Board Structure, Intra-Industry Competition and R&D Announcement Effect

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Abstract

How do investors perceive and respond to firm's revelation of fundamental news? In this study we investigate R&D announcement that is associated with risks from information asymmetry and growth potentials linked to intra-industry competition. To mitigate the asymmetric-information risks, investors prefer an R&D investment that has been conscientiously scrutinized by a well-structured board. To ensure profit potentials, investors prefer a monumental and sustainable R&D investment that is not diluted by drastic intra-industry competition. Our results from 229 announcements made by 116 Taiwan listed firms, mainly consists of high-tech firms, show that investors on average respond favorably to a firm's R&D announcement. They respond more favorably to firms with a small and independent board, verifying the concern of information asymmetry. However, we find that investors respond less favorably to R&D intensified firms or firms operate in an R&D intensified industry. We construct two variables to capture the notion of intra-industry competition: the lapse of days from prior rival's announcement and the ordinal number of announcements in the same industry. The results show that the announcement effect is smaller for firms operate in a highly R&D intensified industry and with a short lapse of days from prior rival's announcement. Moreover, the announcement effect is also diluted for high R&D intensified firms that have experienced numerous prior R&D announcements in the same industry. Finally, the negative impact of industry R&D intensity and firm R&D intensity is only significant for firms operate in a highly concentrated industry.

Keywords: R&D announcement, board structure, industry competition

1. Introduction

R&D projects that involve long-term commitment of resources directing towards the innovation, introduction, and improvement of projects and processes are supposed to be value additive. However, from investors' perspective there are two dimensions concerning their response to the news announcement. The first involves information asymmetry[1] and agency cost in the sense that R&D activities are not value additive and probably value destructing ones[2]. Being informationally disadvantaged *per se*, outside investors would prefer R&D announcements initiated by firms with a better governance structure[3].

The second dimension regarding firm's R&D announcement is the growth potentials that are dictated by intra-industry competition. Industry rivalry might have a negative impact on investors' perception of a positive information signal initiated by a firm. For example, Massa et al. (2007) indicate that repurchasing firms in more concentrated industries experience a lower increase in value in that their mimicking behavior is simply to correct the negative market perception of a weaker competitive

[1] Information asymmetry is much aggravated in R&D activities than in other investments in that R&D is not a mandatory item for information disclosure and the details are therefore not accessible to outside investors. Moreover, in gauging the value of R&D investment, one would find it is difficult to locate comparable firms that map with the unique growing characteristics of the underlying firm (Abody and Lev, 2000).

[2] For example, Jensen (1993) indicates that R&D investments in many large firms failed to increase firm value, that can attributed to malfunctioning internal control system. It is also possible that managers "time" R&D spending to increase their total compensation (Healy, 1985; Zantout and Tsetsekos, 1994) and therefore the announcement is less informational.

[3] The literature has evidence to show that firms with better governance are less likely to manipulate R&D spending for earning management (Bushee, 1998) and to be associated with financial statements fraud.

position with respect to the repurchasing firm. Moreover, the expected future profits of a firm's R&D investment might be affected by industry rivalry. For example, Markovich and Moenius (2006) posit that an opponent firm may receive a windfall increase in market share (value) as a result of its competitor's upgrade. This spillover effect would be less attractive from investors' perspective. Therefore, intra-industry competition drains a firm's R&D investment either from the perspective of investors' suspicion of the potential mimicking incentive or from the perspective of windfall effect that is freely shared with competitors. Intra-industry competition could be manifested in the repetitiousness and intensity of industry R&D activities.[4]. Therefore, we hypothesize that investors would respond less favorably to the R&D announcement under a competitive product market.

The existing literature regarding R&D announcement is mixed[5]. In this study, we explore the issue from two alternative perspectives: board structure and intra-industry competition. Board structure relates to internal governance that dictates reliability of R&D announcements in the sense that firms with a better governance structure would closely scrutinize the R&D investment before making it public information.

[4] The condition is similar to the one depicted in Clark and Fujimoto (1991) and Williams (2005) that product development processes and management practices created for relatively long product life cycle, stable market, and technology-based competition are no longer capable of producing low cost and high quality products at a rapid pace.

[5] Mc Namara and Baden-Fuller (2007); Jones and Danbolt (2003); and Chung et al. (2003) find supporting evidence of a positive signal associated with R&D announcement. However, there are cases indicating an insignificant announcement effect associated with a firm's R&D expenditure (see Doukas and Switzer, 1992; Sundaram et al, 1996).

Intra-industry competition dictates the extent and duration of the announcement effect. Drastic competition among rivals dilutes the expected profit potentials.

Only a few studies emphasize the relation between internal governance structure and R&D announcement effect[6]. However, to our best knowledge the impact of market competition on investors' response has been sparsely explored. The failure to tapping intra-industry competition into analysis might overlook the whole picture of how investors perceive a firm's R&D announcement. More importantly, the two dimensions might truly capture investors' most concerns: risk and return. Board structure is related to the risk from information asymmetry and agency cost, while intra-industry competition dictates the profit potentials to be materialized.

We use the data of Taiwan listed firms to explore the R&D announcement effect. In our effective sample, the majority firms operate in electronic industry that is pivotal to the advancement of Taiwan economy in the past two decades. According to Breznitz (2005), Taiwanese electronic industry has invested a large portion of resources in R&D activities and has become one of the biggest electronic design and production centers in the world. The rate of international patents per capital in 2003-2006 was ranked the second worldwide. This achievement was also widely

[6] For example, Jones and Danbolt (2003) find that the level of abnormal returns is significantly lower for companies with large institutional investors. They attribute the negative relationship to short-term pressures on the performance of institutional investors. Chang, Chen and Lin (2006) find that stock markets respond more favorably to announcements of R&D expenditure increase by firms with stronger internal governance.

recognized and once reported in *Time* as a strong innovator. Moreover, electronic industry attracts most investors' attentions with an evidence to show that its trades once comprised 86.51% of the total market trades in 2001. Therefore, our sample of Taiwan listed firms is a splendid forum for the investigation of R&D announcement effect.

Using 229 R&D announcements made by 116 Taiwan listed firms we find that the cumulative abnormal returns of sampling firms are negatively associated with board size[7] and positively associated with board independence[8]. This verifies that investors do concern the risk associated with information asymmetry and agency cost. In the exploration of market competition we find that investors respond less favorably to firms that are R&D intensified and operate in a concentrated and highly R&D intensified industry. To further check the issue of whether the negative relations are due to industry competition that dilutes the announcement effect, we alternatively use the lapse of days from prior competitor's announcement and the ordinal number of announcements in the same industry. The regression that includes the two variables interactive with industry and firm R&D intensity verifies our conjecture and shows that the announcement effect is smaller for firms operate in a highly R&D intensified industry and with a short lapse of days from prior competitor's announcement.

[7] Jensen (1993) indicates that a large board tends to be less effective as decision-making becomes slower due to the involvement of more people. Yermack (1996) and Eisenberg et al. (1998) find that board size is negatively related to firm's value.

[8] See Hermalin and Weisbach (2003) for an overview.

Moreover, the effect is diluted for highly R&D intensified firms that have experienced numerous prior rival announcements in the same industry. Finally, the negative impact of industry R&D intensity and firm R&D intensity on the announcement effect is only significant for firms operate in a highly concentrated industry.

The potential contributions of this paper are as follows: First, we identify an alternative conduit that connects the relation between firm's governance structure and value. For example, Dittmar and Mahrt-Smith (2007) find that governance has a substantial impact on value through its impact on cash by showing that good governance approximately doubles the value of cash holdings. Gordon et al. (2004) indicate that weaker corporate governance mechanisms associated with more and higher dollar amounts of related party transactions. They also find that industry-adjusted returns are negatively associated with related party transactions. Our finding that use R&D announcement is similar in vein to theirs. Therefore, R&D activity provides another manifest that links the relationship between corporate governance and firm value. However, we use short-window event study to capture investors' spontaneous response and to avoid possible contamination by other factors that affect firm value. Second, we explore intra-industry competition that might abate the positive response from investors. In this study we specifically decompose the electronic industry into eight sub-industries. The decomposition allows us to capture

intra-industry competition in the sense that firms categorized in the same industry confront with a similar context environment and are rivals to one another. We use the time lapse from prior rival's announcement and the ordinal number of announcements in the same industry to capture intra-industry rivalry. Their interactions with R&D intensity provide additional explanation on the announcement effect, indicating that investors do care intra-industry competition in gauging the impact and duration of an R&D announcement.

The rest of the paper is organized as follows. Section 1 introduces. Section 2 develops testable hypotheses. Section 3 depicts the sample. Section 4 reports the empirical results. Section 5 concludes.

2. Hypotheses Development

In this section we develop the testable hypotheses. Since shareholder's wealth in this study is measured by the abnormal returns in the short event windows around R&D announcement, it would be nature to explore the factors from the perspective of investors who spontaneously respond to the information revelation. Form investors' perspective, they would concern firm's internal governance structure and external market competition. The two manifests that attract investors' attentions drive stock returns. A traditional view of internal governance is to decompose it into ownership

structure and board structure. However, the relationship between ownership structure and firm value received mixed support in prior studies[9]. Moreover, R&D expenditure needs to be finally approved by the boards through which investors could perceive the quality of a firm's governance structure. Therefore, we would mainly focus on board structure and market competition for hypotheses development while control variables of ownership structure in multivariate analysis.

Board Structure and R&D Announcement Effect

The board of directors should, in principle, be one of the major checks on the management as it is directly elected by shareholders to act on their behalf. The existing theory mainly focuses on the issue of whether directors can enhance governance structure in such a way to monitor top management and to replace poor managers. Since executive directors are closely tied to incumbent CEO and are therefore not likely to self-monitor or monitor effectively (e.g. Hart, 1995; Jensen, 1993), outside directors are therefore reliant on providing the monitoring function not only because they possess the relevant human capital but also because they need to signal their management competence to external managerial labor market (Fama and

[9] For example, Morck et al. (1988) indicate a non-linear relationship between managerial ownership and firm value where the relationship is jointly determined by the positive interest alignment and the negative entrenchment. They indicate that the negative entrenchment dominates in the range of 2%-25% managerial shareholding. Faleye (2007) in an exploration the relationship between classified boards and firm value also find insider ownership and block ownership are negatively related to firm value. In contrast, Shome and Singh (1995) show a positive relationship between blockholder ownership and financial performance.

Jensen, 1983; Weisbach, 1988).

Even though the empirical evidence provided to date on the monitoring role of the board and its wealth creation remains inconclusive[10], the standard view is that the board of directors is more independent as an increase in proportion of outside directors. For instance, TIAA-CREF, one of the largest pension funds in the world, has stated that it will invest only in companies that have a majority of outside directors on the board. Similarly, CALPERS, another large pension fund, recommends that the CEO should be the only inside director on a firm's board (also see Jensen, 1993). The Sarbanes-Oxley Act of 2002 requires that the audit committee consist entirely of outside directors and both the NYSE and NASDAQ require listed firms to use a majority of independent directors on the board. Investors nowadays are educated to keep alert on how boards are structured. We therefore argue that investors in spontaneously responding to R&D announcement would prefer boards with higher degree of board independence that could mitigate the information asymmetry between the R&D announcing firms and insiders.

Similar to German boards, corporate boards in Taiwan are comprised of two separate organizations—a board of directors and board of supervisors. Directors are responsible for managing the company. Supervisors on the other hand do not

[10] See Bhagat and Black (1998), John and Senbet (1998) and Lin (1996) for extensive surveys of the literature on the monitoring role of the board.

participate in the decision-making but are designated to monitor the board of directors[11]. Unlike German boards, Taiwanese boards of directors and supervisors are parallel organizations. Supervisors do not have the right to approve but have the right to ask directors' decisions to address questions. However, it is less likely for a supervisor to sue directors or managers partly because they could control over what information is given to supervisors and partly because supervisors are elected from and by current shareholders. Moreover, the law does not prohibit family members of current employees or directors nor institutional shareholders who are ultimately controlled by the controlling shareholder from serving as supervisors[12].

Since the board directors and the board of supervisors are independent organizations and the members are selected separately, the term of "independence" could be observed from different perspectives. In this study we define board independence as the number of independent directors in proportion to total number of directors. Moreover, we use the internalized-supervisor dummy that is assigned the value 1 when one or more controlling owner's affiliated persons serving in supervisory board, and 0 otherwise. If "independence" is highly appreciated by

[11] They can investigate a firm's finances or operations at any time and are entitled the right to sue the directors or managers once they find the directors or managers have either transgressed the law or hurt firm value. Because supervisors can individually exercise their rights, Taiwanese companies tend to have a small number of supervisors. The minimum requirement by law is one supervisor.

[12] Taiwan's Corporate Law relaxed the restriction that directors and supervisors should be firm shareholders at the end of 2001, and the Taiwan Stock Exchange began requiring that IPO firms listing from January 2002 on include two independent directors and one independent supervisor on the board. Security Exchange Law also increased the minimum requirements in 2001 to be 5 directors and 3 supervisors for newly listed companies.

investors, its relation with the R&D announcement effect could be formulated as follows.

Hypothesis 1-1: The R&D announcement effect is positively associated with board independence.

Hypothesis 1-2: The R&D announcement effect is negatively associated with internalized supervisory board

Lipton and Lorsch (1992) and Jensen (1993) argue that larger boards are unlikely to be effective in that large boards result in ineffective coordination, communication and decision-making, and are more likely to be controlled by the CEO. Empirical findings of Yermack (1996) and Eisenberg et al. (1998) support Jensen hypothesis and found that large boards are associated with lower market value, as measured by Tobin's Q. Moreover, Aggarwal and Nanda (2004) illustrate that the number of social objectives that a firm pursues is positively related to board size. Social objectives, such as community, diversity, environment, etc., might divert the supreme goal of value maximization. Moreover, board size is negatively related to managerial incentives, i.e. larger boards are associated with lower managerial pay-performance sensitivities. Therefore, form investors' perspective, a small board

that might ameliorate ineffective coordination among members and focuses on firm value maximization would be preferred. More importantly, a small board is much important in high-tech firms than in others for the reason of timely responding to ever-changing markets.

Hypothesis 2: The R&D announcement effect is negatively associated with board size

Industry Competition and R&D Announcement Effect

The relation between industry competition and R&D announcement effect could be analyzed from two different perspectives. The first one relies on the relation between intra-industry competition and firm value. The second one is through the stimulus/response dyad that captures investors' response to information.

Competitor analysis is central to strategy and organization research (Hitt et al., 2005; Porter, 1980). Firms belonging to the same strategic or competitive group will face comparable degrees of competition and hence compete similarly. In our study we adopt a new classification scheme[13] that decomposes the electronic industry into eight subcategories: semiconductor, computer peripherals, optoelectronics,

[13] Early work regarding competitor analysis drew mainly from industrial organization economics (Bain, 1956; Porter, 1980) to study competition at the industry level, relying on the assumption that firms in the same industry are *de facto* competitors. Later researchers refined the notion of competitors to take into account intra-industry heterogeneity by studying the formation of various groups in the same industry (Cool and Schendel, 1987). Therefore, firms being classified into the same competitive group have to be homogeneous and face comparable degrees of competition.

communication network, electronic components, electronic distribution, information service and other electronics. Moreover, most firms in the same subcategory are geographically approximate, mainly located in Science Parks. Geographic approximation allows opposing forces to hold each other in check and that build up tension of rivalry. Our sample that mainly comprised of high-tech firms is a good target to examine inter-firm competition.

The relation between market competition and productivity tends to be positive. For example, Nickell et al. (1997) find that product market competition has a positive effect on total factor productivity. Consistently, Januszewski et al. (2002) find that firms experience higher productivity growth when operating in markets with intensive competition. However, the relation between industry competition and firm value is less clear. As indicated by Griffith (2001), competition lowers firm's profits and thus reduces incentives to exert effort on one hand while it reduces agency costs thus increasing incentives to exert effort on the other. The contrast between the two streams of studies lies in the intermediating role of governance structure. Beiner, Schmid and Wanzenried (2005) suggest that intensive product market competition is associated with stronger incentive schemes for managers and a lower firm value. From the perspective of intra-industry competition, we hypothesize that the announcement effect is less favorable to drastic product market competition.

The second one of apprehending investors' response to a firm's R&D announcement might be through the stimulus-response dyad that was initially proposed by Pavlov. Classical conditioning has been demonstrated in numerous species using a variety of methodologies. One of the most relevant theories to this study is sensory evaluation that makes use of the remarkable virtuosity and range of the human senses. The brain protects itself from an overload of information from the senses by two processes: feature extraction and adaptation. The former involves information reduction by the extraction of selected features from the environment; these form the basis for the reconstruction of the percept in consciousness. It could therefore be argued that firms that experienced success in R&D announcement will imprint positive impression on investors and a follow-on positive stock return. The latter, adaptation, involves the attenuation of repetitive and constant input so as not to overload the brain with redundant information.

According to O'Mahony (1986), the effect is that a constant odor or taste stimulus will be perceived as decreasing in intensity while sensitivity to that stimulus is also decreased. In this study we construct two variables to capture investor's adaptation to stimulus: the time lapse from prior rival's R&D announcement and the ordinal number of R&D announcement. Following the adaptation theory, we argue that the positive response to R&D announcement would be less significant when the

lapse of time from prior rival's announcement is short and the ordinal number of announcements is large.

Hypothesis 3: Under drastic intra-industry competition, Investors' positive response to R&D announcement would be less significant when the lapse of time from prior rival's announcement is short and the ordinal number of announcements is large.

3. The Sample

3.1 Source of the Sample

The sample that is comprised of firms that announced R&D investment in the 2000-2006 period and is hand collected from new paper clips, websites, and the Market Observation Post System (an official information website). To avoid confounding effects in gauging the firm value (John and John, 1996), we exclude firms that disclose fundamental news 15 days before and after R&D announcements. Firms that are in lack of complete specific information on the R&D expenditure or data of stock returns available from the Taiwan Economic Journal (a data company in Taiwan), operate in financial industry, or have been delisted from Taiwan Stock Exchange are excluded from the sample. In total, the effect sample is comprised of 229 announcements that were released by 116 firms.

Panel A of Table 1 reports the sample distribution with industry breakdown. The number of announcements is highest in semiconductor industry (72, 31%) while the number of announcing companies is highest in the computer peripherals industry (23, 20%). The eight subcategories of electronic industry in total represent 79% of the number of announcements and 74% of the number of announcing companies. Moreover, the traditional chemistry industry that was further categories into chemistry industry and biochemical medicine industry is second to electronic industry and represent 11% in terms of number of announcements and 9% in terms of number of announcing firms. Either electronic industry or chemistry industry is characterized as high capital and R&D intensity and therefore the focal point to be investigated in this study.

In panel B the sample is categorized based on number of announcements. There are 71 firms (61%) engaging in one-shot announcement in our sampling period. The majority firms (82%) were engaging in fewer than two R&D announcements. It could therefore be inferred that the diluting effect, if it's ever existed, is from intra-industry rivalry rather than self-attrition. The result in panel C with yearly breakdown indicates that there is no specific clustering in certain year. We note that the reason that the total number of announcing firms (179) is higher than the number reported in Panel A and B is due to the fact that there are firms that spread their R&D announcements across

different fiscal years.

<<Insert Table 1 Here>>

3.2. Abnormal Returns

The standard event-study method is applied herein to examine the stock price responses to a firm's R&D announcement. Day 0 is defined as the day in which the announcement appears in major publication. The abnormal return is calculated as the difference between the raw return and an expected return derived from the market model with the parameters estimated by regressing the underlying firm's raw returns on the value-weighted TSEC index, a proxy for market returns, over the period from 210 to 70 days before the announcement date. The wealth effect of R&D announcement is estimated via the cumulative abnormal returns over the event window of day -1 through day 2. Day -1 being included in estimation is due to the possibility that the announcement was released during the trading hours while was reported in publication on the following day. To avoid the possible delayed reaction of investors, the observation window is extended to day 2.

The distribution of cumulative abnormal returns is tabulated in panel A of Table 2. The CARs monotonically increase from 0.58 % in the window (-1, 0) up to 0.84%

in the window (-1, 2). The corresponding medians are 0.31% and 0.42%, respectively. An unreported test shows that the cumulative abnormal returns for different windows are all significant at 1% level. This is consistent with prior studies (Mc Namara and Baden-Fuller, 2007; Jones and Danbolt, 2003; Chung et al., 2003)

3.3. Board Structure

In board structure, we emphasize the importance of board independence that has been illustrated in prior studies of being positively associated with firm's performance (Weisbach, 1988). Board independence is calculated as the number of independent board members divided by board size. The average board independence, as shown in panel B of Table 2, is 0.05%. Low level of board independence is mainly due to the fact that the law in our sampling period has not stipulated the listed firms to include independent members in boards. Firms that voluntarily include independent members send a positive signal to outsiders that the firm's governance structure is rather good. The average board size which is tend to negatively related to firm value (Lipton and Lorsch, 1992; Jensen, 1993; Yermack, 1996; and Eisenberg et al.,1998) is 9.91. The median size is 9. One additional indicator of how controlling owner internalizes the boards is through the dummy that assign value 1 when supervisors are affiliated to the controlling owner and 0 otherwise. There are 68% of the sampling firms assigning

affiliated persons to supervisory board. On average, the large shareholders hold 13.04% shareholdings and the board members hold 21.85% shareholdings.

3.4. Industry Nature and Firm Characteristics

Panel C of Table 2 reports industry nature and firm characteristics. Industry R&D intensity, referred to Kelm, Narayanan, and Pinches (1995), is calculated as the three-year industry averaged R&D expenditure divided by the industry averaged net sales. On average, the industry R&D expenditure comprises 3.7% of its total sales. Firm's R&D intensity is calculated as the underlying firm's three-year R&D expenditure divided by its corresponding net sales. On average, the firm's R&D intensity is comparatively lower than industry R&D intensity, which is probably due to size effect that larger firms expend a larger portion in R&D activities. We also calculate industry concentration referring to Kelm et al. (1995) as the sum of the top four companies' sales in proportion to the total sales of that industry. On average, the top four firms' sales represent 55% of the total sales of the industry.

Referring to Chung and Pruit (1994), Tobins' q is calculated as the sum of market value of equity, preferred stocks, and debt divided by the book value of the firm's total assets. On average, the proxy q is 1.47. The firm's assets are highly skewed with the mean value of 102.38 billion NTD and the median of 10.72 billion

NTD. The debt ratio, defined as firm's total debt divided by total assets, is 34%. Finally, an employee's contribution to the firm that might affect investors' perceiving the quality of firm's personnel is measured by the total sales divided by number of employees. On average, each employ contribute 9,131 NTD of sales to the firm.

3.5. R&D Announcement

To capture the announcement effect, we also include four variables in analysis. The first one is the number of announcement. On average, the firms made 2.72 R&D announcements in the sampling period. The median value is 2 times. The second one is to capture whether investors would pay additional attentions to firm's initial R&D announcement. The dummy that assign value 1 for initial announcement is on average 0.49, indicating that around half of the sampling firms initiate their first R&D announcement in the sampling period. Two vairables were used to capture intra-industry rivalry: the lapse of days from prior rival's announcement and the ordinal number of announcement in the same industry. On average, the duration between two competitors' annoucements is 114.5 days. However, the distribution is highly skewed to the right and widely distrituted with the median of 47 days and the first and third quartile of 16 days and 137 days, respectively. The ordinal number of announcement is on average 18.14.

<<Insert Table 2 Here>>

4. Empirical Results

4.1 Univariate Test

In Table 3 we categorize the sample firms into two groups based on the medians[14] or dichotomies of the variables and reports the test in difference of CAR(-1, 2)[15] around R&D announcement window. The results show that small board size is associated with more favorable response from investors, which corroborates the arguments or findings from prior studies (Lipton and Lorsch, 1992; Jensen, 1993; Yermack, 1996; Eisenberg et al., 1998). The average abnormal returns are 0.59 % and 1.34% for large and small boards, respectively. Moreover, the average abnormal return for firms with affiliated members in the supervisory board (0.58%) is lower than that for firms without (1.40%).

The results show that firms in a high intensified R&D industry have lower abnormal returns upon R&D announcement (0.39%) than firms in low intensified

[14] We note that some variables are discontinued and that results in unbalanced numbers when classifying based on sample medians. For example, the median board size is 9. We classify firms with board size equal to or greater than 9 in one group, and the rest in other group. For consistency, all variables are classified into one group (≧ sample median) and the other （< sample median）.

[15] In an unreported result, the coefficients of partial correlation between CARs in different windows and variables of interest are qualitatively similar. For brevity, we only report the empirical results based on CAR (1-,2) hereafter.

industry (1.25%), with the difference significant at 5% level. This implies investors respond less favorably to firms that confront drastic intra-industry R&D competition that would dilute the duration and profit potential of the firm's R&D expenditure. We also find that firms with higher q ratio are associated with lower abnormal returns. The mean abnormal return for high q firms is 0.51%, as compared to 1.17% for low q firms. This could be understood that the marginal contribution of launching an R&D activity diminishes for the firms that have been perceived of having higher growth potential (high q). In contrast, firms with low q tend to be undervalued and their R&D announcement tends to be marginally significant. The same algorithm could be applied to the contrast in firm size. The result shows that larger firms in terms of assets value are associated with lower R&D announcement effect. This could be understood that larger firms attract more investors' attentions than for small firms or that a ceiling of growth potential is more likely to incur to larger firms than for small firms. Finally, we find that firms with higher sales per employee are associated with a lower abnormal return (0.46%) than firms with lower sales per employee (1.21%). The same argument from size effect could be applicable here.

The overall picture from industry and firm characteristics indicates that investors would respond less favorably to firms that encounter more intra-industry competitions, potentially being overvalued by the market, or encounter a glass ceiling

of growth potential. We will further explore the impact of intra-market competition in the latter passages.

<< Insert Table 3 Here>>

4.2. The Regressions

In Table 4, the abnormal returns in different windows are regressed on the board structure and intra-industry competition. The results show that the abnormal returns are positively associated with board independence and negatively associated with board size. The results are consistent with the dictation of hypothesis 1 and 2, indicating that independent board is more likely to provide surveillance function that ameliorates the agency cost and information asymmetry embedded in firm's R&D announcement. Moreover, the negative relation between the abnormal returns and board size implies that small boards tend to effectively monitor the managers and therefore draw favorable response from investors.

We find that industry R&D intensity and industry concentration are significantly and negatively related to the abnormal returns. The two variables imply intra- industry competition in the sense that firms reside in an oligopoly market and concentrate R&D resources within these countable players. Drastic competition would reduce the

profitability expected from launching an R&D activity. Investors in turn respond less favorably to the information revelation. Moreover, largest shareholder's shareholding is negatively associated with the abnormal returns, which is probably due to the fact that the largest owners' shareholding in most of the listed firms is in the range where the entrenchment effect prevails (Morck et al., 1988). The results also show that the abnormal returns are negatively associated with sales per employee and positively associated with number of announcement. We will revisit this part latter. In an unreported result we include the natural logrithm of assets into regression and find it is insignificant.

<<Insert Table 4 Here>>

In Table 5 we explore the possible interaction between board structure and intra-industry competition in that the prior studies indicate that the two might be interrelated (e.g. Januxzewski et al, 2002). In this table we additional include the interactive terms of the dummy of internalized supervisors and market concentration, industry R&D intensity, and firm R&D intensity, respectively. The interaction between internalized dummy and industry concentration and the interaction between internalized dummy and firm R&D intensity are negative and significant at 10% level.

Januszewski et al. (2002) find that competition and tight control are compliments: the positive effect of competition is enhanced by the presence of strong ultimate owner. Our finding is somewhat different from theirs. First, we investigate the impact of competition on investors' response rather than on productivity. As indicated by Griffith (2001), the relation between industry competition and firm value is less clear in that competition reduces managerial incentive on one hand while it reduces agency costs on the other. Moreover, we find investors' response to a firm's R&D announcement would be even less favorably if it reside in a competitive product market and is centralized controlled by controlling owner. The negative impact of centralized control could be evidenced not only by the negativity of the interactive term between industry concentration and the dummy of internalized supervisors by also by the much significant regression coefficient of large shareholder's shareholding.

<<Insert Table 5 Here>>

In the prior passages we find that industry R&D intensity, firm's R&D intensity, and industry concentration to be negatively related to the abnormal returns around the R&D announcement window. They are meant to serve the proxies of intra-industry

rivalry in this study. However, some might concern the legitimacy of using the three variables by arguing that they are at best to depict industry structure rather than intra-industry rivalry. In other words, we might need much direct proxies to simulate investors' perception of inter-firm rivalry.

We meticulously trace the time lapse between a firm's announcement and its competitor's prior announcement. A longer duration of the lapse implies that the announcement this time is more likely to be monumental on one hand and the underlying firm is less likely to confront drastic intra-industry competition. Investors would prefer an R&D announcement that lasts long. Moreover, we also count and number the announcements in the same industry. A large ordinal number indicates repetitive R&D activities in the industry, which would dilute the announcement effect partly because of intra-industry competition and partly because of investors' insensitivity to repetitive stimulus (O'Mahony, 1986).

In Table 6 we additional include the interactive terms of the two variables and R&D intensity in the regression analysis. The result shows that the interaction between the lapse of days and industry R&D intensity is significantly positive. This indicates that the longer the duration from prior competitor's announcement reduces the negative impact of industry R&D intensity. Moreover, the interactive term of the ordinal announcement and firm's R&D intensity is significantly negative; implying

that investors respond less favorably to high R&D intensified firms confronting repetitive rivals' announcements. We note that the number of announcement is significantly positive while the interaction between the ordinal number and firm's R&D intensity is negative. The contrast indicates that investors respond positively to the firm's repetitive announcements while only less favorably to the cases when firms encounter many rivals' challenges. This provides peripheral evidence on the negative impact of rivalry on the announcement effect.

However, in unreported result we fail to find supporting evidence that the lapse of days and the ordinal number of announcement are significant when they are independently included in the regression. Their impact on R&D announcement effect would only be materialized when interacting with R&D intensity. Therefore, we would not overemphasize the two variables are manifests of intra-competition. Rather, their interactions with R&D intensity capture how investors perceive a firm's R&D announcement and react correspondingly.

<<Insert Table 6 Here>>

In Table 7 we split the sample into two subcategories based on the sample median of industry concentration. If intra-industry competition affects the

announcement effect, we would expect to find that the negative impact of R&D intensity would only be evidenced in the concentrated subcategory. The results in Table 7 indicate the negative impact of industry R&D intensity, firm's R&D intensity, and industry concentration measure are only significant in the high industry concentration subcategory. In contrast, these variables are insignificant in the low concentration subcategory. The result provides additional explanations on why intra-industry competition might drain the abnormal returns of R&D announcement. Moreover, we find that the abnormal returns for firms in the low concentration group are positively correlated with board shareholding and number of announcement.

<<Insert Table 7 Here>>

5. Concluding Remark

In this study we explore firm's R&D announcement from the perspective of investors. In general, investors respond positively to this information. However, they prefer firms with better governance structure and confront with fewer intra-industry competitions to ensure that the R&D investment has been carefully scrutinized by the board and its profit potential would last long. Our empirical results basically support

the aforementioned hypotheses.

The results illustrate that investors in gauging the value of a firm's R&D investment take into considerations of both internal governance and intra-industry competition. We find internal governance such as board size and independence to be influential on the R&D announcement effect. A small while independent board is more likely to function well and to effectively review a firm's R&D investment. In contrast, drastic intra-industry competition drains the profit potential associated with R&D investment. Firms residing in a concentrated or R&D intensified industry are less likely to enjoy big profit potentials and are less favorably valued by investors. In the exploration of intra-industry competition we contrive two novel measures: the lapse of day since prior rival's announcement and the ordinal number of announcement. However, their impact on abnormal returns can only be evidenced via interactions with R&D intensity. Further research can focus on finding direct and sensible measures of intra-industry competition.

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Table 1: Sample Distribution

The sample consisting firms that announced R&D investment in the 2000-2006 sampling period is hand collected from news paper clips and their related websites, and the Market Observation Post System, an official information website. This table summarizes the statistics of our sample. Panel A reports the number of announcements and number of companies by industry breakdown. Panel B reports the statistics breakdown by number of announcements. Panel C reports the statistics with yearly breakdown. The percentage with respect to total amount is reported in parentheses.

Panel A: Breakdown by industry		
Industry	# of Announcements (%)	# of Companies (%)
Chemistry	11 (4.80%)	7 (6.03%)
Biochemical medicine	16 (6.99%)	4 (3.45%)
Semiconductor	72 (31.44%)	19 (16.38%)
Computer peripherals	29 (12.66%)	23 (19.83%)
Optoelectronics	19 (8.30%)	11 (9.48%)
Communication network	26 (11.35%)	10 (8.62%)
Electronic components	15 (6.55%)	9 (7.76%)
Electronic distribution	1 (0.44%)	1 (0.86%)
Information service	3 (1.31%)	1 (0.86%)
Other electronics	16 (6.99%)	12 (10.34%)
Electric machinery	5 (2.18%)	4 (3.45%)
Electronic equipment & cable	4 (1.75%)	3 (2.58%)
Foods	1 (0.44%)	1 (0.86%)
Textile	2 (0.87%)	2 (1.72%)
Plastic	1 (0.44%)	1 (0.86%)
Rubber	3 (1.31%)	3 (2.59%)
Automobile	1 (0.44%)	1 (0.86%)
Glass	1 (0.44%)	1 (0.86%)
Others	3 (1.31%)	3 (2.59%)
Total	229 (100.0%)	116 (100.0%)
Panel B: Breakdown by number of announcement		
# of announcements		# of Companies (%)
1		71 (61.21%)
2		25 (21.55%)
3		9 (7.76%)
4		3 (2.59%)
5		1 (0.86%)
6		2 (1.72%)
7		0 (0.0%)
8		2 (1.72%)
9		1 (0.86%)
10		1 (0.86%)
17		1 (0.86%)
Total		116 (100%)
Panel C: Breakdown by year		
Year	# of announcements (%)	# of companies (%)
2000	27 (11.79%)	20 (11.17%)
2001	53 (23.14%)	35 (19.55%)
2002	43 (18.78%)	31 (17.32%)
2003	36 (15.72%)	30 (16.76%)
2004	22 (9.61%)	21 (11.73%)
2005	29 (12.66%)	28 (15.64%)
2006	19 (8.30%)	14 (7.82%)
Total	229 (100.00%)	179 (100.00%)

Table 2: The Basic Statistics of Variables

This table summarizes the basic statistics of variables of interest. Panel A reports the cumulative abnormal returns in different windows that are calculated using traditional market model where the systematic risk is estimated in the window of 210 days through 70 days prior to R&D announcements. Panel B reports board structure. D (independent supervisor) denotes a dummy being assigned the value 1 when supervisors are affiliated to the largest shareholder and 0 otherwise. Board independence refers to the number of independent board members divided by the total number of board members (board size). Large (board) shareholding refers to the percentage of shareholdings held by board members (large shareholders). Panel C reports industry nature and firm characteristics. Industry R&D intensity, referred to Kelm, Narayanan, and Pinches (1995), is calculated as the three-year industry averaged R&D expenditure divided by the industry averaged net sales. Firm's R&D is the underlying firm's three-year R&D expenditure divided by its corresponding net sales. CR4, referred to Kelm et al. (1995), denotes to the sum of the top four companies' sales in proportion to the total sales of that industry. Referring to Chung and Pruit (1994), Tobins' q is calculated as (MVA + PS +Debt)/TA where MVA refers to the market value of equity, PS refers to the market value of preferred stocks, Debt refers to total debt, and TA refers to the book value of firm's assets. Panel D reports R&D announcement. D (initial announcement) is a dummy that is assigned 1 when the announcement is first announcement in the sampling period and 0 otherwise. Number of announcement refers to the number of R&D announcement of an underlying firm in the sampling period. The lapse of days from prior rival's announcement refers to the days since the latest competitor's R&D announcement in the same industry. Ordinal announcement refers to the ordinal R&D announcement in the same industry.

	Mean	S.D.	Q1	Median	Q3
Panel A: Cumulative abnormal return					
CAR (-1, 0) (%)	0.58	1.96	-0.59	0.31	1.87
CAR (-1, 1) (%)	0.72	2.55	-0.72	0.36	1.86
CAR (-1, 2) (%)	0.84	3.06	-0.98	0.42	2.12
Panel B: Board Structure					
Independent board members	0.53	1.22	0.00	0.00	0.00
Board size	9.91	2.60	8.00	9.00	11.00
Board independence (%)	0.05	0.12	0.00	0.00	0.00
D (internalized supervisor)	0.68	0.47	0.00	1.00	1.00
Large shareholder's shareholding (%)	13.04	8.47	6.74	12.29	18.39
Board shareholding (%)	21.85	11.99	12.71	21.54	27.77
Panel C: Industry nature and firm characteristics					
Industry R&D intensity (%)	3.70	2.50	1.60	2.50	6.30
Firm's R&D intensity (%)	1.90	1.89	0.83	1.31	2.27
CR4	0.55	0.14	0.44	0.55	0.60
Tobin's q	1.47	1.35	0.63	1.04	1.88
Assets (in billion NTD)	102.38	230.31	3.85	10.72	64.57
Sales per employee (in thousand NTD)	9,131.44	9,349.22	3882.50	6369.00	11260.5
Debt ratio (%)	34.44	14.31	23.25	33.36	43.00
Panel D: R&D announcement					
Number of announcement (X)	2.72	2.89	1.00	2.00	3.00
D (initial announcement)	0.49	0.50	0.00	0.00	1.00
Lapse of days since latest announcement (days)	114.50	193.90	16	47	137
Ordinal announcement (X)	18.14	18.26	5	12	25

Table 3: Difference Test in CAR(-1,2) around R&D Announcement

This table reports the difference test in CAR(-1,2) around R&D announcement. The classification is based on the medians or dichotomies of the variables defined in Table 2. t-statistics are reported in the last column. ***, **, and * represent the significance level of 1%, 5%, and 10%, respectively.

Variable	Classification	Sample size	Mean	t-statistics
D(independent board)	Yes	41	1.10	0.60
	No	188	0.78	
Board size	Large	153	0.59	-1.75*
	Small	76	1.34	
D(internalized supervisor)	Yes	155	0.58	-1.91*
	No	74	1.40	
Large shareholder's shareholding	High	115	0.48	-1.83*
	Low	114	1.21	
Board shareholding	High	115	1.04	1.03
	Low	114	0.63	
CR4	High	118	0.58	-1.29
	Low	111	1.11	
Industry R&D intensity	High	109	0.39	-2.14**
	Low	120	1.25	
Firm R&D intensity	High	116	1.03	0.98
	Low	113	0.64	
Tobin's q	High	114	0.51	-1.64*
	Low	115	1.17	
Assets	Large	115	0.26	-2.89***
	Small	114	1.41	
Debt ratio	High	115	1.03	0.89
	Low	114	0.66	
Sales per employee	High	115	0.46	-1.86*
	Low	114	1.21	
D (initial announcement)	Yes	118	0.66	-0.90
	No	111	1.03	
Number of announcement	High	115	1.15	1.56
	Low	114	0.52	
Lapse of days since latest announcement	Long	106	1.15	1.5
	Short	104	0.50	
Ordinal announcement	High	116	0.98	0.71
	Long	113	0.69	

Table 4: Regression of CAR on Board Structure, Industry Competition, and Firm Characteristics

This table reports the regression CARs in different windows on board structure, industry nature, and firm characteristics. All variables are defined in Table 2. In each cell, the regression coefficient is reported in the upper case and the t-value in parentheses is reported in the lower case. ***, **, and * represent the significance level of 1%, 5%, and 10%, respectively.

	CAR (-1,0)	CAR (-1, 1)	CAR (-1,2)
Intercept	4.26	5.82	7.93
	(3.20)***	(3.32)***	(3.80)***
Board Independence	3.64	3.99	3.25
	(3.56)***	(2.97)***	(2.03)**
Ln (Board size)	-0.87	-1.21	-1.68
	(-1.70)*	(-1.70)*	(-1.98)**
D (internalized supervisor)	-3.84	-0.47	-0.60
	(-1.36)	(-1.28)	(-1.36)
Industry R&D intensity	-14.50	-15.29	-20.57
	(-2.36)**	(-1.89)*	(-2.14)**
Firm's R&D intensity	-0.07	-0.09	-0.20
	(-0.96)	(-0.94)	(-1.73)*
CR4	-2.13	-2.78	-3.54
	(-2.28)**	(-2.27)**	(-2.42)**
Large shareholder's shareholding	-0.02	-0.03	-0.05
	(-1.30)	(-1.64)	(-1.91)*
Board shareholding	0.01	0.02	0.02
	(1.00)	(1.23)	(1.11)
Sales per employee	-1.95E-05	-4.27E-05	-5.76E-05
	(-1.37)	(-2.29)**	(-2.59)**
D (initial announcement)	-0.41	-0.55	-0.42
	(-1.26)	(-1.28)	(-0.82)
Number of announcement	0.29	0.35	0.48
	(1.67)*	(1.52)	(1.77)*
Adjusted R^2	0.11	0.10	0.10

Table 5: The Regression that Includes the Interaction of Industry Competition and Internalized Supervisor

This table reports the regression of CAR (-1,2) on board structure, industry competition, firm characteristics and the interactive term of industry concentration (CR4) and D(internalized supervisor), industry R&D intensity and D(internalized supervisor), and firm R&D intensity and D(internalized supervisor) in column 1,2, and 3, respectively. In each cell, the regression coefficient is reported in the upper case and the t-value in parentheses is reported in the lower case. ***, **, and * represent the significance level of 1%, 5%, and 10%, respectively.

	CAR (-1,2)		
Intercept	7.54	7.31	7.68
	(3.56)***	(3.32)***	(3.66)***
Board Independence	3.16	3.24	3.18
	(1.97)**	(2.02)**	(1.99)**
Ln (Board size)	-1.66	-1.60	-1.72
	(-1.97)**	(-1.82)*	(-2.07)**
Industry R&D intensity	-20.43	-10.93	-21.26
	(-2.13)**	(-0.84)	(-2.21)**
Firm's R&D intensity	-0.21	-0.21	-0.02
	(-1.76)*	(-1.74)*	(-0.15)
CR4	-2.85	-3.48	-3.72
	(-1.91)*	(-2.38)**	(-2.52)**
Large shareholder's shareholding	-0.05	-0.04	-0.05
	(-1.93)*	(-1.78)	(-2.00)**
Board shareholding	0.02	0.02	0.02
	(1.14)	(1.11)	(1.08)
Sales per employee	-5.78E-05	-5.87E-0.5	-5.48E-05
	(-2.60)***	(-2.64)***	(-2.44)**
D (initial announcement)	-0.40	-0.42	-0.40
	(-0.79)	(-0.83)	(-0.77)
Number of announcement	0.48	0.47	0.48
	(1.76)*	(1.72)*	(1.78)*
CR4* D(internalized supervisor)	-1.15		
	(-1.72)*		
Industry R&D intensity * D(internalized supervisor)		-13.10	
		(-1.17)	
Firm R&D intensity * D(internalized supervisor)			-0.25
			(-1.81)*
Adjusted R^2	0.11	0.10	0.11

Table 6: The Regression that Includes the Interactions of the Days since Prior Rival's Announcement, the Ordinal Number of Announcements, and Industry and Firm's R&D Intensity

This table reports the regression of CAR (-1,2) on board structure, industry nature, firm characteristics and the possible interactions of ln (days), ln (ordinal announcement), industry R&D intensity, and firm R&D intensity, where ln (days) and ln (ordinal announcement) represent the natural logarithm of the lapse of days since latest announcement and the nature logarithm of the ordinal number of announcements in the same industry, respectively. In each cell, the regression coefficient is reported in the upper case and the t-value in parentheses is reported in the lower case. ***, **, and * represent the significance level of 1%, 5%, and 10%, respectively.

	Dependent variable: CAR (-1,2)			
Intercept	8.63	8.69	7.85	8.68
	(3.63)***	(3.60)***	(3.75)***	(4.07)***
Board Independence	3.21	3.73	3.49	4.08
	(1.93)*	(2.23)**	(2.13)**	(2.43)**
Ln (Board size)	-1.98	-1.86	-1.71	-1.82
	(-2.05)**	(-1.90)*	(-2.01)**	(-2.14)**
D (internalized supervisor)	-0.70	-0.73	-0.56	-0.62
	(-1.45)	(-1.48)	(-1.25)	(-1.40)
Industry R&D intensity	-38.60	-19.97	-7.93	-17.31
	(-3.07)***	(-1.87)*	(-0.39)	(-1.76)*
Firm's R&D intensity	-0.34	-0.46	-0.20	-0.07
	(-2.33)**	(-1.30)	(-1.72)*	(-0.44)
CR4	-3.26	-3.39	-3.67	-3.90
	(-1.94)*	(-1.99)**	(-2.49)**	(-2.64)***
Large shareholder's shareholding	-0.06	-0.06	-0.04	-0.05
	(-2.53)**	(-2.30)**	(-1.87)*	(-2.07)**
Board shareholding	0.02	0.01	0.02	0.01
	(0.93)	(0.60)	(1.01)	(0.87)
Sales per employee	-6.38E-05	-6.73E-05	-5.57E-05	-6.23E-05
	(-2.68)***	(-2.79)***	(-2.48)**	(-2.79)***
D (initial announcement)	-0.19	-0.16	-0.39	-0.51
	(-0.35)	(-0.29)	(-0.77)	(-1.00)
Number of announcement	0.54	0.58	0.51	0.50
	(1.92)*	(2.04)**	(1.86)*	(1.84)*
Ln (days) * Industry R&D intensity	17.97			
	(2.31)**			
Ln (days) * Firm R&D intensity		0.07		
		(0.43)		
Ln (ordinal announcement) * Industry R&D intensity			-7.68	
			(-0.70)	
Ln (ordinal announcement) * Firm R&D intensity				-0.30
				(-1.72)*
Adjusted R^2	0.13	0.11	0.10	0.11

Table 7: The Regressions that Split the Sample Based on Industry Concentration

The sample is divided into halves based on the sample median of industry concentration (CR4). For each half, CAR (-1,2) is regressed on board structure, industry nature, and firm characteristics. In each cell, the regression coefficient is reported in the upper case and the t-value in parentheses is reported in the lower case. ***, **, and * represent the significance level of 1%, 5%, and 10%, respectively.

	CR4 ≧ Median	CR4 < Median
Intercept	12.41	5.43
	(2.69)***	(1.46)
Board Independence	6.42	-1.98
	(2.95)***	(-0.78)
Ln (Board size)	-1.59	-2.32
	(-1.24)	(-1.90)
Industry R&D intensity	-30.94	-14.11
	(-1.87)*	(-0.73)
Firm's R&D intensity	-0.24	0.11
	(-1.85)*	(0.37)
CR4	-7.48	-2.90
	(-1.90)*	(-0.41)
Large shareholder's shareholding	-0.04	-0.02
	(-1.06)	(-0.68)
Board shareholding	-0.00	0.06
	(-0.15)	(2.18)**
Sales per employee	-5.22E-05	-5.53E-05
	(-1.79)*	(-1.55)
D (initial announcement)	-1.58	0.92
	(-2.06)**	(1.32)
Number of announcement	0.05	0.94
	(0.15)	(2.33)**
Adjusted R^2	0.15	0.10