	–		
6. $(CAPITAL/ASSET)_{i,3t}$	-.25 (.0000)	-.079 (.0024)	-.194 (.0037)	.32 (.0120)	.57 (.0112)	–	
7. $GROWTH_{i,t}$	.09 (.0000)	.06 (.0004)	.05 (.0002)	.12 (.0015)	.08 (.0000)	.07 (.0001)	–

Notes : The values of Variance Inflation Factor (VIF) show that there is no indication of multicollinearity. Significance levels are in parentheses.

4. Results

Table 4 presents the estimation results. As expected, a significant positive effect of technology licensing on profitability is generally demonstrated in both the short run and the long run. Even though individual coefficient for transport industry is not significant[3], the consistency of signs and significance of coefficients across all other industries as well as in the total industry as a whole leaves little doubt that this must be the case. Further, the magnitude of the effect (i.e. the size of coefficient) is bigger in the long run than in the short run. This suggests that the transferred technology requires time to be implemented, modified and mastered better by the licensee.

<Table 4> Fixed effects OLS estimates of profitability of technology licensing, 1993~1999

Variables	Total Industry[a]	SIC 28	SIC 35	SIC 36	SIC 37	SIC 73
$LICENSE_{i,1}$	.11** (.05)	.283** (.14)	.076** (.035)	.059* (.033)	.07 (.05)	.02** (.008)
$LICENSE_{i,2}$	.17** (.06)	.34** (.16)	.12* (.067)	.08** (.04)	.14 (.17)	.08** (.039)
$LOGSALE_{i,t}$	.005** (.002)	.016** (.005)	.002** (.001)	.0009** (.0004)	.001** (.0004)	.006** (.002)
$(R\&D/SALE)_{i,3t}$	.098 (.072)	.007* (.0038)	.40 (.37)	−.08 (.06)	.31 (.35)	−.012 (.01)
$(CAPITAL/ASSET)_{i,3t}$	−.006* (.0032)	3.53 (2.56)	−.009* (.0048)	−.009* (.0049)	−.32 (.31)	−.105* (.057)
$GROWTH_{i,t}$	.0039 (.0035)	.0027 (.0029)	.0041 (.0045)	.0108 (.0089)	.003 (.0029)	.002 (.0017)
Constant	−.47** (.19)	−.61** (.28)	−.14** (.067)	−.15** (.07)	−.11 (.15)	−.29** (.13)
N	21705	4182	3013	4401	1107	9002
R2	.60	.62	.63	.61	.64	.63

Notes : [a] Sum of all industry including SIC 28, SIC 35, SIC 36, SIC 37, and SIC 73.
** significant at the 5% level; * significant at the 10% level; Standard errors are in parentheses.

Firm size also has a significant positive effect on profitability across all five industries. R&D intensity has a positive and statistically significant impact on profitability only in chemicals industry. It is, however, not statistically significant in other industries as in the case of the total industry altogether. It shows even negative

3) Transport industry has the smallest number of licensees of all five industries. Firms in this industry might be systematically different than firms in other industries due to intrinsic characteristics related to management style and strategic behavior.

signs in electronic & other electronic equipment and business services industry. This is a little puzzling since expected signs was a positive considering that R&D and capital investment is usually associated with higher value-added and more profitable activities. One of the possible explanations is that firms sometimes reduce R&D expenditure to increase profits. Like other discretionary expenditures, R&D often becomes an easy target in the effort to raise profits by cutting down extra expenses. Chemicals industry is the exception given continuous increase in the R&D efforts during the past few decades on which the industry's future depends. Capital expenditure is negatively related to licensee firms' profit significantly, both in the total industry as a whole and in others such as industrial machinery & equipment, electronic & other electronic equipment and business services industry. The reason is the same offered for above R&D intensity. Industry growth has an insignificant impact on profitability even though it shows a positive sign.

5. Concluding Remarks

This paper empirically examines the effects of technology licensing on licensee firms' profits in five industries (Chemicals, Industrial Machinery & Equipment, Electronic & Other Electronic Equipment, Transport, and Business Services) for the time period 1993~1999. Obtaining technology licenses from other technology holders is found to be positively and significantly related to firms' profitability in both the short run and the long run in most of industries. Also we find that the long run effect is stronger than the short run effect. A statistically significant positive effect of firm size on profitability is also shown across all five industries. Lagged R&D has a significant positive effect on profitability only in chemicals industry. Lagged capital, however, shows a significant negative effect on profitability in most of industries including industrial machinery & equipment, electronic & other electronic equipment, and business services industry. Industry growth rate has an insignificant effect on firms' profitability.

This study provides some managerial implications. The findings show that technology licensing raises firms' profitability. Thus, for firms, aggressive management strategy of collaborating with technology holders through licensing agreements would be beneficial. Also, managers need to consider the fact that transferred technology from technology holders requires time to become more effective for the generation of profits when they draw up the plan for adopting the latest technology.

Technology licensing also exercises an important impact on the society as a whole. As mentioned above, technology licensing is one of only a few significant methods of technology transfer between firms. Thus, if governments want to promote technology diffusion through inter-firm technology transfer, they need to frame the policy that provides firms with extra incentives to participate in licensing market. As Arrow (1962) argues, knowledge inappropriability is one of the main obstacles to the efficient market for technology. Scholars such as Anand and Khanna (2000) and Cohen, Nelson and Walsh (2002) suggest that strong intellectual property rights (IPRs) protection can be considered as the remedy for appropriability problem in the market for technology, observing the fact that the higher the degree of knowledge appropriability (i.e. the strong IPRs protection), the better the ability of the licensor to capture a larger share of the rents generated from the licensed technology. Therefore, the policy that facilitates efficient transactions of technology (e.g. strengthen IPRs protection level) can give an impetus to technology licensing between firms, and can thus give an impetus to technology diffusion in the society.

The limitation of this analysis relates to the fact that it has considered only a set of factors affecting firms' profitability: characteristics of the licensee firm. In addition, given the fact that different types of firms may call for different approaches to make innovation successful (Kim and Kim, 1985), more diverse set of organizational characteristics that might affect firm's profitability need to be considered. The next step should be to also incorporate the characteristics of the licensors as well as a set of variables describing the relationship between licensor and licensee. Such an extension will require a different empirical model and an additional data altogether.

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