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Abstract

Using survey data of licensing activities of Japanese firms, this paper studies the interaction between patenting and multiple contracting and their effects on license revenues for large and small licensors. We find that small firms are more likely to license their technologies to multiple licensees and receive more revenue from multiple contracting, confirming a theory that multiple contracting makes small firms less vulnerable in forming profit-sharing alliances with downstream technology users. We also find that patented technologies are less likely to be licensed to multiple licensees. However, patenting itself has no significant effect on increasing license revenues. We provide implication for small firms which want to appropriate from licensing out their technology: it is more difficult to get one dollar from one licensee than it is to accrue pennies from many to make a fortune, even under patent protection. Our result suggests a necessity in providing platforms for active interactions between small innovators and downstream technology users.

Keywords: Multiple contracting, Markets for technology, License revenue

JEL classification: O32, O34, O31

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1 INTRODUCTION

Markets for technology allow innovators to receive rent from licensing rather than in-house exploitation. They are particularly important for small technological ventures lacking complementary assets to commercialize their technologies. They also provide large enterprises with additional profiting opportunities to exploit their sleeping technologies. Two key points are widely discussed in the literature on markets for technology: intellectual property (IP) protection and multiple contracting.

IP protection, especially patent protection, is considered as important in overcoming the limitation of the markets for technology: the opportunistic behavior of technology buyers (Gambardella, 2002; Teece, 1988). A properly designed patent claim can prevent potential technology users from exploiting the technology after it is disclosed. Empirical studies have found that stronger patent protection increased the propensity of licensing (Gambardella, Giuri, & Luzzi, 2007; Kani & Motohashi, 2012), though this effect may not be valid for patent owners owning specialized complementary assets (Arora & Ceccagnoli, 2006). Arora (1996) argue that packaging know-how with patents facilitates flows of tacit knowledge, leading to more licensing. Patent protection may be more important for small firms as they lack other appropriation means such as manufacturing assets (Arora & Gambardella, 1994). However, IP protection is not perfect in many industries (Gans & Stern, 2003), and there is strong concern about whether small firms with weak legal resources can effectively enforce their patent rights.

While IP protection ameliorates the “paradox of disclosure” problem, another key feature, “multiple contracting”, highlights the benefits of the markets for technology. Multiple contracting, or supplying a technology to more than one buyer, justifies the economic benefits of specialization or “division of innovative labor” (Arora, Fosfuri, & Gambardella, 2001; Gambardella & McGahan, 2010). Especially, the supplier can accrue returns from several market niches if the technology is a general purpose technology (GPT) which can be applied to different sectors without bringing competition among buyers/licensees. Multiple contracting also increases the bargaining power of small innovators and makes them less vulnerable (Gambardella & McGahan, 2010). Firms may differ in their capabilities to create more general technologies which are more likely to be licensed out (Gambardella & Giarratana, 2013).

Fruitful literature indicates that both patent protection and multiple contracting provide opportunities for technology suppliers to capture more rent from their innovations, but empirical analysis investigating the role of patent in multiple contracting is scarce. Existing studies (Gambardella & Giarratana, 2013; Gambardella et al., 2007; Kani & Motohashi, 2012) analyze the factors of the markets for technology from a dichotomous view: whether a technology has been licensed out, but does not extend estimations to the determinants of the number of licensees for a technology, due to data limitations.

In addition, empirical studies on the transfer of non-patented technology are also very limited, with only few exceptions (Arora, 1996). A general view is that patents help innovative technology suppliers successfully catch monopoly rent. However, many firms, such as the specialized engineering firms in chemical industry, may just provide non-patented know-how in the markets for technology (Arora et. al, 2001). Are they disadvantaged in the markets for technology? Studies are needed to evaluate the value of patents not just in their role in making the markets, but also in their effect in catching the rent.

This paper addresses the above questions using a novel survey data of Japanese firms' technology licensing and contracted research activities. We find that small firms are more likely to license their technologies to multiple licensees, and that they receive more revenues from multiple contracting, confirming a theory that multiple contracting makes small firms less vulnerable in forming profit-sharing alliances with downstream technology users.

The paper is organized as follows. Section 2 reviews the literature. Section 3 describes our data and empirical models. Section 4 presents the results and discussions. Section 5 concludes the paper.

2 LITERATURE REVIEW

2.1 Multiple contracting

Multiple contracting allows a wider exploitation of the technology's potential use. A good example is the famous Cohen-Boyer rDNA technology. It is impossible for any single company to exploit the technology at the current scale, where an estimated 2,442 new products have been developed over the duration of the patents (Feldman, Colaianni, & Liu, 2007). Though it is quite a special case and only a small number of technologies have such a large potential to attract hundreds of licensees, relying on one licensee to fully exploit a technology is unrealistic. Licensors may also be concerned about the competency of one licensee and suffer the opportunity cost in an exclusive contract (Aulakh, Jiang, & Pan, 2009). Thus, multiple contracting may be preferable as it gives a benefit of "fully exploitation".

However, multiple contracting has its cost—the loss of monopoly rent. Exclusive licenses would allow the licensee to monopolize the end product if there is no close substitute, while multiple contracting may bring competition among the licensees in the product market. Arora et al. (2001) use a "revenue effect" vs. "rent dispersion" model to explain the choices between self-exploitation and licenses. In their model, a firm would prefer licenses only if the license revenue outweighs the rent dispersion resulting from competitions between the licensor and the licensee in the product market. This model can still be used in analyzing the choice between exclusive licenses and multiple (non-exclusive) contracting. Here the rent dispersion effects are taken place among the licensees, not between the licensor and licensees. Adding more licensees can increase the exploitation opportunities, bringing a "revenue effect". If there are several separate applying fields of the technology, competition among licensees would be weak, increasing the propensity of multiple contracting (Gambardella & McGahan, 2010). Empirical evidence showed that propensity to use multiple licenses increases when the technology has great potential to produce differentiated products (Aulakh, Jiang, & Pan, 2009).

2.2 Transaction cost and intellectual property protection

Transfer of technology can incur substantial transaction cost due to information asymmetry and optimistic behaviors of both parties (Arora et al., 2004; Gambardella, 2002). Patent protection alleviates the problem and plays an important role in the markets for technology. Before a transaction, the innovator needs to disclose information about the technology to let potential buyers assess the value of the technology. Strong patent protection prevents those buyers from free riding the technologies after disclosure. However, technologies based on tacit knowledge may not be suitable for patenting. In this case, bundling tacit know-how with patented codified knowledge can be an efficient strategy for technology transfers (Arora, 1996).

Patent protection is important in "making markets" for technologies. Empirical studies provide evidence that the propensity of technology licensing is increased by stronger patent protection, either from views of the degree of patent right enforcement (Kani & Motohashi, 2012) or patent claim scope (Gambardella et al., 2007). Patents can also facilitate technology transfers by decreasing the search cost as technology users can find technologies they desire from patent publications and approach the innovators. However, patenting itself is not a necessity for successful technology transfers. Arora (1996) find that know-how can be traded with provisions of complementary inputs other than patents, such as plant commissioning. Kani and Motohashi (2013) find that though patents moderate transaction costs among non-business partners, co-specialization of technology and its complementary assets are more important for technology transfers among business partners.

2.3 Large firms vs. small firms

Literature on markets for technology never neglects the differences among large and small firms. Main differences lie in the incentives and the bargaining power.

Small firms may lack complementary resources to implement their technology, thus licensing has become a critical way to commercialize their technologies. These technologies usually are key technologies which the small innovators developed. Large firms may license their technologies for more complex reasons. For example, the technology may not fit the core business of the licensor or it is quite a fundamental technology where commercialization opportunities are unclear. Large firms may also license technologies for standardization. Compared to small ones, large firms are concerned more about product market competition brought about by licensing, especially for technologies in their core business.

The barging power of licensors determines the share of the total value finally accrued to the licensor. There are concerns that small, specialized firms only have weak bargaining power in negotiations because they lack the resources to commercialize the technology independently and have to rely on the licensee's complementary assets (Gambardella & McGahan, 2010; Gans & Stern, 2003). Bargaining power can be strengthened if many potential partners are available and the licensor threatens to cooperate with a third party (Gans & Stern, 2003; MacDonald and Ryall 2004). From this point of view, a licensor can be tougher in multiple contracting than it would be in a negotiation for exclusive licensing. Thus, multiple contracting is especially important for small innovators to catch rent in the markets for technology. A counter-argument is that multiple contracting is costly as the licensor needs to provide technology support and training to a number of licensees, making resource-constrained small firms less likely to choose multiple contracting (Jiang, Aulakh, & Pan, 2007).

3 DATA AND VARIABLES

3.1 Data description

In 2011, we conducted a survey of 18,000 business units of Japanese firms on their new product development (NPD) (Kani & Motohashi, 2013). In addition to questions about NPD, the questionnaire also asked several questions about licensing-out/contracted research activities from 2008 to 2010. Among the 3,705 business units (for simplicity, hereinafter, referred to as firms) that responded, 241 reported having licensing-out/contracted research activities. Excluding answers that contained missing data on important questions, we obtained 209 firms as the dataset of this paper. The questionnaire asked the firms to consider their most important technology ("main technology") that was licensed out or transferred through technology consulting services, mergers and acquisitions (M&A), or by forming joint ventures. Therefore, it should be noted that the unit of observations in our data is one particular technology, instead of the firm (or business unit with multiple business firm). The following are the data items used in this study:

- Number of contracts
- Whether or not the technology is initially developed for a special client (customized)
- Whether or not the technology is patented
- Type of technology: product, process, or know-how
- Main application fields of the technology

The questionnaire was designed to cover technology transfers in a broad meaning, which is not limited to licensing-out. The technologies include both patented and non-patented ones. Table 1 shows the observations tabulated by technology transfer methods and patented/non-patented. For technology transfers by licensing, about three-quarters of the technologies are patented, while one-quarter is licensing by "know-how". For the rest of technology transfer methods, "consulting" is used frequently. In addition, there are a substantial number of "others", and it is found that most of this category corresponds to technology transfers embodied in products (parts), such as original equipment manufacturer (OEM) supplies or blueprints of new products. Therefore, we can divide whole samples into two broad categories: licensing and non-licensing by the type of technology transfer. The former category is based on IP protection, by licensing contracts of patents or trade secrets, while the technology to be transferred in the latter categories is embodied in products or services. Therefore, in the majority of the latter case, the technologies are not patented.

(Table 1)

Table 2 shows the cross tabulation of patented/non-patented technologies and customized/non-customized technologies. Customized technology has been developed for the demand of the particular customer, while non-customized technology is driven by the technology owner's initiative. It is natural to see that the share of patented technology is greater for non-customized cases. However, we can see that a substantial number of firms have patented their technologies even in the case of customized technology.

(Table 2)

Table 3 tabulates the number of contracts. Among the 209 firms, 78 reported have supplied their "main technology" to only one buyer, while 131 firms have supplied to more than one buyer. In non-customized cases, more than half of the firms provide their technologies to two or more contractors. In the case of customized technology, it is natural to see the major portion is with only one contractor, but a substantial number of firms (12 out of 37) have multiple contracts. They have initially developed a customized technology only for a special client, but subsequently successfully licensed this technology to others.

(Table 3)

The dataset contains technologies applied in 54 industrial sectors. The largest share (10.1%) is taken by software technologies, followed by automobiles (9.2%) and pharmaceutical technologies (6.3%). The fragmental distribution of those technologies allows us to conduct empirical analysis from a general view as compared to current literature which generally focuses on a special industry.

The questionnaire also asks the firms to indicate their total license revenue (not only for the "main technology") as a percentage of sales. Among the 209 firms, 197 firms provided this information.

3.2 Dependent variables

Our empirical analysis includes two parts. In the first step, we use ordered logit model to test the determinants of the number of contracts (***Num***). ***Num*** is an ordinal variable generated from the ranges given in the questionnaire. The value of ***Num*** is set by taking the average of the bottom and top boundaries of the ranges. For the last option with only the bottom boundary (>10), we set ***Num*** = 20. This treatment shall not bring significant bias in our results as we use ordered logit models, where the order, rather than the quantity, is the major stake. Then, we use an ordered logit model to test how license revenue (***Rev***) is affected by the number of contracts (***Num***), together with other factors. ***Rev*** is the share of license revenue in total sales. It is also an ordinal variable generated from the selected ranges. We make similar treatment in setting values based on boundaries.

3.3 Independent variables

Patented: Dummy, =1 if the technology is patented
License: Dummy, =1 if the technology is transferred by license
Customized: Dummy, =1 if the technology is initially developed for one buyer
Non-core: Dummy, =1 if the technology's application sector is different from the main business sector of the licensor
Product: Dummy, =1 if the technology is a product, 0 if the technology is a process or know-how
Process: Dummy, =1 if the technology is for manufacturing or processing, o if the technology is a product or know-how
Size: logarithms of the number of employees of the technology supplier

We also include 15 industrial dummies in our estimation as control variables.

4 EMPIRICAL RESULTS

4. 1 Determinants of number of contracts

Using ***Num*** as a dependent variable, we test whether non-patented, non-core technologies are likely to be supplied to more downstream technology users, and whether small firms are more likely to supplier their technologies to multiple licensees as suggested in literature.

In models (1) and (2), we use all of the observations including both licensing and other types of technology transfers, embodied in product and services. In model (1), variable ***License*** is negatively but not statistically significant. However, in model (2), it becomes statistically significant when we include the cross term of ***License*** and ***Size***. This suggests that technologies by license contract are supplied to fewer buyers than in the non-licensed case, particularly for smaller firms. Variable ***Size*** is negatively significant, showing that small firms generally supply their technologies to more buyers. A tendency of supplying to a small number of buyers is greater for licensing technology and smaller firms. But, smaller firms tend to provide their technologies embodied in products or services to larger numbers of buyers.

(Table 4)

Variable ***Customized*** shows a strong negative significance, which is not surprising as customized technologies are developed to fit the special needs of a client and generally are not provided to others. However, the cross product of ***Customized*** and ***License*** is positively significant, which indicates that if the innovator decides to patent a technology initially developed for a special client, it is a sign that the innovator believes the technology has the potential to be supplied to other users.[2] Patenting the technology can help the innovator in negotiating with potential buyers.

Models (3) and (4) look like they have the same relationship, but it is only for licensing samples. The coefficients of ***Patented***, ***Size***, and their interaction terms have the same signs, but are not significant as the results of estimations using all observations. The cross product of ***Customized*** and ***Patented*** shows a positive significance, confirming that patenting can be a sign of potential broader applications of technologies developed under special needs.

Models (5) and (6) use another group containing technology transfers other than licensing, mainly technology consulting and new products (parts) supply. A negative and significant coefficient is found for ***Patented,*** suggesting exclusiveness of patent protection works stronger in technology consulting and new products (parts) supply. In addition, a negative size effect is found for this sample.

The results generally support the theory that small firms are more likely to provide their technologies to multiple buyers in the case of non-license type technology transfers, where technology itself is not traded but is embodied with consultations or products. In this case, patenting is used more frequently for technology transactions with a smaller numbers of counterparts, since potential damage by technology leakage to their counterparts is larger in this case. In contrast, a formal licensing contract mitigates this problem, so that the patenting and size effect cannot be found regarding the number of counterparts (in Models (3) and (4)).

4.2 Determinants of license revenue

License revenue data for a special technology are not widely available as they are usually a trade secret. Our survey on the firms' licensing activities is about the

[2] It should be noted that a major portion of licensing technologies are patented.

“main technology” technology licensed out, while license revenue is coded as the percentage of the licensor’s total license revenue of its total sales. It is not a direct measure of the earnings of the technology in the sense that other technologies of the licensor may also contribute to the revenue. However, we think it is still a useful measure of license revenue of the “main technology” due to the following reasons:

- License revenue distribution is highly skewed, where a small percentage of technologies contribute a large part of license revenue. Thus, for a single licensor in a rather short period (3 years), the “main technology” very likely contributes a dominant part to the total license revenue. This is especially true for small firms.

- The percentage measurement has a scale controlling effect allowing a comparison among licensors of different sizes. Though several technologies may have been licensed out by different divisions of a large firm in the same time period, dividing license revenue by sales can reflect the contribution of one technology.

Thus, we use ***Rev*** as a dependent variable in the following ordered logit models to identify the determinants of license revenue. Though license revenue information is available for 197 of the 209 observations, only 103 firms have supplied their technology by licensing. For those firms which supply their “main technologies” by others methods, such as consulting services, the revenues may not be clarified as license revenue. Therefore, we provided the regression results for 103 observations with licensing contracts as the main results in Table 5.

(Table 5)

Table 5 shows a consistent positive correlation of ***Num*** and the dependent variable ***Rev***, suggesting that supplying technologies to a large number of licensees increases license revenue significantly. More interestingly, the cross product of ***Num*** and ***Size*** is negatively significant, suggesting that the effect of number of contracts is more significant for small firms than it is for large firms. The results support the theories of Gambardella & McGahan (2010) that small innovators need to develop general purpose technologies which can be supplied to multiple downstream technology users.

In contrast, we cannot find the effect of patenting on licensing revenue. The interaction effect with ***Patenting*** and ***Num*** is not significant either. Therefore, a choice between licensing by patent and by know-how does not make a difference in licensing revenue, and this trend holds for both small and large firms. Licensing contracts is supposed to work well in protecting propriety technologies even in the case of non-patented know-how. Therefore, it would be appropriate to categorize technology transfers by licensing (either patented or know-how) as a whole in contrast to the patterns found in technology transfers embodied in products and services.

We also provide the regression results for whole samples to see the difference between licensing and non-licensing cases in Table 6. The dependent variable is the share of licensing revenue of the whole company (or business unit in multiple-business firms), which reflects the general capability of firms to generate revenue based on their own technologies. Therefore, we would believe that these regression results provide some meaningful information. The results of ***Num*** and ***Size*** are almost same as those in Table 5, suggesting that more buyers generate more revenue, particularly for smaller firms. In addition, we have found a positive and statistically significant coefficient to the cross term of ***Num*** and ***License***, implying that the effect of multiple contracts works more for technology transfers by license.

(Table 6)

5 CONCLUSIONS

Literature on markets for technology has emphasized the role of patent protection and multiple contracting. However, the two concepts have been discussed separately, and their interactions often have been neglected. This paper addresses the interaction between the two factors and their effects on license revenues for large and small licensors.

We find that generally patented technologies are less likely to be supplied to multiple licensees in the case of non-licensing type technology transactions such as consultancy and new products (parts) supplies. The users may want to use exclusively the technology and receive monopoly rent without formal licensing contracts. This effect is significant in informal technology trades such as technical consulting services involving many non-patented technical know-hows. However, for formal technology licensing, such patent effect cannot be found.

One of the interesting results is that in the case of customized technology where the propensity of patenting is lower, if a developer patents its technology, the technology has a high probability of being licensed to other licensees. This is a sign that innovators believe that patenting will help them get more licensees in the markets for technology. However, our results also show that small firms are more likely to provide their technologies to multiple licensees, especially in non-licensing type technology transfers, embodied in products and services, instead of supplying technology per se. Therefore, smaller firms may be facing more severe market failure in technology transactions by patents or know-how.

We further tested how the two factors affect license revenues. We find that a large number of contracts is the decisive effect in securing high license revenues and that this effect is especially significant for small firms. The result provides empirical support to current theory that small firms generating GPTs can catch higher rent from innovation and survive without complementary manufacture assets. However, our results show no convincing effect that patenting itself helps firms get higher rent.

Combing the results, we can conclude that patenting helps make the market for technologies, but does not secure higher license revenue. The major stake is still in the generality of technologies. Especially, small innovators need to develop more general technologies and pursue multiple contracting for survival in the markets for technology.

Current innovation policies have emphasized the role of intellectual properties, and governments have made efforts in encouraging and supporting small innovators to protect their inventions by patenting. However, our empirical results, together with the theory of GPTs in literature, highlight the importance of multiple contracting in sustainable growth of small, technologically specialized firms. Innovation policy may put more emphasis in supporting small firms to develop the capability of generating GPTs, and governments can provide platforms for interactions of different industrial sectors and help the innovators to find more applications for their technologies.

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Table 1
Tabulations of technology transfer methods

	Technology transfer methods						
	Licensing	Consulting	M&A	JV	Other	NA*	Total
Non-patented	25	28	1	2	23	14	93
Patented	81	10	1	5	9	10	116
Total	106	38	2	7	32	24	209

*Not answered

Table 2
Tabulation of patented and customized technologies

	Patented	Non-patented	Total
Non-Customized	106	66	172 (83%)
Customized	10	27	37 (17%)
Total	116	93	209

Pearson chi2(1) = 14.7608 Pr = 0.000

Table 3
Tabulation of number of contracts

	Number of contracts				
	1	2~5	6~10	>10	Total
Non-customized	53	82	20	17	172
Customized	25	7	3	2	37
Total	78	89	23	19	209

Table 4
Ordered logit estimations of determinants of number of contracts

Dependent var: *Num*	All observations		Licensing		Other technology transfers	
	(1)	(2)	(3)	(4)	(5)	(6)
License	-0.356	-2.309**				
	(-1.12)	(-2.39)				
Patented			-0.461	-1.672	-0.930*	-0.0763
			(-0.84)	(-0.87)	(-1.68)	(-0.05)
Size	-0.211**	-0.383***	-0.0833	-0.248	-0.410**	-0.280
	(-2.39)	(-2.72)	(-0.64)	(-0.74)	(-2.57)	(-1.10)
*License * Size*		0.314*				
		(1.85)				
*Patented * Size*				0.154		-0.197
				(0.44)		(-0.62)
Customized	-2.224***	-2.945***	-0.607	-3.248**	-2.967***	-3.114***
	(-4.88)	(-5.35)	(-0.66)	(-2.15)	(-4.80)	(-4.55)
*Customized * License*		2.866***				
		(2.95)				
*Customized * Patented*				4.492**		0.640
				(2.41)		(0.46)
NonCore	-0.386	-0.375	-0.599	-0.710	0.0590	0.0617
	(-1.21)	(-1.16)	(-1.15)	(-1.32)	(0.13)	(0.14)
Product	1.036***	1.059***	1.287**	1.250**	1.678***	1.640**
	(2.71)	(2.74)	(2.28)	(2.18)	(2.62)	(2.56)
Process	0.418	0.634	0.365	0.466	1.598*	1.614*
	(0.74)	(1.11)	(0.45)	(0.56)	(1.68)	(1.69)
cut1	-1.683***	-2.585***	-0.915	-2.290	-2.241**	-1.703
	(-2.64)	(-3.15)	(-0.91)	(-1.20)	(-2.21)	(-1.28)
cut2	0.763	-0.0396	1.994*	0.763	0.334	0.897
	(1.23)	(-0.05)	(1.93)	(0.40)	(0.35)	(0.69)
cut3	1.866***	1.099	3.009***	1.825	1.739*	2.310*
	(2.90)	(1.37)	(2.79)	(0.95)	(1.76)	(1.74)
Technology dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	209	209	106	106	103	103
LogLik	-214.5	-209.1	-98.58	-95.44	-97.88	-97.57
chi-squared	69.42	80.17	34.83	41.09	65.21	65.82

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5
Ordered logit estimations of determinants of license revenue (technology transfers by licensing)

Dependent var: *Rev*	(1)	(2)	(3)	(4)	(5)
Num	0.914***	3.482***	3.441***	3.665***	3.822***
	(3.18)	(3.91)	(3.67)	(3.97)	(3.77)
Patented	0.481	0.577	0.389	3.333*	3.973
	(0.86)	(1.02)	(0.27)	(1.81)	(1.46)
Size	-0.113	0.706**	0.719**	1.240***	1.285***
	(-0.89)	(2.37)	(2.29)	(2.71)	(2.67)
*Num * Size*		-0.436***	-0.444***	-0.465***	-0.464***
		(-3.04)	(-2.90)	(-3.10)	(-2.90)
*Num * Patented*			0.102		-0.169
			(0.14)		(-0.22)
*Patented * Size*				-0.541	-0.591
				(-1.59)	(-1.62)
Customized	-0.103	0.0219	0.00343	0.308	0.834
	(-0.11)	(0.02)	(0.00)	(0.33)	(0.50)
*Customized * Patented*					-0.693
					(-0.35)
NonCore	0.235	-0.0432	-0.0396	0.0178	0.0216
	(0.48)	(-0.08)	(-0.08)	(0.03)	(0.04)
Product	-1.639***	-1.529***	-1.531***	-1.573***	-1.589***
	(-2.88)	(-2.66)	(-2.66)	(-2.72)	(-2.74)
Process	-1.204	-0.815	-0.820	-0.965	-0.988
	(-1.52)	(-1.02)	(-1.03)	(-1.20)	(-1.23)
cut1	-1.966*	2.848	2.772	5.504**	6.103**
	(-1.74)	(1.50)	(1.40)	(2.11)	(2.03)
cut2	0.901	5.875***	5.797***	8.592***	9.190***
	(0.81)	(2.99)	(2.84)	(3.21)	(2.98)
cut3	2.655**	7.747***	7.670***	10.49***	11.10***
	(2.32)	(3.83)	(3.66)	(3.83)	(3.53)
cut4	3.375***	8.549***	8.472***	11.30***	11.92***
	(2.90)	(4.14)	(3.97)	(4.08)	(3.73)
Technology dummies	Yes	Yes	Yes	Yes	Yes
Observations	103	103	103	103	103
LogLik	-120.0	-114.8	-114.7	-113.5	-113.4
chi-squared	38.73	49.24	49.26	51.84	51.99

t statistics in parentheses

Table 6
Ordered logit estimations of determinants of license revenue (all technology transfers)

Dependent var：*Rev*	(1)	(2)	(3)	(4)	(5)
Num	0.354**	1.622***	1.545***	1.623***	1.605***
	(1.97)	(3.42)	(3.23)	(3.23)	(3.14)
License	1.717***	1.903***	0.561	1.258	1.167
	(4.96)	(5.34)	(0.73)	(0.87)	(0.77)
Size	0.0391	0.520***	0.614***	0.691***	0.685***
	(0.44)	(2.70)	(3.09)	(2.86)	(2.82)
*Num * Size*		-0.243***	-0.299***	-0.302***	-0.301***
		(-2.83)	(-3.26)	(-3.28)	(-3.27)
*Num * License*			0.719*	0.646*	0.657*
			(1.94)	(1.66)	(1.67)
*License * Size*				-0.102	-0.0941
				(-0.57)	(-0.51)
Customized	-0.307	-0.0872	-0.250	-0.208	-0.279
	(-0.67)	(-0.19)	(-0.53)	(-0.44)	(-0.46)
*Customized * License*					0.188
					(0.19)
NonCore	0.240	0.205	0.218	0.222	0.225
	(0.76)	(0.64)	(0.69)	(0.70)	(0.70)
Product	-0.124	-0.0674	-0.0429	-0.0702	-0.0665
	(-0.33)	(-0.18)	(-0.11)	(-0.18)	(-0.17)
Process	0.397	0.526	0.507	0.448	0.456
	(0.75)	(0.98)	(0.95)	(0.82)	(0.84)
cut1	1.141	3.937***	3.720***	4.213***	4.148***
	(1.54)	(3.18)	(2.98)	(2.75)	(2.65)
cut2	2.970***	5.820***	5.633***	6.123***	6.058***
	(3.84)	(4.55)	(4.37)	(3.92)	(3.79)
cut3	4.380***	7.267***	7.110***	7.604***	7.539***
	(5.41)	(5.52)	(5.37)	(4.76)	(4.62)
cut4	4.981***	7.884***	7.744***	8.243***	8.177***
	(5.99)	(5.91)	(5.76)	(5.09)	(4.94)
Technology dummies	Yes	Yes	Yes	Yes	Yes
Observations	197	197	197	197	197
LogLik	-238.2	-234.1	-232.1	-231.9	-231.9
chi-squared	69.36	77.65	81.58	81.91	81.95

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$