Acquisitions by Business Group and Technology Transfer

Young Gak KIM and Sadao NAGAOKA

Two important opportunities for accelerating the growth of newly established firms are initial public offerings and acquisitions. This study focuses on the acquisition of a firm and its subsequent transformation into a subsidiary by business groups and investigates how such governance facilitates technology transactions (i.e., transfer of patent rights) and firm growth in Japan. The analysis reveals that such acquisitions can lead to increased technology transactions even when the transactions directly related to the acquisition are excluded and the transactions with firms outside the business group are included. However, the increase in technology transactions is limited mainly to wholly owned subsidiaries. The transfer of patent rights to a subsidiary is accompanied by an improvement in its sales, R&D, and productivity, controlling for the increase in its capital base. The sales and other performance of the business group also improve with the number of acquisitions.

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I. Introduction

The growth of newly established firms is crucial to the introduction of new technologies and industry innovation (Acemoglu *et al.*, 2007; Aghion and Tirole, 1997; Gompers, Lerner, and Scharfstein, 2005; Kaplan and Schoar, 2005). Two important opportunities for such growth are initial public offerings (IPOs) and acquisitions. Two types of acquisitions exist: those in which a company is integrated into the acquired company and those in which it is incorporated into a business group but maintains its legal personality. The latter acquisition type maintains a certain degree of the management autonomy of the acquired firm but at the same time facilitates risk financing and technology transactions (transfer of patent rights). This study empirically investigates this concept.

According to the Japan Exchange Group, an average of 53 IPOs occurred in Japan between 2007 and 2021, with an average raised capital amounting to about 2.4 billion yen per IPO. The mergers and acquisitions (M&A) data of RECOF showed that for the M&A of independent[1] companies during the same period (2007–2021), an average of 32 mergers took place per year, with an average amount of about 18.4 billion yen per merger, as well as an average of 672 acquisitions per year, with an average purchase price of 7.7 billion yen per acquisition. Thus, M&A of independent firms by business groups significantly outnumber IPOs by independent firms in number and in value.

Fully integrating an independent company into an organization through acquisition is only one option and maintaining its legal entity and ensuring its management autonomy is another. When Google acquired YouTube, the two companies became integrated, but in Fitbit's case, the company became a subsidiary. Millennium, which is a Boston-based biotech company acquired by Takeda, is also a subsidiary with a legal entity, like Genentech, which was acquired by Roche. An acquired firm can maintain its legal person status when its business requires a unique approach differing from that of the parent company and when a strong initiative by the firm is essential. Such firms typically conduct a

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[1] In RECOF's M&A data, independent firms are defined as "where the M&A is not classified as within a business group and the parent company prior to the M&A is not reported." This definition differs from that of independent firms in the analysis.

high level of research and development (R&D) and file their own patent applications. Thus, such governance may provide important growth opportunities to acquired firms.

The transfer of patent rights plays an essential role in a business group, where the subsidiary retains its legal personality. First, in forming a business group (when a subsidiary with a legal personality is established through acquisition), reorganization is conducted to optimize the allocation of resources across the business group, and patent rights are transferred as part of such reorganization. Patent rights are transferred to an organization that can utilize the rights efficiently. In the extreme case, if the acquired firm specializes in manufacturing as a result of an acquisition, then the patent rights will be concentrated to the parent company, and the R&D of the acquired firm will decline.

Second, technology transfer, including the transfer of patent rights, may be facilitated among the firms within a business group. Technology markets are constrained by asymmetric information on the technology to be licensed (adverse selection), efforts to develop the technology (moral hazard), and contractual imperfections, such as opportunistic behavior (Caves *et al.*, 1983; Zeckhauser, 1996; Arora and Gambardella, 2010). However, long-term cooperation in business (*e.g.*, cooperation in vertical relationships, in which the parent company produces the finished goods, and the subsidiary manufactures the parts) and personnel flows across the firms in a group may increase the degree of information sharing among the firms and inhibit opportunistic behavior. In addition, as the parent company of the group makes an equity investment in the subsidiary, it can extensively internalize the benefits from the transfer of patent rights. As a result, the incentive to transfer technology is likely to be higher among firms in a business group.[2]

Thus, the transfer of patent rights may be an important channel and have the potential to increase the efficiency of business groups that acquire and establish subsidiaries with a legal personality. In other words, the transfer of patent rights allows business groups to invest their resources in the growth of the acquired firms while maintaining their legal personality and some degree of management autonomy

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[2] Adding equity participation to the contract menu can efficiently reduce moral hazard and adverse selection problems due to information asymmetry (Jensen and Thursby, 2001; Savva and Taneri, 2015).

and independence. Despite its importance, little research has been conducted on this mechanism. This study develops a comprehensive data set that matches data on business groups that establish subsidiaries with a legal personality, the financial data of the related firms before and after the acquisitions, and the transfer of patent rights.

The rest of this paper is organized as follows: Section 2 presents the hypotheses, Section 3 discusses the data and descriptive statistics, and Section 4 describes the basic estimation results for the acquired subsidiary. In addition, Section 5 reports the estimation results at the business group level, and Section 6 concludes the study.

II. Hypotheses

First, we examine whether business groups facilitate the interfirm transfer of patent rights. That is, transactions related to patent rights will increase when an independent firm is acquired by a business group, even if we exclude the transactions made as part of the acquisition. To address the issue of selection, in which the acquisition encourages the transfer of patent rights within the group at the expense of those outside the group, we test whether the whole transactions including the transfer of patent rights to firms outside the group will increase as a result of the acquisition. If a pure selection effect is present, then the transactions with firms outside the group will not increase.

Thus, we propose the following Hypothesis 1 as our initial hypothesis, focusing on post-acquisition patent transfers, excluding the transactions directly related to the acquisitions.

Hypothesis 1: *After an independent firm is acquired and becomes a subsidiary of a business group, the transfer of patent rights will increase.*

Such effects would depend on the governance of the subsidiary. As partially owned (PO) firms have minority shareholders, the possibility of conflicts of interest among the parties can reduce the parent company's incentive to transfer patent rights. Thus, we propose the following hypothesis:

Hypothesis 2: *The effect of business groups on facilitating technology*

transfer to a subsidiary is strong in wholly owned (WO) subsidiaries, where the interests of the subsidiary and parent firm are highly aligned.

The next hypothesis concerns the transfer of patent rights directly connected with an acquisition. If the acquired firm retains its legal personality, in the absence of a transfer of patent rights, the parent company and its subsidiaries will continue to hold the patent rights, as before the acquisition. However, for the acquisition to be effective, an intercompany transfer of patent rights may be necessary in light of the consistency between the business portfolio of each company, the ownership of the patent rights as well as its ability to exploit the IP, including the enforcement of the rights. At the same time, such firms must shoulder the cost of evaluating the patents to be transferred as well as the registration fees and excise tax. Therefore, a transfer will occur when its benefits outweigh its costs.

Hypothesis 3: *If the subsidiary retains its legal personality after the acquisition and the effect of the patent transfer is significant, then patent rights are transferred between the firm becoming subsidiary and the firm becoming the parent company as an integral part of the reorganization.*

Finally, a firm will improve its sales, productivity, and performance through exploiting the patent rights transferred. In addition, if the effects are significant, then the performance at the group level or that of the parent firm will be enhanced.

Hypothesis 4: *A subsidiary receiving patent rights from intragroup transactions will increase its sales and productivity performance. In addition, if these effects are large, then performance at the group level or that of the parent firm will be enhanced.*

III. Data Overview

This section describes the data used in the analysis and provides an overview of patent transactions and corporate governance patterns, which are the focus of this study.

A. Orbis IP Patent Rights Transaction Data

Bureau van Dijk (BvD)'s Orbis IP data provide a variety of information on patent rights as well as their transactions, which can be classified according to the following categories:

- *Intercompany*: Acquisition is between two practicing entities (any firm, excluding universities, banks, investment funds, law groups, and nonpracticing entities), excluding *intragroup* transactions
- *Intragroup*: Patents are transferred among entities belonging to the same global ultimate owner for tax/legal reasons
- *M&A related*: Patents are transferred as part of an M&A deal.
- *Research and innovation partnership (RIP)*: Transfer of IP from any innovation institute or university to another entity
- *Government*: Assets of interest are acquired or reassigned to government agencies
- *NPEs*: Transactions involving a nonpracticing entity (NPE)
- *Assignment as collateral*: The acquirer's name involves an entity type, such as a bank/funding agency.
- *Release of collateral*: The vendor's name involves an entity type, such as a bank/funding agency.

Figure 1 shows the number of patent rights transactions by type based on the matched data of reported patent rights transactions worldwide involving Japanese companies (Orbis IP data)[3] covered by the Basic Survey of Japanese Business Structure and Activities (BSJBSA). Aside from the recent decline in the number of transactions owing to database truncations, the overall number of patent transactions increased in recent years. Among them, the number of *intercompany* transactions (those with firms outside of business groups) is almost as important as that of *intragroup* transactions (intercompany transactions within a business group).

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[3] In the case of an employee invention, the individual researcher may apply for a patent then assign it to his/her company (as was the case in the United States). Thus, we consider and exclude such an employee invention in the case of a transaction in which the BvD ID is not assigned to either party in the transaction (seller or acquirer). We also exclude patents provided as collateral (assignment as collateral) or their dissolution (release of collateral) from the analysis, because they are not technology transactions.
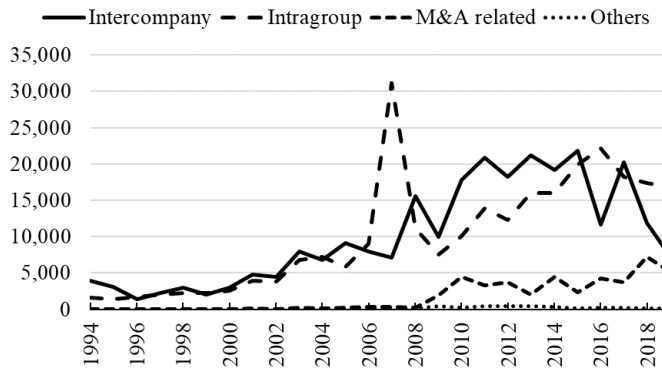
Source: Authors' calculations from Orbis IP and the BSJBSA
Note: Others is the sum of RIP, government, and NPE transactions

FIGURE 1
PATENT TRANSACTIONS BY TYPE (ORBIS IP + BSJBSA)[4]

As patents of the same inventions are generally filed in multiple countries and regions, the transactions are likely to be recorded multiple times for virtually the same inventions. Thus, our analysis focuses only on US patents, which have the largest number of reported transactions in the Orbis IPO (accounting for more than half of the total number of transactions) and are of high economic importance.

B. Distribution and Performance of Firms by Governance Type: Analysis of Data from BSJBSA

In this section, we review corporate governance and performance (especially innovation performance) using the data from the BSJBSA. The corporate governance structure in the BSJBSA can be broadly divided into two categories: firms belonging to a business group and standalone (SA) firms. Companies belonging to a business group can be further divided into parent companies (headquarters [HQ]), WO

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[4] The large number of intragroup intercompany transactions in 2007 can be attributed to the more than 20,000 intragroup intercompany patent transactions that occurred for the organizational transformation of a single business group. The results of the analysis excluding all the outliers are not included, because they are nearly identical to the results of the analysis in the main text.

subsidiaries (WO affiliates), and PO subsidiaries (PO affiliates), where minority shareholders are present. For our analysis, we define the types of companies, as follows:

· Parent company (HQ): A company with no parent company but with one or more manufacturing subsidiaries (not including pure holding companies).
· WO affiliate: A company with a parent company having 100% voting rights.
· PO affiliate: A company with a parent company having 50% or more but less than 100% voting rights.[5]
· SA: A company with no parent company and no manufacturing subsidiaries.
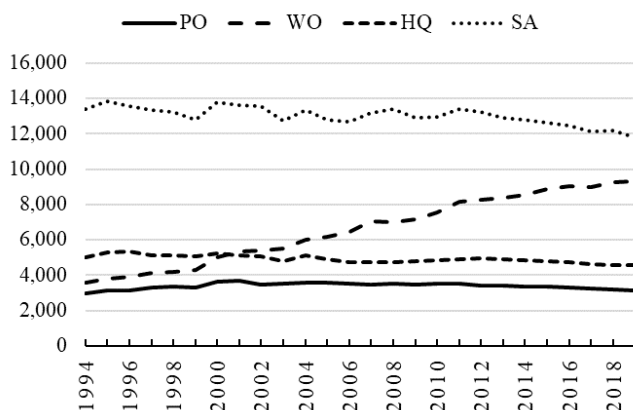
Source: Authors' calculations from the BSJBSA
Note: *PO* (partially owned affiliate) - a company with a parent company having 50% or more but less than 100% voting rights; *WO* (wholly owned affiliate) - a company with a parent company having 100% voting rights; *HQ* (parent company, headquarters) - a company with no parent company but with one or more manufacturing subsidiaries; *SA* (standalone) - a company with no parent company and no manufacturing subsidiaries.

FIGURE 2
NUMBER OF FIRMS BY GOVERNANCE TYPE

[5] The BSJBSA includes cases in which the parent company has less than 50% voting rights but "effectively" acts as the parent company. However, such cases are excluded from the analysis of this study. Their number is small.
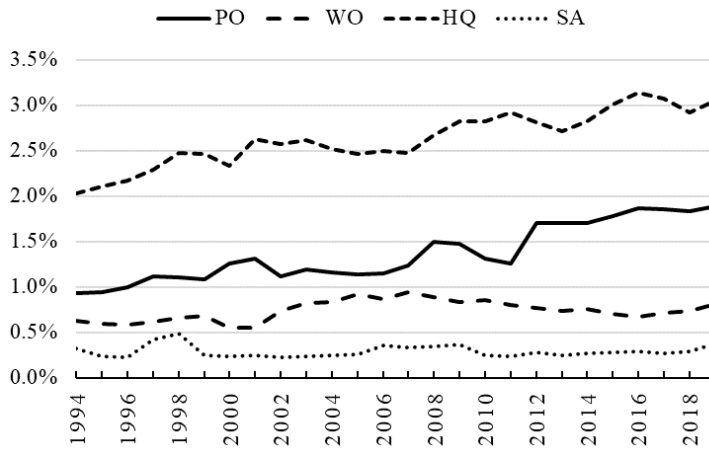
Source: Authors' calculations from the BSJBSA

Note: *PO* (partially owned affiliate) - a company with a parent company having 50% or more but less than 100% voting rights; *WO* (wholly owned affiliate) - a company with a parent company having 100% voting rights; *HQ* (parent company, headquarters) - a company with no parent company but with one or more manufacturing subsidiaries; *SA* (standalone) - a company with no parent company and no manufacturing subsidiaries.

FIGURE 3

AGGREGATE R&D INTENSITY BY GOVERNANCE TYPE (%)

Figure 2, illustrating the number of firms by governance type in the BSJBSA, shows a sharp increase in the number of WOs and a decrease in the number of SAs in recent years.

Figure 3 compares R&D intensity trends (R&D expenditures/sales [%])[6] by governance type. The figure shows that WOs experienced a declining R&D intensity in recent years owing to the lack of growth in their total R&D expenditures relative to their growth in total sales. By contrast, POs are more R&D intensive than WOs, and their R&D intensity increased in recent years, thereby suggesting that PO-governance firms invest more actively in innovation than WO-governance firms.

Table 1 compares firm performance by governance type. Panel A

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[6] Total R&D expenditures divided by total sales by governance type

of Table 1 compares the average performance of the entire sample of the BSJBSA. On average, the HQs are larger, but the WOs are more productive than the other types of companies in terms of Total Factor Productivity (TFP)[7]. In addition, R&D intensity is higher for the POs than for the WOs. For firm age, the WOs are the youngest, followed by the POs, SAs, and HQs.

Panel B shows the results when the sample is limited to firms that do not undergo a change in their governance type and SAs before and after the governance change, independent firms acquired to become WOs or POs.

Panel C of the table uses the matched sample of the BSJBSA and Orbis IP, which is the main data set used in the analyses. As our study focuses on cases in which independent firms are acquired, we compare the firms that continue to be independent with those acquired by a business group to become a subsidiary. SA firms with no change in governance are smaller and less productive than the other types of firms. However, SAs that subsequently became POs or WOs (i.e., became part of a business group) are larger and more productive than SAs with no change in governance. Thus, we control for such selections by conducting fixed-effects estimation in our econometric analysis.

On average, transformation into a WO or a PO is associated with an increase in size, as shown in Panel C. The transformation of SAs into POs or WOs is associated with an increase in R&D, the number of patent holdings, and productivity. Meanwhile, transformation into a WO is associated with an increase in patent rights transactions. However, when an SA becomes a PO, patent selling decreases, whereas patent rights acquisition increases.

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[7] If a division of labor exists between a parent company and subsidiary, resulting in the parent company primarily conducting R&D and the subsidiary performing operations utilizing the fruits of the investment, for example, then the apparent productivity of the subsidiary will be higher. Therefore, caution should be exercised in comparing productivity between corporate forms.

TABLE 1
PERFORMANCE BY GOVERNANCE TYPE (AVERAGE)

	Obs.	ln(Sales)	Age	ln(R&D)	ln(#patent stock)	R&D/sales	lnTFP
Pane A: BSJBSA							
Total	726,061	8.601	42	1.254	42.8	0.57%	-0.082
HQ	127,940	9.224	53	2.807	190.8	1.22%	-0.071
WO	171,386	8.796	32	1.050	19.5	0.48%	-0.048
PO	88,034	8.851	38	1.342	28.8	0.58%	-0.064
SA	338,701	8.202	43	0.747	3.3	0.37%	-0.107
Panel B: BSJBSA firms without governance change and SAs with governance change to WO/PO							
Total	456,668	8.466	40	1.049	47.9	0.49%	0.086
HQ	49,811	9.616	56	3.737	395.8	1.66%	0.061
WO	103,698	8.678	27	0.925	11.8	0.44%	0.046
PO	32,301	8.724	35	1.223	27.8	0.52%	0.064
SA	222,555	8.026	43	0.555	2.0	0.30%	0.114
SA to WO	31,011	8.720	38	0.667	2.8	0.29%	0.083
SA	16,115	8.638	37	0.665	1.3	0.30%	0.098
WO	14,896	8.809	40	0.669	4.2	0.28%	0.065
SA to PO	17,292	8.611	40	0.766	3.0	0.35%	0.083
SA	8,417	8.589	38	0.742	2.0	0.35%	0.096
PO	8,875	8.632	43	0.789	3.9	0.34%	0.070

	Obs.	ln (Sales)	Age	ln (R&D)	ln(#patent stock)	R&D/ sales	lnTFP	#pat. sold	#pat. acquired	1(patents sold)	1 (patents acquired)
Panel C: BSJBSA firms without governance change and Sas with governance change to WO/PO, matched with Orbis IP											
Total	182,919	8.821	45	1.981	101.6	0.94%	-0.058	0.397	0.503	0.017	0.020
HQ	38,252	9.834	58	4.296	450.3	1.94%	-0.047	1.546	1.901	0.053	0.071
WO	32,111	9.078	30	1.822	25.7	0.86%	-0.006	0.283	0.219	0.012	0.015
PO	12,894	9.073	40	2.252	44.3	0.94%	-0.035	0.185	0.372	0.017	0.018
SA	82,419	8.202	46	1.056	4.3	0.57%	-0.085	0.016	0.085	0.005	0.003
SA to WO	10,996	8.889	40	1.292	6.6	0.60%	-0.066	0.048	0.046	0.008	0.005
SA	5,972	8.754	38	1.220	2.5	0.59%	-0.083	0.033	0.020	0.006	0.003
WO	5,024	9.051	42	1.377	11.0	0.62%	-0.043	0.066	0.076	0.009	0.008
SA to PO	6,247	8.809	44	1.478	6.9	0.70%	-0.056	0.015	0.006	0.005	0.003
SA	3,065	8.725	42	1.432	4.0	0.69%	-0.072	0.018	0.003	0.007	0.002
PO	3,182	8.889	46	1.522	9.4	0.71%	-0.039	0.012	0.008	0.003	0.004

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: *PO* (partially owned affiliate) - a company with a parent company having 50% or more but less than 100% voting rights; *WO* (wholly owned affiliate) - a company with a parent company having 100% voting rights; *HQ* (parent company, headquarters) - a company with no parent company but with one or more manufacturing subsidiaries; *SA* (standalone) - a company with no parent company and no manufacturing subsidiaries; SA to WO (OP) indicates an SA that underwent governance change from an independent firm to a WO (PO).

TABLE 2

COMPARISON OF SIZE AND GROWTH RATE PERFORMANCE BY GOVERNANCE TYPE

Dep. Var:	ln(Sales)	ln(R&D)	ln(#pat. stock)	R&D/sales	lnTFP
lnAge	0.212***	0.174***	0.122***	-0.000337***	0.00615***
	[0.00262]	[0.00395]	[0.00279]	[0.0000423]	[0.000400]
lnAge×(1 if initial HQ)	0.167***	0.280***	0.177***	0.00119***	0.00521***
	[0.00129]	[0.00195]	[0.00135]	[0.0000209]	[0.000194]
lnAge×(1 if initial PO)	0.0442***	0.0561***	0.0270***	0.000160***	0.00499***
	[0.00178]	[0.00269]	[0.00186]	[0.0000288]	[0.000271]
lnAge×(1 if initial WO)	-0.0120***	-0.0225***	-0.0295***	-0.000128***	0.00893***
	[0.00184]	[0.00278]	[0.00192]	[0.0000298]	[0.000282]
1 if HQ	0.678***	0.889***	0.606***	0.00301***	0.0277***
	[0.00507]	[0.00764]	[0.00535]	[0.0000819]	[0.000758]
1 if PO	0.653***	0.359***	0.203***	0.000571***	0.0386***
	[0.00618]	[0.00932]	[0.00645]	[0.0000999]	[0.000936]
1 if WO	0.761***	0.353***	0.191***	0.000310***	0.0474***
	[0.00575]	[0.00866]	[0.00596]	[0.0000929]	[0.000880]
Obs.	725,712	725,712	649,048	725,653	665,241
R^2	0.222	0.306	0.230	0.120	0.106

Source: Authors' estimations from the BSJBSA and Orbis IP

Note: OLS; all estimates include industry dummy and year dummy variables; numbers in parentheses are standard errors. *lnAge* is the logarithmic value of the firm age.

Table 2 confirms the differences in the size and growth rate performance of group firms, controlling for industry differences, firm age, and size. Compared with SAs, business group firms are larger, perform more R&D and own more patents, are more R&D intensive, and are more productive. The growth rates of HQs and POs are higher than those of SAs in all aspects, but the growth rates of WOs are lower than those of SAs, except for TFP.

C. Governance Change and Patent Rights Transactions through Acquisition

In this section, we provide an overview of the relationship between corporate governance change and patent rights transactions through acquisition. To clarify the relationship, we exclude the cases in which the governance structure changed more than once during the observed data period. Figure 4 presents the number of firms that underwent

(A) Number

—— Selling ‑‑‑ Acquiring

(B) Percentage

—— Selling ‑‑‑ Acquiring
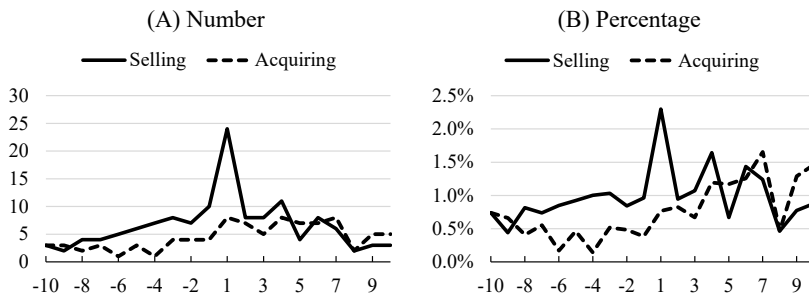
Source: Authors' calculations from the BSJBSA and Orbis IP

Note: Percentage indicates the number of firms engaging in patent rights transactions before and after the acquisition divided by the total number of acquired firms; figures on the x-axis are the number of years before and after the acquisition, with positive values indicating the years after and negative values indicating the years before the acquisition.
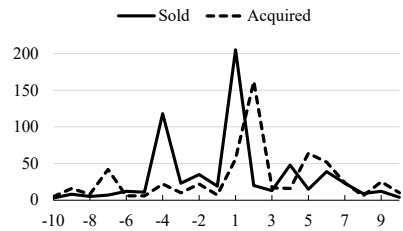
FIGURE 4

CHANGES IN GOVERNANCE STRUCTURE AND NUMBER OF FIRMS TRADING PATENT RIGHTS

governance change from an SA to a WO or a PO through an acquisition and conducted patent transactions for roughly a decade before and after the year of the governance change. The number of firms that engaged in patent rights transactions after being acquired increased (Figure 4[a]) absolutely as well as relatively as a percentage of all the SA firms that were acquired (Figure 4[b]).

Figure 5, which summarizes the number of patent rights traded before and after a change in the governance structure, suggests that the increase in patent rights transactions following a change in the governance structure is significant, and patent sales from (future) subsidiaries occur before firm acquisitions in terms of the number of transactions.

Figure 6 compares the percentage of firms that conducted patent transactions with other firms within the group and the number of patents traded before and after the change in the governance structure. Note that other firms within the group include the firms which become subsidiaries only in the future. Both values show an increase in transactions after acquisition but also suggest that some transactions occurred before the acquisition in anticipation of the event.

We also cover the transactions with other firms outside the business

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: The figures on the x-axis are the number of years before and after the acquisition, with positive values indicating the years after and negative values indicating the years before the acquisition.

FIGURE 5

CHANGES IN GOVERNANCE AND NUMBER OF PATENT RIGHTS TRANSACTIONS
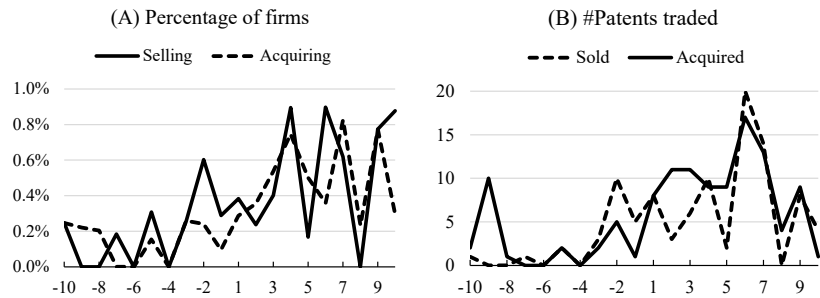
Source: Authors' calculations from the BSJBSA and Orbis IP

Note: Percentage of firms indicates the number of firms that underwent a change from SA to WO/PO and engaged in intra-business group intercompany patent rights transactions divided by the total number of firms that underwent a change from SA to WO/PO. Note that other firms within the group include the firms which become subsidiaries only in the future.

FIGURE 6

CHANGES IN GOVERNANCE PATTERNS AND *INTRAGROUP* PATENT TRANSACTIONS

group. Figure 7, which summarizes the results, suggests that the percentage of firms selling patents decreased, whereas the percentage of firms acquiring patents increased. The results suggest that incorporation into a business group can increase the ability to exploit technology.
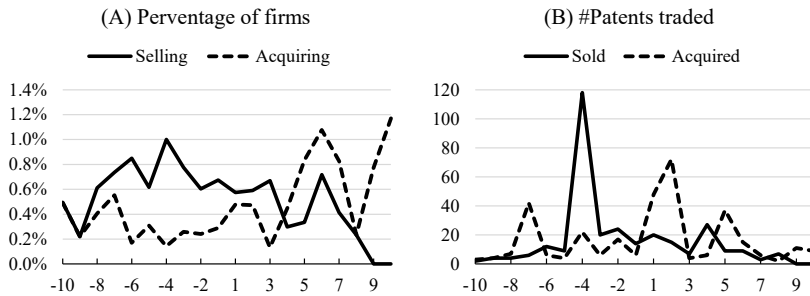
(A) Perventage of firms (B) #Patents traded

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: Percentage of firms indicates the number of firms that underwent a change
from SA to WO/PO and engaged in intercompany patent rights transactions
divided by the total number of firms that underwent a change from SA to
WO/PO.

FIGURE 7

CHANGES IN GOVERNANCE PATTERNS AND PATENT TRANSACTIONS WITH COMPANIES
OUTSIDE THE BUSINESS GROUP

IV. Estimation Results

A. Incidence and Number of Patent Transactions

In this section, based on the data set we constructed from the
databases described in the previous section, we test whether patent
rights transactions become significantly active after an SA is acquired
and transformed into a WO or a PO (Hypotheses [1] and [2]). First,
using the occurrence of patent transactions as the dependent variable
and the dummy variable that takes the value of 1 after the acquisition
as the key explanatory variable, we test whether the likelihood of a
firm engaging in patent transactions after the acquisition increases
and summarize the results in Table 3. We focus on the case in which
the dependent variable is *intragroup* interfirm transactions (Models [5]
and [6] in Table 3), with a dummy variable that takes the value of 1
when a patent transaction occurs and 0 when no patent transaction
occurs as the dependent variable.[8] The key explanatory variables are

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[8] As noted previously, transactions involving the provision or dissolution of
collateral are not included in this study. Models (1) and (2) in Table 3, which

the governance variables, indicating whether an independent firm becomes a WO or a PO. In Panel B of Table 3, we divide the governance change into WO and PO and add a dummy variable that takes the value of 1 when the parent company has 50%–75% voting rights in a PO governance to test for the additional effect of high independence of a PO.[9]

The estimation results in Panel A of Table 3 (Models [5] and [6]) confirm that patent transactions within the group become significantly more active when an SA is acquired and transformed into a WO/ PO. Looking at Panel B, where the subsidiaries are divided into WOs and POs, we see that purchases and sales become highly active in the WOs. However, the effects are not significant in the case of POs, where minority shareholders are present. This outcome may suggest that becoming a WO subsidiary reduces the problems caused by transaction costs and incomplete contracts owing to the nature of the technology, and patent rights transactions become more active.[10]

We observe no additional effect of the acquisition on patent transactions when an SA becomes a PO with high independence, suggesting that regardless of the degree of independence of a PO, only transformation into a WO subsidiary has a significant impact on the reduction of transaction costs associated with technology transactions. However, Figure 6 illustrates that transfers (especially sales) tend to increase in advance in anticipation of an acquisition, and the results in Table 3 are likely to be underestimated for sales.

The results of the estimation of Models (3) and (4) focus on the sum of transactions with firms outside the business group and those among the firms within the group. The estimated coefficients are positive and larger than those of Models (5) and (6), which focus on *intragroup* transactions, in the case of WO. Thus, the results suggest that technology transactions become significantly active for WO, even if transactions with firms outside the business group are included. The same conclusion applies to the WO/PO only for the acquisition of patents.

focus on the total number of patent transactions (including transactions through RIPs and so on), excluding patent transactions based on M&A agreements, show nearly the same results as Models (3) and (4).

[9] All estimates include industry dummy and year dummy variables.

[10] The panel probit estimation yielded nearly the same results.

<div align="center">**TABLE 3**</div>

<div align="center">PROBABILITY OF PATENT RIGHTS TRANSACTIONS[11]</div>

	Total transaction except *M&A-related*							
			Inter-company + intra-group		Intra-group		M&A-related	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1 if pat.sold	1 if pat. acquired	1 if pat.sold	1 if pat. acquired	1 if pat.sold	1 if pat. acquired	1 if pat.sold	1 if pat. acquired
Panel A								
1 if WO/PO	**0.00350****	**0.00429*****	**0.003**	**0.00429*****	**0.00271****	**0.00352*****	**0.00533*****	**0.00138*****
	[0.00159]	[0.00129]	[0.00157]	[0.00128]	[0.00131]	[0.00115]	[0.000767]	[0.000514]
Observations	98,993	98,993	98,993	98,993	15,893	15,893	15,893	15,893
Adj. R^2	-0.073	-0.073	-0.073	-0.073	-0.072	-0.071	-0.068	-0.071
ρ	0.216	0.201	0.214	0.195	0.147	0.170	0.232	0.348
Av. Group size	14.650	14.650	14.650	14.650	14.9	14.9	14.9	14.9
Sample	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)
Panel B								
1 if WO	**0.00745*****	**0.00523*****	**0.00611*****	**0.00523*****	**0.00380****	**0.00427*****	**0.00532*****	**0.00151****
	[0.00199]	[0.00162]	[0.00197]	[0.00161]	[0.00164]	[0.00145]	[0.000962]	[0.000644]
1 if PO	-0.007	0.002	-0.007	0.002	0.000	0.002	0.00466**	0.000
	[0.00459]	[0.00372]	[0.00452]	[0.00371]	[0.00377]	[0.00334]	[0.00222]	[0.00148]
1 if independent PO	0.005	0.001	0.004	0.001	0.001	0.000	0.001	0.001
	[0.00496]	[0.00402]	[0.00489]	[0.00401]	[0.00407]	[0.00360]	[0.00239]	[0.00160]
Observations	98,993	98,993	98,993	98,993	15,893	15,893	15,893	15,893
Adj. R^2	-0.073	-0.073	-0.073	-0.073	-0.072	-0.071	-0.069	-0.071
ρ	0.216	0.201	0.214	0.195	0.147	0.170	0.232	0.348
Av. Group size	14.650	14.650	14.650	14.650	14.9	14.9	14.9	14.9
Sample	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: Fixed-effects estimations; numbers in parentheses are standard errors; sample used in Models (1)–(4) is different from that used in Models (5)–(8). *SA* means SA firms with no governance change; (*SA to WO/PO*) means SA firms acquired by the business group and transformed into WOs or POs in the sample period; all estimates include industry and year dummy variables.

The above estimation does not include patent transactions from M&A as the dependent variable. The extent to which patent rights are transferred as "*M&A-related* patent acquisitions and sales" following reorganization at the time of the acquisition is shown in Models (7)

and (8). The results confirm that the sale and acquisition of patent rights related to M&A also become active when an SA becomes a WO. Meanwhile, the estimation for the POs is unstable.[12]

Table 4 shows the fixed-effects estimation results, with the dependent variable as the logarithm of the number of patent transactions. When focusing on *intragroup* transactions (Models [5] and [6] in Table 4), we find a significant increase in patent rights transactions when an SA becomes a WO. Meanwhile, in the case of a PO, we observe no significant effect on patent transactions. However, as shown in Figure 6, the number of patent transfers (especially sales) among the intragroup companies tends to increase in advance in anticipation of an acquisition. The results in Table 4 are also likely to be underestimates.

Models (3) and (4), which use the overall patent rights transactions within and outside the group as the dependent variable, show that the number of patent rights transactions increases significantly (at the 10% significance level) with acquisition only when an SA becomes a WO.

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[11] As the dependent variable in Models (5)–(8) is transactions with firms in the business group, only the firms that were SAs but became POs or WOs are included in the estimation sample for the estimation of the models. In addition, the subsample from 1 and 2 years before the acquisition is excluded from the estimation, because the transactions with the firms in the future business group began two years before the acquisition.

[12] In Model (8) in the lower part of Table 3, the case in which an SA becomes a PO and acquires M&A-related patent rights is the explained variable. However, as such cases are few (only four), stable estimation is not possible.

[13] Similar to the estimation in Table 3, only SA firms that became POs or WOs are included in the estimation sample for Models (7) and (8), because only transactions with firms in the business group is the explained variable. In addition, as shown in Figure 6, the sample 1 and 2 years before the acquisition is excluded from the estimation, because the transactions with the firms in the future business group began two years before the acquisition.

TABLE 4
NUMBER OF PATENT TRANSACTIONS[13]

	Total transaction except *M&A-related*							
			Inter-company + intra-group		Intra-group		M&A-related	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln(#pat.sold)	ln(#pat. acquired)	ln(#pat. sold)	ln(#pat. acquired)	ln(#pat. sold)	ln(#pat. acquired)	ln(#pat. sold)	ln(#pat. acquired)
Panel A								
1 if WO/PO	**0.00517****	**0.00746*****	**0.001**	**0.003**	**0.00376****	**0.00517*****	**0.00767*****	**0.00330*****
	[0.00220]	[0.00206]	[0.00190]	[0.00171]	[0.00154]	[0.00159]	[0.00132]	[0.00103]
Observations	98,993	98,993	98,993	98,993	15,893	15,893	15,893	15,893
Adj. R^2	-0.073	-0.073	-0.073	-0.073	-0.071	-0.071	-0.069	-0.071
ρ	0.229	0.260	0.227	0.259	0.145	0.169	0.458	0.233
Av. Group size	14.650	14.650	14.650	14.650	14.910	14.910	14.9	14.9
Sample	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)
Panel B								
1 if WO	**0.00948*****	**0.00960*****	**0.00435***	**0.00370***	**0.00500*****	**0.00663*****	**0.00774*****	**0.00474*****
	[0.00275]	[0.00258]	[0.00238]	[0.00214]	[0.00193]	[0.00200]	[0.00166]	[0.00129]
1 if PO	-0.007	0.002	-0.007	0.000	0.001	0.002	0.00906**	0.000
	[0.00634]	[0.00594]	[0.00548]	[0.00492]	[0.00445]	[0.00459]	[0.00382]	[0.00297]
1 if independent PO	0.006	0.002	0.005	0.001	0.001	0.001	-0.002	0.001
	[0.00685]	[0.00642]	[0.00592]	[0.00532]	[0.00481]	[0.00497]	[0.00412]	[0.00321]
Observations	98,993	98,993	98,993	98,993	15,893	15,893	15,893	15,893
Adj. R^2	-0.073	-0.073	-0.073	-0.073	-0.072	-0.071	-0.070	-0.071
ρ	0.229	0.259	0.227	0.259	0.144	0.168	0.458	0.233
Av. Group size	14.650	14.650	14.650	14.650	14.910	14.910	14.9	14.9
Sample	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	SA+(SA to PO/WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)	(SA to PO/ WO)

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: Fixed-effects estimations; numbers in parentheses are standard errors; sample used in Models (1)–(4) is different from that used in Models (5)–(8). *SA* means SA firms with no governance change; (*SA to PO/WO*) means SA firms acquired by the business group and transformed into POs or WOs in the sample period; all estimates include industry and year dummy variables.

B. Association between Patent Transactions and Firm Performance

What is the subsequent impact of patent transactions on the performance of acquired firms? To conduct our investigation, first, we examine the relationship between the sale or acquisition of patent rights and subsequent firm performance, using the SA firms that underwent no governance structure change as the control group. The

investigation below focuses on how patent transfers to a subsidiary and the increase in its capital base are associated with the improvement of firm performance. Even though changes in the governance structure, access to intragroup product markets, and other factors can affect post-acquisition performance, they are partially endogenous. However, in this study, we do not identify such effects separately.

Table 5 demonstrates the impact of the accumulation of externally acquired patents and the level of equity capital on the subsequent firm performance, with the fixed-effects estimation. The dependent variable is the logarithmic values of firm R&D expenditures, the number of patents held, and sales, whereas the explanatory variable is the cumulative number of externally acquired patent rights and the capital base.[14] Panel A summarizes the results of the estimation, using all patent transactions, excluding M&A-related patent transactions, as the explanatory variable, and shows that the patent acquisitions and the increase in the capital base are significantly associated with the increase in R&D, the number of patents held, sales, and productivity.

When separating the transactions into those within the business group (*IG*: intragroup firm + M&A-related transactions) and those outside the business group (*OG*: outside group firms), we find that the overall results are similar to those in Panel A, but the effects of the *intragroup* transactions on R&D and productivity are significant (Panel B of Models [1] and [4]). Panel C further divides the patent transactions within the business group into M&A-related transactions and other *intragroup* firm transactions and examines the effects of each type. The results show that non-*M&A-related* and *intragroup* transactions are significant to R&D and productivity, whereas *M&A-related* transactions are significant to sales (Panel C).[15]

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[14] Patent transactions, especially the effects of patent rights acquisition, are likely to be long lasting and cumulative.

[15] As the estimates in Panel C use only *intragroup* transactions as the explanatory variable, we conduct estimates that restrict the sample to only acquired SA firms that were transformed into WOs and Pos and obtain generally similar results to those in Panel C.

<div align="center">

TABLE 5

PATENT TRANSACTIONS AND SUBSEQUENT FIRM PERFORMANCE

</div>

		(1)	(2)	(3)	(4)
		lnR&D	ln(#patent)	lnSales	lnTFP
Panel A	ln(cum. #pat. Acquired)	**0.106*****	**0.566*****	**0.0777*****	**0.0131*****
		[0.0268]	[0.0175]	[0.00966]	[0.00401]
	ln(Capital)	**0.205*****	**0.0799*****	**0.232*****	**0.00404*****
		[0.00939]	[0.00625]	[0.00339]	[0.00142]
	Observations	100,628	92,959	100,628	92,675
	Adj. R^2	-0.058	-0.029	0.025	-0.002
	ρ	0.786	0.777	0.930	0.672
	Av. Group size	14.960	13.820	14.960	13.870
Panel B	ln(cum. if #pat. Acquired$_{OG}$)	**0.0651***	**0.504*****	**0.0364*****	**0.005**
		[0.0334]	[0.0213]	[0.0121]	[0.00494]
	ln(cum if #pat. Acquired$_{IG+M\&A}$)	**0.0996****	**0.418*****	**0.0773*****	**0.0195*****
		[0.0434]	[0.0283]	[0.0157]	[0.00650]
	ln(Capital)	**0.204*****	**0.0796*****	**0.232*****	**0.00396*****
		[0.00940]	[0.00625]	[0.00339]	[0.00142]
	Observations	100,628	92,959	100,628	92,675
	Adj. R^2	-0.058	-0.027	0.025	-0.002
	ρ	0.786	0.777	0.930	0.672
	Av. Group size	14.960	13.820	14.960	13.870
Panel C	ln(cum. #pat. Acquired$_{IG}$)	**0.159*****	**0.653*****	**0.0621*****	**0.0297*****
		[0.0451]	[0.0301]	[0.0163]	[0.00678]
	ln(cum. #pat. Acquired$_{M\&A}$)	0.098	0.671***	0.193***	-0.020
		[0.0852]	[0.0544]	[0.0308]	[0.0131]
	ln(Capital)	**0.204*****	**0.0758*****	**0.231*****	**0.00387*****
		[0.00940]	[0.00626]	[0.00339]	[0.00142]
	Observations	100,628	92,959	100,628	92,675
	Adj. R^2	-0.058	-0.032	0.025	-0.002
	ρ	0.786	0.777	0.930	0.672
	Av. Group size	14.960	13.820	14.960	13.870

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: *cum #pat. acquired* is the cumulative number of patent rights acquired; subscript *OG* refers to patent rights transactions, excluding intragroup transactions (*IG*) plus M&A-related transactions (*M&A*) from the total patent rights transactions; fixed-effects estimations; numbers in parentheses are standard errors; all estimates include industry and year dummy variables. Panel A refers to all other patent rights transactions, excluding M&A-related patent transactions; Panel B divides transactions into those within the business group (among firms within the group + M&A-related transactions) and those outside the business group (among firms outside the group + RIPs + research institutions + others); Panel C shows the M&A-related transactions and all other intragroup transactions.

We further investigate whether the effects of patent rights transactions differ depending on the governance structure of an SA when it becomes a subsidiary. To examine such effects, we conduct the following estimation by dividing the sample into two groups: SA firms that became WOs and SA firms that became POs. The estimation results (Table 6) show that patent transfers within the business group (*intragroup*) are highly significantly related to the increase in patent rights in the POs and WOs, whereas the relationship with *R&D* (Models [1] and [5]) has a highly significant coefficient only for the *intragroup* transactions in the case of WOs. In the relationship with sales, *M&A-related* transactions have a strong effect in the case of the WOs, and *intragroup* transactions have a highly significant coefficient in the case of the POs.

TABLE 6

INTRAGROUP PATENT TRANSACTIONS AND SUBSIDIARY PERFORMANCE

	SA to WO				SA to PO			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln(R&D)	ln(#patent)	ln(Sales)	lnTFP	ln(R&D)	ln(#patent)	ln(Sales)	lnTFP
ln(cum. #pat. Acquired$_{IG}$)	**0.184***** [0.0571]	**0.609***** [0.0421]	-0.019 [0.0212]	**0.0280***** [0.00824]	-0.008 [0.140]	**0.698***** [0.0988]	**0.171***** [0.0568]	-0.026 [0.0222]
ln(cum. #pat. Acquired$_{M&A}$)	0.129 [0.102]	**0.588***** [0.0716]	**0.188***** [0.0381]	**-0.0287*** [0.0152]	0.938 [0.878]	1.031* [0.600]	0.060 [0.355]	. .
ln(capital)	**0.256***** [0.0208]	**0.116***** [0.0149]	**0.180***** [0.00773]	**0.00694**** [0.00306]	**0.111***** [0.0298]	**0.0972***** [0.0223]	**0.175***** [0.0120]	**-0.0213***** [0.00439]
Observations	11,003	10,246	11,003	10,173	6,529	6,003	6,529	6,053
Adj. R^2	-0.033	0.025	0.080	0.010	-0.036	0.000	0.038	0.046
ρ	0.781	0.703	0.923	0.679	0.824	0.767	0.907	0.698
Av. Group size	16.520	15.380	16.520	15.300	17.500	16.090	17.500	16.320
Sample	(SA to WO)	(SA to WO)	(SA to WO)	(SA to WO)	(SA to PO)	(SA to PO)	(SA to PO)	(SA to PO)

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: *cum #pat. acquired* is the cumulative number of patent rights acquired; subscript *IG* refers to patent rights transactions with intragroup firms; *M&A* means *M&A-related* transactions; fixed-effects estimations; numbers in parentheses are standard errors; all estimates include industry and year dummy variables. *SA to PO/WO* means SA firms acquired by the business group and transformed into POs or WOs in the sample period.

V. Extensions (Impact at Business Group Level)

In this section, we examine whether the performance improvement of the target firm through its acquisition occurs at the expense of the other firms in the group, that is, whether acquisition is a zero-sum game. As for technology transactions, as examined in the previous section, we confirm the net increase in the total incidence and the total number of patent transactions, combining the transactions within and outside the business group. In this section, we examine the relationship between the number of the acquisitions and the performances of the business group and the parent company. Specifically, we aggregate the performance of the firms in the BSJBSA at the business group level and examine its relationship with the cumulative number of acquisitions of independent firms by the business group.

In aggregating the firm-level data at the business group level, we include the data of the acquired firms in the business group during the pre-acquisition period, in comparing the business group performance before and after the acquisition. If the parent company of a subsidiary changed during the data period (1994–2018), then we exclude the subsidiary from the analysis.

Table 7 shows the results of the estimations, using the logarithm of business group sales, the number of employees, R&D expenditures, the number of patents held, the number of patents sold, and the number of patents acquired as the dependent variables and the cumulative number of firms acquired during the data period as the explanatory variable, controlling for fixed effects.[16] The acquisition of an independent firm is significantly associated with the overall business group sales and the number of employees. However, R&D expenditures, the number of patents held, and the number of patent transactions increase significantly only when the acquired firm becomes a PO subsidiary after the acquisition, thereby suggesting that PO governance is significantly related to innovation in the business group, as a whole.

Table 8 shows the results of the estimations when the dependent variable is the logarithmic values of the parent firm's performances.

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[16] The performance of a business group is likely to be affected by industrywide movements. To control for industry movements, we also conduct an estimation in which the group's performance divided by the aggregate performance of the industry as a whole is the explained variable.

TABLE 7
ACQUISITION AND BUSINESS GROUP PERFORMANCE

	ln(Sales)	ln(#emp)	ln(R&D)	ln(#patent)	ln(#patent, sold)	ln(#patent, acquired)
	(1)	(2)	(3)	(4)	(5)	(6)
ln(#WO after SA to WO)	**0.0439***	**0.0559***	-0.032	-0.018	0.029	0.011
	[0.0243]	[0.0207]	[0.0669]	[0.0584]	[0.0193]	[0.0206]
ln(#PO after SA to PO)	**0.212***	**0.171***	**0.302***	**0.845***	**0.141***	**0.169***
	[0.0258]	[0.0221]	[0.0713]	[0.0623]	[0.0206]	[0.0220]
Observations	11,672	11,672	11,672	11,672	11,672	11,672
Adj. R^2	0.037	0.045	-0.058	0.234	-0.025	-0.038
ρ	0.903	0.896	0.811	0.701	0.442	0.327
Av. Group size	12.7	12.7	12.7	12.7	12.7	12.7

Source: Authors' calculations from the BSJBSA and Orbis IP
Note: Dependent variables are the performances of the business group; # *of WO after SA to WO* represents the cumulative number of acquired firms that became WOs; # *of PO after SA to PO* represents the cumulative number of acquired firms that became POs; fixed-effects estimations; numbers in parentheses are standard errors; all estimates include industry and year dummy variables. We include the acquired firms in the business group for the pre-acquisition period too.

The results indicate that an acquisition of a firm and its subsequent transformation into WO is associated with the expansion of sales and employment of the parent firm. The number of patent transactions of the parent firm also increases, but no such increase occurs in the transactions of the group as a whole (see the results in Table 7). The findings suggest that the parent firm redistributes the patents within the group and gains in sales and employment. However, acquisitions of SAs and their subsequent transformation into POs have no significant effects on the parent company's sales, number of employees, and R&D expenditures but are positively associated with the number of patents held and the number of patents acquired. As an increase in the number of patents held and in the number of patents acquired occurs both for the parent company and at the business group level (see Table 8), the acquisition of an SA for its subsequent transformation into a PO is associated with increased patent transactions involving firms outside the group.

TABLE 8

ACQUISITION AND PARENT COMPANY PERFORMANCE

	ln(Sales)	ln(#emp)	ln(R&D)	ln(#patent)	ln(#patent, sold)	ln(#patent, acquired)
	(1)	(2)	(3)	(4)	(5)	(6)
ln(#WO after SA to WO)	**0.0421*****	**0.0453*****	-0.007	-0.052	**0.0928*****	**0.0729****
	[0.0126]	[0.0123]	[0.0413]	[0.0675]	[0.0290]	[0.0345]
ln(#PO after SA to PO)	-0.016	0.017	0.029	**0.178****	0.027	**0.177*****
	[0.0134]	[0.0131]	[0.0438]	[0.0708]	[0.0309]	[0.0367]
Observations	11,672	11,672	11,615	10,531	11,672	11,672
Adj. R^2	0.023	0.033	-0.053	-0.048	-0.042	0.041
ρ	0.970	0.959	0.948	0.889	0.442	0.530
Av. Group size	12.7	12.7	12.6	11.4	12.7	12.7

Source: Authors' calculations from the BSJBSA and Orbis IP

Note: Dependent variables are the parent firm's (HQ) performance in the business group; *# of WO after SA to WO* represents the cumulative number of acquired firms that became WOs; *#PO after SA to PO* represents the cumulative number of acquired firms that became POs; fixed-effects estimations; numbers in parentheses are standard errors; all estimates include industry and year dummy variables.

VI. Conclusion

The transfer of patent rights can increase the efficiency of business groups that establish subsidiaries through acquisition, which in turn can increase the long-term growth opportunity of newly established firms. Despite its importance, research on the mechanisms is limited. We conduct this study by developing a comprehensive data set that matches data on business groups that establish subsidiaries (*WO* and *PO* subsidiaries), the financial data of the related firms before and after the acquisitions and data on the transfer of patent rights.

The analysis yields several findings. First, we find that patent transactions by firms that became WOs or POs become more active, even when we exclude the transactions directly related to the acquisition, and the total number of transactions covering the firms not part of the business group also increases. This finding suggests that business groups can enhance the technology market by reducing transaction costs owing to information asymmetry and incomplete contracts. However, the increase in patent transactions is limited to WOs.

Second, patents are significantly transferred between the acquired firm and the parent company (group) as part of the acquisition agreement. The transfer is used to optimize the location of the patent rights within the group.

Third, the transfer of patent rights to a subsidiary is accompanied by an improvement in its sales, R&D, and productivity performance. The sales and R&D performance of the business group as a whole (the basis of the comparison includes the acquired firms in the pre-acquisition period in the business group) also improves in the case of a PO acquisition. Since the sales performance of the parent company significantly expands in the case of a WO acquisition, there is a significant redistribution in such a case.

Thus, the transfer of patent rights plays an important role in the functioning of a business group, which in turn contributes to governance diversity, patents utilization, and R&D promotion. As the larger diversity of subsidiary governance, the increase in opportunities to utilize patents, and the expansion of R&D are likely to entail significant positive externalities, reducing as many obstacles as possible in the transfer of patent rights across organizations is important. In Japan, a relatively high registration tax is imposed on the transfer of patent rights (15,000 yen per patent), and the assessment of the appropriateness of this tax is an important policy issue.

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