
Capital Market Response according to Payment Mechanism of Technology Transfer Agreement

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Abstract

By investigating public announcements on technology transfer contracts in the stock exchange market in Korea, this study shows licensee and licensor choose one of fixed or output-contingent payment based on their financial condition at the time of technology transfer agreement. However, the capital market assesses the mixed type of them as the most effective payment to control total agent cost of licensee and licensor, and lead to successful technology transfer.

Keywords

technology transfer, payment mechanism, fixed payment, output-contingent payment, capital market, agent cost

I. INTRODUCTION

In an open innovation system, a technology transfer (hereafter TT) activity can be an efficient strategy for firms. Specially, it is more important as recent innovation shows shorter life cycle and higher costs.¹⁾ However, there must be the asymmetries of information between licensor and licensee in every TT, which caused its performance to be below the expected level. For this reason, the contracting parties include many complicated clauses to design TT contracts such as types of payment, provisions of governance, terms of renegotiation and duration, safeguard for exclusivity, usage restriction and grant-back and so on.

This study is focusing on various payment mechanisms in TT agreement. Much scholarly work has paid attention to them as the instruments to reduce asymmetric information between licensor and licensee. As a result, the optimal choice of a payment mechanism can lead to the successful commercialization of transferred technologies. Assuming risk neutrality and no additional effort by the inventor or licensor, for example, a simple upfront fee can be optimal.²⁾ However, in the circumstance without this assumption, some forms of output-contingent payment can mitigate the moral hazard problems by linking the licensor's revenue to its effort and the future outcomes of the transferred technology. Because the inventor's effort increases the probability of commercial

1) Agrawal, A. & R. Henderson, "Putting patents in context: Exploring knowledge transfer from MIT", *Management Science*, Vol.48 No.1(2002), pp.44-60.; Cohen, W.M. et al., "Links and impacts: The influence of public research on industrial R&D", *Management Science*, Vol.48 No.1(2002), pp.1-23.; Toole, A.A. & D. Czaritzki, D., "Commercializing science: Is there a university brain drain from academic entrepreneurship?", *Management Science*, Vol.56 No.9(2010), pp.1599-1641.

2) Jensen, R. & M. Thursby, M., "Proofs and prototypes for sales: The licensing of university inventions", *American Economic Review*, Vol.91 No.1(2001), pp.240-259.

success, the licensor who expects marginal benefits from its efforts is incentivized to contribute to the commercialization project of transferred technology.

However, these individual types of payments are not perfect mechanism to control asymmetric information in TT agreements. For example, an output contingent payment can cause the licensee to commit shelving problem if his intention to TT is just to prevent his rivals from obtaining the technology, or if the future return after TT agreement is expected to be less than what was originally anticipated. Similarly, because fixed payment does not include any reward for licensor's effort to commercialize transferred technology, fixed payment, it can cause the licensor to shirk the transferred technologies.³⁾ As a result, a two-part tariff to combine fixed and output contingent payment can be the optimal terms of compensation to minimize the information asymmetry in TT agreements.

The objective of this study is to verify whether the types of payment mechanism show different performance for the licensee by playing a role of controller to reduce asymmetric information in TT agreements. This study investigates the excess return of the licensee's stock price around the day to announce the news of TT agreements. This measure is based on the assumption of an efficient capital market.

In this paper, Section 2 reviews the previous studies on the factors affecting the choice of payment mechanism in TT agreement and its evaluation from the viewpoint of capital markets. Section 3 designs the econometric model, describes the data set and variables, and displays the descriptive statistics. Section 4 interprets the results of the regression model. Finally, Section 5 summarizes the study, and suggests implications and limitations.

3) Thursby, M.C. et al., "Shirking, sharing risk, and shelving: The role of university license contracts", *NBER Working Paper* #11128, 2005.

II. THEORETICAL BACKGROUND

1. *Factors affecting the choice of payment mechanism*

Payment mechanisms in TT can be categorized into one or a combination of upfront lump-sum fees, royalties, milestone payment, and equity grants. With upfront lump-sum and annual fees, first of all, the licensee has to pay an agreed amount of fixed costs. And a royalty represents the payment that is proportional to revenues received from the output. A milestone payment is also based on the outcome of the licensee, compensating the licensor at every achievement of some stipulated events in terms of sales or development stage. In addition, licensees may grant their own equities instead of paying large amounts of upfront fees.

The choice of optimal payment in a TT agreement has been based on the competition in output markets, the attitudes to the uncertainties of licensee and licensor, and other characteristics such as corporate governance, financial condition and reputation. Much scholarly work⁴⁾ has suggested the factors affecting the choice of a payment type based on fixed payment (lump-sum) and output contingent payment (royalty, milestone, equity-grant).

First of all, in terms of market competition, when a licensee already holds monopolistic power in the output market or gets unrestricted use of transferred technology, the licensee wishes the remuneration through a

4) Arrow, K., "Economic Welfare and the allocation of resources for inventions", in R. Nelson (editor), *The Rate and Direction of Inventive Activity*, Princeton University Press, New Jersey, 1962, pp.609-625.; Kamien, M. & Y. Tauman, Y., "Fees vs. royalties and the private value of a patent", *Quarterly Journal of Economics*, Vol.101 No.3(1986), pp.471-491.; Schachter, B. & J. Huston, J., "Tech transfer office shouldn't be your first stop", *Venture Capital Journal*, June, 2005.; Vishwasrao, S., "Royalties vs. fees: How do firms pay for foreign technology?", *International Journal of Industrial Organization*, Vol.25 No.4(2007), pp.741-759.

fixed payment.⁵⁾ On the other hand, when competing with the licensee in the same industry, the licensor prefers the output contingent payment to minimize the boomerang effect caused by the growth of the rival.⁶⁾

And regarding the attitude to risk and uncertainty, the licensor prefer a fixed payment contract in transferring technology when the risk or uncertainty caused by a low level of IP protection is significant.⁷⁾ On the other hand, in a circumstance with strong protection of IP, a licensor seeks an output contingent payment because he expects to get financial benefits from the commercialization as much as possible.⁸⁾

Factors affecting the choice of TT payment are various. For example, Schachter and Huston⁹⁾ address that when a licensor is an university, he tends to prefer a fixed payment to raise funds for early-stage research. However, according to Feldman et al.¹⁰⁾ and Dechenaux et al.¹¹⁾, recent universities increase to choose output contingent payment. Sometimes, they prefer equity-based deals as they have observed a few big success by start-ups of licensee. And Vishwasrao¹²⁾ points out that the licensee with stronger bargaining power and more cash reserves prefers a fixed payment even if the commercialization of transferred technologies is highly

5) Katz, M.L. & C. Shapiro, C., "On the licensing of innovations", *Rand Journal of Economics*, Vol.16 No.4(1985), pp.504-520.

6) Rockett, K., "The quality of licensed technology", *International Journal of Industrial Organization*, Vol.8 No.4(1990), pp.559-574.

7) Aulakh, P.S. et al., "Compensation in international licensing agreements", *Journal of International Business Studies*, Vol.29 No.2(1998), pp.409-419.

8) Nagaoka, S., "Determinants of high-royalty contracts and the impact of stronger protection of intellectual property rights in Japan", *Journal of the Japanese and International Economies*, Vol.19 No.2(2005), pp.233-254.

9) Schachter, B. & J. Huston, J., *supra* note 4.

10) Feldman, M. et al., "Equity and the technology transfer strategies of American research universities", *Management Science*, Vol.48 No.1(2002), pp.105-121.

11) Dechenaux, E. et al., "Appropriability and the timing of innovation: evidence from MIT invention", *NBER Working Paper* #9735, 2003.

12) Vishwasrao, S., *supra* note 4.

uncertain. On the other hand, he suggests that a licensee prefers output-contingent contract to delay the date of payment until the commercialization of transferred technologies starts, especially more when the licensee is a financially constraint-startup. And he also mentions that the contract with the renowned licensor tends to be based on output contingent payment because the licensee expects more technical and operational supports from the licensor which wish to maintain reputation. And when a licensee is expected to grow fast, a licensor prefers payment contingent on the output of the licensee.

Many studies¹³⁾ have pointed out that payment mechanism in TT can be the control mechanism to minimize the agent costs of licensee and licensor because the licensor better knows the nature of technology and the licensee better recognizes the prospective market.

A fixed payment can let a licensor better recognize the commitment of the licensee, who is better informed of market condition, about whether keeping on sincere efforts to improve the transferred technology.¹⁴⁾ On the other hand, it might cause the licensor to shirk the development process of transferred technology without any technical and commercial assistance because it provides the licensor with no additional incentives contingent on the commercial success of the licensee.¹⁵⁾

A output contingent payment can contribute to reducing the moral

13) Gallini, N. & B. Wright, "Technology transfer under asymmetric information", *Rand Journal of Economics*, Vol.21 No.1(1990), pp.147-160.; Beggs, A.W., "The licensing of patents under asymmetric information", *International Journal of Industrial Organization*, Vol.10(1992), pp.171-191.; Vishwasrao, S., "Intellectual property rights and the mode of technology transfer", *Journal of Development Economics*, Vol.44 No.2(1984), pp.381-402.; Macho-Stadler, I. et al., "The role of information in licensing contract design", *Research Policy*, Vol.25 No.1(1996), pp.25-41.; Bousquet, A. et al., "Risk sharing in licensing", *International Journal of Industrial Organization*, Vol.16 No.5(1998), pp.535-554.; Jensen, R. & M. Thursby, M., *supra* note 2.; Thursby, M.C. et al., *op. cit.*

14) Thursby, M.C. et al., *op. cit.*

15) Jensen, R. & M. Thursby, M., *op. cit.*; Thursby, M.C. et al., *op. cit.*

hazard of licensor by encouraging licensor to assist and monitor the licensee continuously.¹⁶⁾ Also, it can help the licensee overcome the adverse selection problem in purchasing technologies by delaying the reward up to the beginning of commercialization.¹⁷⁾ However, it can cause the licensee to shelve the transferred technologies without any additional challenge or devotion because it may impede the licensee to monopolize full value of rent flowing from the commercialization.¹⁸⁾ In specific, this moral hazard problem of the licensee might be exacerbated when the intent of the licensing is simply to block the rivals, or if the expected profits are less than originally anticipated before the termination of contract.¹⁹⁾

Finally, in spite of the individual role of fixed and output contingent payments to reduce the asymmetric information problem between licensee and licensor, no single measure has been likely to address moral hazard, risk-sharing and shelving and shirking of all participants in TT with satisfaction. Ultimately, in the condition of information asymmetry between licensee and licensor, it must be natural that the payment mixing the fixed and output contingent one serves as the most efficient mechanism to optimize the total agent cost in every TT agreement.²⁰⁾

16) Aulakh, P.S. et al., *supra* note 7.; Bray, M.J. & J.N. Lee, "University revenues from technology transfer: Licensing fee vs. equity positions", *Journal of Business Venturing*, Vol.15(2000), pp.385-392.; Jensen, R. & M. Thursby, M., *op. cit.*; Feldman, M. et al., *supra* note 10.; Vishwasrao, S., *supra* note 4.

17) Vishwasrao, S., *op. cit.*

18) Jensen, R. & M. Thursby, M., *op. cit.*; Efenbein, D., "Contract structure and performance of technology transfer agreements: Evidence from university licenses", *Working Paper*, University of California, Berkley, 2004.; Thursby, M.C. et al., *op. cit.*; Crama, P. et al., "Milestone payments or royalties? Contract design for R&D licensing", *Operations Research*, Vol.56 No.6(2008), pp.1539-1552.

19) Thursby, M.C. et al., *op. cit.*

20) Macho-Stadler, I. et al., *supra* note 13.; Jensen, R. & M. Thursby, M., *op. cit.*; Thursby, M.C. et al., *op. cit.*; Erat, S. et al., "The pitfalls of subsystem (over-) integration", *Georgia Tech Working Paper*, 2009.

2. Evaluation of TT agreement in terms of the response of capital market

Based on the assumption of efficient capital markets, much scholarly work²¹⁾ has assessed various strategic alliances including R&D investment, marketing strategies and technology licensing contracts based on the response of stock market.

In a TT agreement, despite no direct evidence, capital markets assess it based on the characteristics of licensee and licensor, and IP protection in the market of the licensee and so on. First of all, Elliott²²⁾ suggests that who the licensee is matters in the perspective of capital markets. On the other hand, Vishwasrao²³⁾ pointed out that the capabilities and reputation of the licensor are critical factors to appreciate a TT activity. Some studies²⁴⁾ assert that TT from a university focusing on early-stage technology or basic research may be less attractive to capital markets compared to that from corporation preferring later-stage project. However, it is also reported that recent TT from universities can appeal to capital markets by a few big successes.²⁵⁾ In addition, strong IP protection in the market of transferred technology encourages capital markets to pay more attention to TT activities.²⁶⁾

21) Chan, S.H. et al., "Do strategic alliance create value?", *Journal of Financial Economics*, Vol.46 No.2(1997), pp.199-221.; Haussler, C., "When does partnering create market value?", *European Management Journal*, Vol.24 No.1(2006), pp.1-15.; Campart, S. & E. Pfister, E., "Technology, corporation and stock market value: an event study of new partnership announcements in the biotechnology and pharmaceutical industries", *Economics of Innovation and New Technology*, Vol.16 No.1(1997), pp.31-49.

22) Elliott, D.R., "Asset-backed IP financing", in B. Berman(editor), *From Ideas to Assets: Investing Wisely in Intellectual Property*, John Wiley & Sons, New York, 2002, pp.459-483.

23) Vishwasrao, S., *supra* note 4.

24) Thursby, J.G. & M.C. Thursby, M.C., "Industry perspectives on licensing university technologies: sources and problem", *Journal of the Association of University Technology Managers*, Vol.12(2000), pp.9-22.; Schachter, B. & J. Huston, J., *supra* note 4.

25) Feldman, M. et al., *supra* note 10.

26) Grindley, P. & D. Teece, "Managing intellectual capital: Licensing and cross-licensing in

This study is focusing on the assessment of the capital markets on the payment mechanism in TT agreement after controlling above factors. If the payment contingent on commercialization would be assessed most positively, the result suggests that capital markets strongly emphasize sincere assistance of licensor as a driving factor for successful commercialization. On the other hand, if the capital market would mostly evaluate fixed payment, the result reveals that the capital markets put more priority on long-term benefits expected by the strong commitment of the licensee about the commercialization than short-term costs caused by upfront fees. Finally, the most positive assessment of two-party tariff implies that controlling the total agent problem such as the shirking and shelving problem from licensee and licensor, mixed payment is considered as the most optimal instrument, regardless of the real expenditure imposing on licensee and licensor, to minimize the asymmetric information in TT agreement.

III. MODEL

1. *Empirical approach*

Showing that capital markets respond differently to the types of payment mechanisms in TT agreements, this study empirically investigates which of them is recognized as the best instrument to reduce information asymmetry.

This study collected 348 contracts announced as TT agreement in KOSDAQ (Korea Securities Dealers Automated Quotation) market between 2000 and 2007. We deleted the sample after 2008 because

semiconductors and electronics", *California Management Review*, Vol.39 No.2(2003), pp.8-41.; Dechenaux, E. et al., *supra* note 11.

KOSDAQ was irrational by financial crisis. And we deleted the announcements without the information of payment mechanisms, and with vague clauses such as free grant or cross licensing. In addition, because the effect of technology transfer on stock price can be contaminated when other news are announced simultaneously around the day of TT agreement, we omitted the sample with other news between before and after three days of TT agreement. Finally, this study analyzed 205 contracts.

This paper designs an empirical model based on advanced econometrics. That is to say, if the model is built as the OLS regression of one equation to include the response of capital market as dependent variable, and the types of payments as independent variables, it can bring about an inconsistent estimate from the endogeneity problem. As previously mentioned, the payment mechanism has an impact on capital markets endogenously, depending on other factors to also affect capital markets such as the degree of IP protection, the capabilities and types of licensee and licensor and unobservable factors included in the disturbance term. Specially, because the unobservable factors can be correlated with the probabilities of licensee and licensor to choose a payment mechanism, its self-treatment effect can also cause the estimate to be less consistent.

When an independent variable is a dummy and endogenous variable, some scholarly work²⁷⁾ suggested the econometric treatment. Classifying payment mechanisms into three categories of fixed, output contingent and mixed payment, the current paper introduces the polychotomous choice selectivity and instrumental variable methodologies of Dubin and McFadden.²⁸⁾

27) Green, W.H., *Econometric Analysis*, Prentice Hall, New Jersey, 2003.; Dubin, J.A. & D.L. McFadden, "An econometric analysis of residential electric appliance holdings and consumption", *Econometrica*, Vol.52(1984), pp.345-362.

28) Dubin, J.A. & D.L. McFadden, *op. cit.*

$$D_{i, m} = \alpha_m^0 + \beta_m^0 X_i^0 + \delta_m^0 Z_i^0 + \epsilon^0 \quad \text{Eq. (1)}$$

$$R_{i(t1, t2)} = \alpha^1 + \beta_0^1 MR_{(t1, t2)} + \beta_1^1 X_i^1 + \beta_2^1 Z_i^1 + \Sigma \gamma_{im} D_{im} + \epsilon^1 \quad \text{Eq. (2)}$$

That is to say, admitting the existence of correlation between ϵ^0 and ϵ^1 , the model is organized as a two-equation system model, simultaneously estimating Eq. (1) to explain the factors affecting the choice of payment, and Eq. (2) to show the response of capital markets according to three payment mechanisms.

In Eq. (1), a dependent variable represents the payment type in *i*th TT agreement of fixed ($D_{i, 0}$), output-contingent ($D_{i, 1}$) and mixed ($D_{i, 2}$) payment. And independent variables include the characteristics of licensee and licensor (X_i^0), and other factors such as the nature of transferred technology and contract year (Z_i^0) in *i*th TT agreement. In Eq. (2), a dependent variable means the daily stock return ($R_{i(t1, t2)}$) of the licensee *I* for the periods between *t1* and *t2* to include the event day when a TT agreement is announced, and independent variables consist of the types of payment ($D_{i, m}$) as main factors in this study, the daily market return ($MR_{(t1, t2)}$) during the same period with the dependent variable, the characteristics of licensee and licensor (X_i^1), and other control variables (Z_i^1) in *i*th TT agreement.

2. Variables

1) Dependent variables

The dependent variables in the model comprise the types of payment and the daily stock return of a licensee.

In terms of payments, they are classified into three categories: Fixed, output contingent, and mixed payment. As a payment independent of the

commercial performance, the fixed payment consists of the lump-sum contract to charge up-front payment, typically due upon the signing of TT agreement, and the periodic payment to require remuneration of licensee annually or quarterly. As a payment sensitive to the commercialization process, the output contingent payment consists of milestone, royalty and equity based contracts. A milestone means that a licensee pays a licensor based on some non-recurring event like passing a certain stage of commercialization, receiving a specific type of financing, or selling the first unit of a product. A royalty contract means the payment by a fraction of end-product sales or a fixed amount per unit sold. An equity-based deal, recently receiving increased attention as an instrument to expect more gain, diversify the risk limited to transferred technologies, and give more control tools to licensor, means that the licensor receives a share of corporate equity of the licensee. At last, a mixed payment represents a two-part tariff, consisting of fixed and output contingent clauses.

Responses of capital markets to TT agreement are measured from the daily stock return of the licensee as the corporations listed in KOSDAQ around the day of public announcement on TT agreement. The dependent variables in the second equation are based on three event periods to overcome the uncertainty from the ambiguity of the event day. The basic event period was measured from the daily return based on the closing price from event day -1 to event day. The measure was complemented by calculating from event day -1 to event day +1 because when TT agreement is announced near to the closing time of trading, the response of capital market may not be reflective of it. A supplementary measure is based from event day -3 to the event day because capital markets can recognize some TT agreements prior to the announcement.

2) Independent variables

Explanatory variables commonly used in two equations, AGE and SIZE are based on the years passing from the foundation of a licensee until the contract and the logarithm value of total assets in balance sheet at the contract year respectively. The types of licensor (TYPE) are divided into five actors of domestic (1)individual, (2)university, (3)public research institute, (4)corporation and (5)foreign institution. Regarding the protection of IP, the current paper basically follows the approach of Anand and Khanna²⁹⁾ to use standard industrial classification. Classifying chemical and pharmaceutical, general machinery, IT hardware and IT software industries as the sectors with strong IP protection, and defining the rest as unclassified industries, the model in this study includes four industrial dummy variables.

With respect to the explanatory variables affecting the choice of payment terms, the model includes the growth of sales (SALES), profitability (PROFIT) and uncertainty (UNCERTAINTY) of a licensee and dummy variables of contract years. First, measuring the difference between the growth of sales at event year -1 and the event year, the estimate of SALES addresses that the contract with a highly growing licensee depends on more output contingent payment because it encourages the licensor to share the benefit of the commercialization by transferred technologies. Second, defining one when a licensee achieves the positive net profit during successively two years before the event year, the positive value of PROFIT shows that less financially distressed licensee prefers a fixed payment in order to appropriate more future return based on stronger negotiation power. Third, dividing the average by the standard deviation of daily stock

29) Anand, B.N. & T. Khanna, "The structure of licensing contracts", *Journal of Industrial Economics*, Vol.48 NO.1(2000), pp.103-135.

prices of a licensee between event day -190 and event day -10, the positive value of UNCERTAINTY leads the equilibrium of negotiation into the contract by mixed payment because the licensee tends to avoid the devaluation of the current stock price through an output contingent payment while the licensor is willing to remove the future risk through an upfront payment. Last, year dummies are involved in order to control the recent phenomenon to converge compensation patterns into mixed payment.

In terms of the explanatory variables affecting the response of capital markets, the model includes market return (MR), pre-existing relationship between two parties (RELATION). First, MR is calculated as stock market return during the same period with the event time of dependent variable. It is used to control market effect already known as the most critical factor affecting an individual stock return. Second, defining one if a licensee is a subsidiary or affiliation of a licensor, RELATION is used in order to control existing network effect between two parties on the capital market. In spite of non-subsidiary or non-affiliation, the licensee can expect network effect from licensor if they have been business partners or have experience to trade technology from each other. Given dataset, however, this study uses only narrow definition to measure network effect between licensee and licensor.

3. Descriptive statistics

<Table 1> describes the distribution of three payment mechanisms by year. It shows that mixed payment has been popular term in TT agreements, accounting for 47.1% of total payment types.

<Table 2> displays the distribution of payment mechanisms by the types of licensor.

<Table 1> Payment mechanisms by year (number, %)

	2000	2001	2002	2003	2004	2005	2006	2007	Sum
Fixed	8 (40.0)	8 (29.6)	6 (15.4)	9 (27.3)	9 (39.1)	9 (31.0)	3 (10.7)	3 (42.9)	55 (26.7)
Output Contingent	3 (15.0)	5 (18.5)	14 (35.9)	13 (39.4)	6 (26.1)	6 (20.7)	7 (25.0)	0 (0.0)	54 (26.2)
Mixed	9 (45.0)	14 (51.9)	19 (48.7)	11 (33.3)	8 (34.8)	14 (48.3)	18 (64.3)	4 (57.1)	97 (47.1)
Sum	20 (100.0)	27 (100.0)	39 (100.0)	33 (100.0)	23 (100)	29 (100.0)	28 (100.0)	7 (100.0)	206 (100.0)

<Table 2> Payment mechanisms by the types of licensor (number, %)

	Fixed	Output Contingent	Mixed	Sum
Individual(Domestic)	3(42.9)	3(42.9)	1(14.3)	7(100)
University(Domestic)	4(28.6)	3(21.4)	7(50.0)	14(100)
Public Research Institute(Domestic)	5(13.5)	3(8.1)	29(78.4)	37(100)
Corporation(Domestic)	15(31.3)	18(37.5)	15(31.3)	48(100)
Corporation(Abroad)	28(28.0)	27(27.0)	45(45.0)	100(100)
Sum	55(26.7)	54(26.2)	97(47.1)	206(100)

First of all, occupying approximately 48.5% of total sample, TTs from foreign corporations are still dominant in domestic TT system. And in coincidence with the increasing attention of universities and public research institutions to TT, their activities have grown enough to compare with those of corporation, occupying almost half of total domestic transactions. However, unlike Schachter and Huston (2005), they seem to prefer a mixed

payment. This result implies that recent universities seek for monetary risk and return simultaneously not only by playing a role of non-profit organizations with the responsibilities to proliferate knowledge, but also by responding to the increased social pressure to urge their financial performance. On the contrary, the preference of the individual in less favor of mixed payment can be based on the attribute to avoid time- and energy-consuming process to design the complicated TT agreement with licensee.

<Table 3> illustrates the distribution of payment mechanisms by an industry.

<Table 3> Payment mechanisms by industry (number, %)

	Fixed	Output Contingent	Mixed	Sum
Chemistry (Including Pharmaceutical Industry)	7(25.9)	4(14.8)	16(59.3)	27(100)
General Machinery	8(20.0)	14(35.0)	18(45.0)	40(100)
IT Hardware	21(26.9)	23(29.5)	34(43.6)	78(100)
IT Software	6(22.2)	6(22.2)	15(55.6)	27(100)
Others	13(38.2)	7(20.6)	14(41.2)	34(100)
Sum	55(26.7)	54(26.7)	97(47.1)	206(100)

Accounting for 37.8% of total TT agreements, IT hardware industry seems like a dominant actor contributing to the open innovation system. However, even if <Table 3> shows that chemical, pharmaceutical and IT software industry focus on the mixed payment just a little more, there seems no definite evidences that the preference of payment mechanism can be differentiated according to industry.

IV. RESULTS

1. *Choice of payment mechanism*

<Table 4> displays the result of the first regression on the factors affecting the choice of payment mechanism.

<Table 4> Factors affecting the choice of payment mechanisms

	Mixed Payment		Output Contingent Payment	
	Coeff.	t-stat.	Coeff.	t-stat.
Constant	-16.245**	-2.06	-22.700**	-2.51
AGE	-0.737*	-1.87	-1.191***	-2.67
SIZE	0.605*	1.84	1.005***	2.64
SALES	0.313*	1.76	0.518*	1.74
PROFIT	-0.634	-1.36	-1.269**	-2.42
UNCERTAINTY	3.884*	1.9	-0.605	-0.24
University(Domestic)	1.502	1.05	-0.211	-0.16
Public Research Institute(Domestic)	3.326**	2.49	-0.039	-0.03
Corporation(Domestic)	1.167	0.92	0.551	0.56
Corporation(Abroad)	1.715	1.41	-0.042	-0.05
Chemistry	0.846	1.24	0.727	0.84
Machinery	1.499**	2.25	2.182***	2.87
IT Hardware	0.227	0.43	0.710	1.15
IT Software	0.583	0.8	0.567	0.67
Year dummy	Included		Included	
Observation	205			
Pseudo R2	0.1595			

* (**, ***): Significant at the 0.10 (0.05, 0.01) level.

Unlike Vishwasrao³⁰⁾ to show that the bargaining power of large corporations leads themselves to agree upon upfront contract with more favor condition, the estimate of SIZE in <Table 4> suggests that larger firms prefer an output contingent payment to a fixed payment. However, from the negative values of AGE and PROFIT, the assertion of Vishwasrao can be partly supported by explaining that start-ups with higher information asymmetry would like to delay their payment until the commercialization begins, and the licensee with more cash reserves prefers a fixed payment affected by the strong bargaining power. Finally, this study discovers the evidence that the terms of payment are chosen by depending on the financial condition of the licensee.

And showing a significant and higher value in output contingent payment, the estimate of SALES implies that the high growth of a licensee motivates a licensor to choose output contingent payment by expecting to extract more benefits from commercialization of the licensee than fixed payment. The significance of UNCERTAINTY meaning a high return and risk of a licensee in choosing mixed payment implies that high uncertainties do not only urge the licensee to avoid the fixed payment causing corporate value to be negatively unstable, and but they also make the licensor avoid the output contingent payment involving more future risk than return.

Even though the above results are supported by previous studies, and also seem reasonable from intuition, the other attributes such as the type of licensor and the degree of IP protection are not recognized as significant factors affecting the choice of payment mechanisms.

In addition, there exists no evidence of Schachter and Huston³¹⁾ that universities and corporations prefer fixed and output contingent payment respectively. This is because there have been no definite style for

30) Vishwasrao, S., *supra* note 4.

31) Schachter, B. & J. Huston, J., *supra* note 4.

universities, corporations or foreign institutions to prefer as the number of TT agreements increases at heterogenous environment. For example, universities increase to adopt output contingent payment more frequently, especially by equity licensing, as they come to realize the benefits of output contingent deals.³²⁾ Specially, Table 4 shows that the contract with public research institutes are based on more mixed payments. However, there is no evidence on the effect of IP protection. It might be due to measurement error by the strong assumption that industrial classification is closely related to IP protection.

In summary, even though some evidence debated in previous studies cannot be confirmed, <Table 4> empirically confirms that the characteristics of licensee such as age, sales, profitability and uncertainty serve as the distinctive factors in choosing the payment mechanism in TT agreement.

2. Response of public capital market

<Table 5> explains the result of the second regression on the response of capital markets in three event periods to different payment contracts.

Showing the significant positive and negative value of MR and SIZE respectively, <Table 5> bolsters the reality of the model that individual stock return strongly depends on market impact, and its fluctuation decreases by the size of firms.

In terms of payment mechanisms as main variables in this study, only mixed payment derives a positive response of capital markets. As already mentioned, because of the restricted role to reduce asymmetric information between contractors, fixed and output contingent payments cannot fully

32) Bray, M.J. & J.N. Lee, *supra* note 16.; Thursby, J.G. et al., "Objectives, characteristics and outcomes of university licensing: A survey of major u.s. universities", *Journal of Technology Transfer*, Vol.26 No.1(2001), pp.59-72.

<Table 5> Factors affecting on the response of public capital markets

	Return [-1,0]		Return [-1,1]		Return [-3,0]	
	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
Constant	0.188	1.32	0.272	1.22	0.252	0.96
MR	0.983***	5.12	0.839***	3.81	1.211***	6.16
AGE	0.006	0.82	0.007	0.65	0.021	1.53
SIZE	-0.011*	-1.79	-0.016*	-1.69	-0.016	-1.38
Mixed Payment	0.066**	2.16	0.105**	2.2	0.120**	2.12
Output-contingent Payment	0.027	0.97	0.032	0.74	0.070	1.37
Relationship	-0.014	-0.94	-0.038	-1.65	0.014	0.51
University (Domestic)	0.062**	2.28	0.055	1.29	0.049	0.98
Public Research Institute(Domestic)	0.044	1.5	0.040	0.87	-0.008	-0.15
Corporation (Domestic)	0.041*	1.81	0.049	1.38	0.018	0.43
Corporation (International)	0.055**	2.31	0.066*	1.79	0.040	0.92
Chemical	-0.032*	-2.09	-0.013	-0.53	-0.030	-1.05
Machinery	-0.022	-1.58	-0.006	-0.25	-0.045	-1.71
IT Hardware	-0.011	-0.99	0.002	0.11	0.013	0.61
IT Software	-0.032**	-2.18	-0.025*	-1.06	-0.025*	-0.9
Bias-Correction Factor1	-0.023*	-1.83	-0.035*	-1.8	-0.028	-1.19
Bias-Correction Factor2	0.002	0.23	0.004	0.24	-0.006	-0.3
Observation	205		205		205	
Adjusted R2	0.1379		0.0724		0.1477	

* (**, ***): Significant at the 0.10 (0.05, 0.01) level.

satisfy capital markets which wish the completeness of contracts. Considering the reduction of total information asymmetry in innovation activities as one of most critical factors to attract external capital providers, <Table 5> confirms that mixed payment serves as an effective instrument to reduce the gap of information inequality between contracts and capital market by self-controlling the moral hazard in TT agreement.

Nevertheless, evidence regarding licensor types and IP protection are still vague. First, there is no evidence that a specific licensor can appeal to capital markets. Showing that the TT from public research institutes compared to other organization is less attractive to capital markets, the first column of <Table 5> infers that the policy for public TT system needs to be more oriented in favor of capital markets. Additionally, only suggesting that the TT from foreign corporation keeps the stability of its valuation after the announcement of TT agreement, the second column of <Table 5> implies that the TT market is deeply dependent on corporations in developed countries. Second, in terms of IP protection, even though the negative response to IT software industry seems to support the relevance between IP protection and TT performance, there is no confirmative evidence because chemical and pharmaceutical industries also induce the negative effect to capital market.

In summary, like the factors affecting the choice of payment, there is no comprehensive evidence on the appeal of licensor types and IP protection to capital markets. Nevertheless, showing the positive estimate of mixed payment in all suggested event periods, <Table 5> verifies the primary hypothesis in this study that the terms of payment in TT agreement serves as a strategic means to reduce the information asymmetry among licensee, licensor and capital markets beyond the function as a financial option for the licensee and the licensor to flexibly handle with the deployment of their financial resources.

V. CONCLUSION

1. *Summary and implications*

Open innovation systems have led actors such as public research institutes, universities and capital providers as well as corporations to take part in TT activities. Because TT systems are embryonic, more empirical understanding must be needed.

This study raises a question of whether a payment mechanism in TT agreement serves as an instrument to reduce information asymmetries between licensee and licensor. Unfortunately, only a few studies³³⁾ have focused on the role of the payment mechanism to control the moral hazard and adverse selection problem of two parties.

This study attempts to empirically prove the role of payment mechanism in capital markets by investigating the public notices on TT agreement in a stock market and the stock return response. Because an efficient capital market pays attention to innovation activities only after checking the reduction of their information asymmetries, the positive response to a certain payment can support its role to minimize the information asymmetries, especially between licensee and licensor in TT agreement.

Previous studies have stressed that because in the condition of asymmetric information of TT agreement, each fixed and output contingent payment can cause the shirking and shelving problem to licensor and licensee respectively, the more complicated payments mixing two attributes are required for the completeness of contract.

Classifying the terms of payment into three categories of fixed, output contingent, and mixed payment, this study empirically investigates the

33) Jensen, R. & M. Thursby, M., *op. cit.*; Thursby, M.C. et al., *op. cit.*

distinctive response of capital markets to these three payment mechanisms. Specially, designing a two-equation system model to treat the endogeneity problem caused by OLS regression model, this study offers additional information on the preference of licensee and licensor about three terms of payment as well as more consistent estimates.

With respect to the motivation to choose a payment mechanism, fixed payments appeal to the licensee with more cash reserves, and output contingent payments appeal to the licensor which contracts with highly growing licensee. These results can be interpreted from the strategy of licensee and licensor to extract future benefit from commercialization. In addition, the contract with high uncertainties is based on mixed payments, which is inferred from the conflicts of interest that the licensee wishes to avoid short-term damage through output contingent payment while the licensor hopes to remove long-term risk through fixed payment.

With regard to the response of capital markets, this study has following implications. First of all, as a main finding, the participants in TT activities need to understand the role of payment mechanisms not only as a financial option to manage financial resources, but also as a control instrument to minimize the moral hazard and adverse selection problem. Additionally, showing the lower assessment of TT activities from public research institutes compared to those from domestic universities and international corporations, the result suggests the public TT market is oriented to favor of private capital market. And from the low evaluation of TT activities from chemical and pharmaceutical, and IT software industry, the result implies that there might not be no relationship between IP protection and the attraction of capital markets, but the weak IP protection even in chemical and pharmaceutical industries, requiring stronger IP policy.

2. *Limitation and future works*

Due to small sample, the classification of payment mechanism is too restrictive to highlight the distinctive characteristics of a payment mechanism within each subcategory. For instance, pointing out an inefficiency of royalty payment to control moral hazard of licensor, a few studies³⁴⁾ have considered a milestone as an optimal mechanism in output contingent payments. Additionally, addressing the limitation of the milestone to control the shelving problem of licensee, Thursby et al.³⁵⁾ consider the contract mixing annual payments and milestones as an optimal one against information asymmetry between licensee and licensor. Feldman et al.³⁶⁾ have insisted that compared to traditional royalty-based license, equity-based deal cannot only provide the licensor with more opportunities to share the fortune of the licensee, but also appeal to capital market or strategic partners. That is to say, based on more detailed classification, future study should describe more various aspects of TT agreement, and suggest more sophisticated evidence on its role.

In addition, TT agreement is recognized to be a non-linear process between licensee and licensor simultaneously considering more various clauses such as provisions on governance, the terms of renegotiation and duration, and safeguards clauses regarding exclusivity, usage restriction and grant-back as well as the terms of payment. For this reason, in spite of more advanced econometric approaches, the model in this study might be restrictive by not considering the endogeneity problem caused by the above factors.

Finally, this study omits many TT agreements because it includes only

34) Jensen, R. & M. Thursby, M., *op. cit.*; Macho-Stadler, I. et al., *supra* note 13.

35) Thursby, M.C. et al., *op. cit.*

36) Feldman, M. et al., *supra* note 10.

contracts to announce in equity market. This may induce sample selection bias, and cause the econometric approach in this study to be still unstable.

In spite of these limitations, this study has originality not only in contributing to sparse empirical studies on TT, but also in shedding light on the role of payment terms in perspective of information asymmetry, especially based on the assessment of capital markets.

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기술이전 가격보상방식이 초과주가수익률에 미치는 영향에 관한 연구

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국문초록

본 연구는 한국 주식시장의 기술이전 공시자료를 통해 기술도입기업과 이전기업이 계약 당시 다양한 조건에 따라 다양한 가격보상방식(고정보수, 성과보수, 혼합방식)을 선택하며, 이에 따라 주식시장의 반응이 차별적임을 보이고 있다. 206건의 기술이전계약을 조사한 결과, 기술이전계약이 고정보수와 성과보수의 혼합방식의 보상체계를 선택할 때, 주식시장의 초과주가수익률이 가장 높았다. 이는 혼합방식의 보상체계가 기술이전계약에서 발생하는 주인-대리인 문제를 가장 효율적으로 통제하는 도구가 될 수 있음을 암시한다.

주제어

기술이전, 가격보상방식, 고정보수, 성과보수, 주식수익률, 주인-대리인 문제