The stock market's valuation of R&D externalities

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Abstract

R&D, particularly basic research, is generally considered as a public good. It provides positive externalities to other firms. This paper investigates rival firms' stock-price responses to an increase in the R&D expenditures of a firm. Examining firms in the pharmaceutical industry, we found that the market valuations of some rival firms benefit from R&D externalities. Moreover, the cross-sectional analysis indicated that R&D-intensive firms benefit immensely from them. From this result, investors might assess that these firms have the full potential to absorb new R&D knowledge.

Key words: event study, R&D externalities, rival firms

JEL classification: G14, G30, O32

1. Introduction

R&D, particularly basic research, is generally considered as a public good. First, it is difficult to exclude anyone from its benefits. Second, the marginal cost of an additional individual enjoying a public good is zero. Consumption is considered to be non-rivalrous. Indeed, sharing the fruits of R&D as soon as they are available can be highly beneficial as other researchers can use this knowledge in their quest for innovation.

Some research has assessed the intra-industry effect in the event of R&D expenditure. However, this research pertains to the US market. To our knowledge, no research has been conducted on the Japanese market thus far.

Zantout and Tsetsekos (1994) examined the effects of announcements of plans to increase R&D expenditures on the stock prices of rival firms. They found that the rival firms suffered statistically significant negative abnormal returns at the announcements. This is known as the competitive effect. This effect suggests that the announcing firm is moving ahead of its rival firms with regard to innovation; in other words, the rival firms are lagging behind in the R&D race.

Sundaram, John, and John (1996) found that competitors' stock prices are positively influenced by the interaction between the market's reaction to the announcing firm and the competitive strategy measure (CSM). CSM is the measure that determines whether the competition is characterized by strategic substitutes or strategic complements.

Previous studies have reported mainly on the relationship between the announcing firm and rival firms. However, they have not investigated the features of the firms that benefit from R&D externalities. In contrast, we aim to reveal the rival firms that benefit from R&D externalities in the Japanese pharmaceutical industry.

Since the pharmaceutical industry is R&D-intensive and the industry classification is clear, it is an appropriate industry for our research[1].

This paper is organized as follows. Section 2 briefly discusses the theoretical background. Section 3 presents the data sets, model, and results of the cross-sectional analysis. Section 4 presents the summary and conclusion.

2. Theoretical Background

R&D activities promote the technological level of the firm investing in R&D. On the other hand, they exert both positive and negative effects on rival firms in the corresponding industry.

The positive effect is the potential for R&D spillovers. Since R&D, particularly basic research, is generally considered as a public good, rival firms benefit from it. They can enjoy being free riders by using the intra-industry technology spillovers, since firms that invest in R&D often cannot prevent others from obtaining the benefits freely.

On the other hand, the negative effect of R&D activities is the competitive threat. The firm investing in R&D is moving ahead of its rival firms with regard to innovation, thereby benefiting from first-mover advantages. These advantages arise due to three primary factors: (1) technological leadership, (2) pre-emption of rivals in the market, and (3) switching costs[2]. Viewed from a different perspective, these are disadvantages for the rival firms, who lag behind in the R&D race.

Thus, some rival firms benefit from R&D externalities, while others are under competitive threat. This paper focuses on the former.

Next, we analyse the factors that significantly influence investors' assessments of the market value of R&D externalities. First, according to theoretical studies, there is a positive relationship between innovation and firm size. One claim is that among the capital market imperfections, large firms are favoured in terms of securing finance for risky R&D projects because firm size is correlated with the availability and stability of internal funds. The other claim is that there are economies of scale and scope in R&D activities; the larger the size of a firm, the more its rival firms benefit from R&D externalities. Second, we use R&D intensity to proxy for technological opportunities. Since firms with high R&D intensity generate more technological and innovative assets, they have the full potential to absorb new R&D knowledge. Thus, it can be expected that R&D intensity will be positively correlated with obtaining benefits from R&D externalities.

3. Empirical Analysis

In this section, to examine the effects of R&D externalities, we use investors' reactions to R&D expenditure announcements. Although R&D expenditure announcements are firm-specific, they may contain value-relevant information about other non-announcing firms in the corresponding industry (rival firms), causing the stock prices of these firms to react to the same news. This is referred to as the intra-industry transfer of information. Generally, R&D expenditure announcements result in positive responses to the stock prices of the announcing firms. However, they are ambiguous in relation to the stock prices of rival firms. Hence, R&D expenditure announcements can have both positive and negative effects on rival firms.

First, it is necessary to define the set of rival firms. In this study, rival firms are those firms that operate in the same pharmaceutical industry and have the same industry ranking in terms of sales as the announcing firms[3]. Based on the industry ranking criterion, five firms above and below the announcing firms are selected. Even if there is only one firm above or below the announcing firm, that firm is selected.

Next, we use an event study methodology and select 15 announcements from the *Nihon Keizai Shimbun* and the *Nikkei Business Daily* from 2000 to 2004[4]. Sample announcements satisfy four screening criteria: (1) the announcement is an initial unanticipated one of a future plan to increase R&D expenditures; (2) the announced plan does not involve funding from customers or government contracts; (3) the announced plan does not pertain to a joint venture or corporative agreement with another firm; and (4) the announcing firm and its rivals have sufficient share-price observations on the database of the stock prices CD-ROM (Toyo Keizai). We choose a two-day event window, which includes the announcement date and the subsequent day. We use the equally weighted TOPIX index as a proxy for market returns and estimate the parameters of the market model by using data for 250 days around the event window.

Then, we estimate the following market model for each announcement.

$$R_{it} = \hat{\alpha} + \hat{\beta} R_{mt} + \varepsilon_{it},$$

where R_{it} is the daily return on the stock of firm i at time t, R_{mt} is the daily return on the equally weighted TOPIX index at time t, and ε_{it} is the zero mean disturbance term.

By using the estimated parameters $\hat{\alpha}_i$ and $\hat{\beta}_i$, the abnormal return (AR) on the stock of firm i in period t is obtained by the following:

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt}.$$

The cumulative abnormal return (CAR) is calculated by summing up the abnormal returns over the event window:

$$CAR_i(t_0, t_1) = \sum_{t=t_0}^{t_1} AR_{it}.$$

We define the event day as t_0, the initial date of the event window as $t_0 = 0$, and the final date of the event window as $t_1 = +1$.

We conclude that if $CAR_i(0,1) > 0$, R&D externalities exist.

Next, we estimate the probit equations. The dependent variables in the probit models are one if $CAR_i(0,1) > 0$, and zero otherwise.

We estimate the following regressions:

$$Y_{it} = \beta_0 + \beta_1 \log(ASSETS_{it-1}) + \beta_2 RD_{it-1} + \beta_3 PERFORM_{it-1} + \sum_{l=4}^{m} \beta_l Dummy_l + u_{it}, \quad (1)$$

$$Y_{it} = \beta_0 + \beta_1 \log(ASSETS_{it-1}) + \beta_2 RD_{it-1} + \beta_3 PERFORM_{it-1} + \beta_4 (CF_{it-1} / SALES_{it-1}) + \sum_{l=5}^{m} \beta_l Dummy_l + u_{it}, \quad (2)$$

where

Y_{it} : 1 or 0

$ASSETS_{it}$: tangible assets

RD_{it} : R&D intensity

$PERFORM_{it}$: net sales growth or ordinary income divided by sales

$CF_{it} / SALES_{it}$: cash flow divided by sales

$Dummy_l$: event dummies

u_{it} : disturbance

We use tangible assets to proxy for firm size. Following Hall (1990) and Blonigen and Taylor (2000), we define R&D intensity as the ratio of a firm’s R&D investment to its tangible assets. Besides tangible assets and R&D intensity, we include control variables such as profitability and financial characteristics. The net sales growth and the ordinary income divided by sales are indicators that a firm is well managed and is performing satisfactorily. In addition, we include a liquidity measure for a firm's cash flow. This suggests that a firm with a higher free cash flow is performing well. Cash flow is defined as retained earnings plus depreciation. We also include event dummies to remove event-specific characteristics. Each event $Dummy_l$ takes one when firm i belongs to event l, and zero otherwise. Finally, to reduce the simultaneity bias problem, the explanatory variables—excluding the dummy variables—are lagged.

Table 1 shows the descriptive statistics for the main variables in this analysis. Tables 2 and 3 summarize the coefficient estimates for equations (1) and (2) for the probit models. The coefficient estimates of tangible assets are not significant in all the models. We found that there is no positive relationship between R&D externalities and firm size. On the other hand, the coefficient estimates of R&D intensity are significant in all the models. Based on these results, as theory indicates, firms with high R&D intensity benefit from R&D externalities. That is to say, investors might perceive that firms with high R&D intensity have the full potential to absorb new R&D knowledge. The net sales growth and the ordinary income divided by sales are not significant in all the models. Finally, even the coefficient estimates of cash flow divided by sales are not significant in all the models.

4. Concluding Remarks

Using an event study methodology, this paper investigated how the stock prices of rival firms respond to the announcement of an increase in the R&D expenditures of a firm. Examining firms in the pharmaceutical industry, we discovered that some firms benefit from R&D externalities. Moreover, the cross-sectional analysis indicated that R&D-intensive firms benefit immensely from them. From this result, investors might assess that these firms have the full potential to absorb new R&D knowledge.

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[1] As many firms in the other industries are diversified, it is difficult to define the industry market. This refers to the problem of market definition.

[2] For example, see Lieberman and Montgomery (1988).

[3] First, in defining rival firms, we attempted to follow Eckbo's (1985) selection procedure. However, many firms are so diversified that it is difficult to classify them into their corresponding industries. Thus, we follow Zantout and Tsetsekos (1994) and Porter (1979).

[4] The standard event study methodology has been described by MacKinlay (1997).

Table 1. Descriptive statistics of the variables

Variable	Description	Mean	Median	Maximum	Minimum	Std. Dev.
log(ASSETS)	tangible assets	18.160	18.298	19.888	15.675	0.765
RD	R&D intensity	0.330	0.333	0.611	0.061	0.135
PERFORM1	net sales growth	0.039	0.032	0.262	-0.321	0.084
PERFORM2	ordinary income divided by sales	0.155	0.143	0.464	0.037	0.093
CF/SALES	cash flow divided by sales	0.173	0.150	0.434	0.002	0.087

Table 2. The results of equation (1)

Variable	Coefficient	Asymptotic t-value		Coefficient	Asymptotic t-value	
Constant	-6.548	-1.192		-4.887	-0.862	
log(ASSETS)	0.279	0.935		0.180	0.583	
RD	2.993	2.677	***	2.522	2.135	**
PERFORM1	0.670	0.383				
PERFORM2				2.525	1.404	
$Dummy_1$	-0.520	-0.701		-0.679	-0.950	
$Dummy_2$	0.746	1.217		0.645	1.037	
$Dummy_3$	-0.226	-0.339		-0.248	-0.367	
$Dummy_4$	0.474	0.773		0.336	0.532	
$Dummy_5$	9.049	17.245	***	9.028	17.609	***
$Dummy_6$	1.030	1.531		0.919	1.353	
$Dummy_7$	-7.667	-10.106	***	-7.741	-10.219	***
$Dummy_8$	-0.896	-1.185		-0.907	-1.192	
$Dummy_9$	0.804	1.128		0.790	1.110	
$Dummy_{10}$	-8.443	-15.905	***	-8.254	-16.845	***
$Dummy_{11}$	-0.338	-0.526		-0.425	-0.686	
$Dummy_{12}$	0.823	1.249		0.772	1.141	
$Dummy_{13}$	0.518	0.689		0.464	0.604	
$Dummy_{14}$	-0.067	-0.098		-0.138	-0.207	
Sample size	117			117		
Log-likelihood	-56.763			-55.737		

Notes:
*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level
PERFORM1 is the net sales growth
PERFORM2 is the ordinary income divided by sales

Table 3. The results of equation (2)

Variable	Coefficient	Asymptotic t-value		Coefficient	Asymptotic t-value	
Constant	-3.071	-0.522		-3.237	-0.549	
log(ASSETS)	0.078	0.243		0.088	0.273	
RD	2.365	1.861	**	2.375	1.729	*
PERFORM1	0.977	0.534				
PERFORM2				1.438	0.320	
CF/SALES	2.686	1.417		1.463	0.312	
$Dummy_1$	-0.751	-1.089		-0.707	-0.991	
$Dummy_2$	0.706	1.096		0.715	1.119	
$Dummy_3$	-0.282	-0.420		-0.233	-0.345	
$Dummy_4$	0.372	0.577		0.367	0.572	
$Dummy_5$	8.920	17.036	***	9.043	17.537	***
$Dummy_6$	0.628	0.951		0.663	0.983	
$Dummy_7$	-7.387	-11.975	***	-7.515	-11.987	***
$Dummy_8$	-0.842	-1.092		-0.853	-1.121	
$Dummy_9$	0.804	1.132		0.823	1.163	
$Dummy_{10}$	-8.218	-14.808	***	-8.219	-16.565	***
$Dummy_{11}$	-0.416	-0.655		-0.391	-0.624	
$Dummy_{12}$	0.796	1.167		0.803	1.174	
$Dummy_{13}$	0.487	0.648		0.459	0.558	
$Dummy_{14}$	0.138	0.193		-0.005	-0.008	
Sample size	107			107		
Log-likelihood	-53.758			-53.839		

Notes:
*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level
PERFORM1 is the net sales growth
PERFORM2 is the ordinary income divided by sales