Keiretsu Style Main Bank Relationships, R&D Investment, Leverage, and Firm Value: Quantile Regression Approach

Hai-Chin Yu[1]
Department of International Business,
Chung Yuan University,
Chung-Li, 32023, Taiwan
haichin@cycu.edu.tw &
haichin@rci.rutgers.edu
Tel: 886-3-265-5209
Fax: 886-3- 265-5299

Chih-Sean Chen
Institute of Management
Chung Yuan University,
Chung-Li, 32023, Taiwan

Der-Tzon Hsieh
Dep. of Economics
National Taiwan University
Taipei,100, Taiwan

[1] Hai-Chin YU is the contact author. This paper had been presented in 2008 Quantitative Finance and Risk Management Conference, National Chou-Tong University, Shi-chu, Taiwan.

Abstract

Using quantile regression, our results provide explanations for the inconsistent findings from using conventional OLS in the extant literature. Our results document that a firm's value from R&D investments, leverage and main bank relationship depend on its quantile effects of Tobin's Q. While the direct effects of these factors are insignificant using conventional OLS regression, these effects do show significant effects in quantile regression. Firms' advantages with high R&D investment over low R&D monotonically increase with firm value for high Q firms; however, firms' advantages with low R&D over high R&D monotonically increase with firm value for low Q firms. Tobin's Q is monotonically increasing with leverage for low Q firms; whereas it is decreasing with leverage in high Q firms. For low Q firms, R&D investment and leverage compliment each other. For high Q firms, R&D investment and leverage substitute each other. Main banks play a significant and positive role in adding value for low to median Q firms, while showing a negative impact for high Q firms. In addition, we extend our study by analyzing the influence of the combined effect between main bank and R&D investment on firm performance. Results of this work provide relevant implications for policy makers. Finally, we document that industry quantile effect is larger than the industry effect itself given that most of the firms in higher quantiles gain from industry effects while lower quantile firms suffer negative effects.

Keywords: R&D investment, quantile regression, *Keiretsu*, main bank, leverage.

JEL Classifications: G32, G34, G30.

Keiretsu Style Main Bank Relationships, R&D Investment, Leverage, and Firm Value: Quantile Regression Approach

1. Introduction

Research and development (R&D) investment is considered a crucial input for firm growth and performance, especially in technology and science intensive industries. Among developed countries, Japan is thought to be one of the most successful countries in manufacturing. Why is manufacturing so successful in Japan but not in the U.S. or other countries? Our data shows that more than 50 % of Japanese listed firms belong to the technology-based industry underscoring the importance of R&D in order to boost long term economic growth.

Owing to the fact that R&D investments is intangible, the asymmetric information problem with respect to R&D investment is expected to be more serious than physical investment since managers may be inclined to keep confidential information for reasons of competitive advantage. This, in turn, makes it difficult for investors to measure the effect of R&D investment on firm value. Extant literature shows divergent findings regarding the impacts of R&D on firms' value so that the conclusions are not consensus. For example, Woolridge (1988) finds a significant market response to the increase in R&D expenditure; however, the reaction differs based on different industries. Chan et al. (1990) and Zantout and Tsetskos (1994) report a positive market response to R&D increases for firms in high-tech industries versus a negative market response for low-tech industries. Acs and Isberg (1996) suggests the final impact of financial leverage and R&D investment on Tobin's Q depends on firm size. Ho, et al (2006) also indicates that a firm's growth opportunity from R&D depends on its size, leverage and industry concentration. Conversely, some researchers such as Doukas and Swizer (1992) and Sundaram et al. (1996) find an insignificant effect. When combined, the above evidence suggests that due to an asymmetry of information outside investors may not completely understand the value-adding characteristic of R&D.

More to the point, if a significant asymmetric information problem exists in intangible R&D investment, then firms with main bank relationships may help reduce this uncertainty and convey a positive signal. If this logic is correct, then firms with main bank relationship facing high R&D investment should provide more credible information for investors to accurately evaluate firm value than those without it. In turn, this superior level of information should be reflected in firm value. Additionally, this signal is expected to be stronger when the asymmetric information problem is more serious between managers and investors.

Another point that makes our paper valuable is due to the impact of R&D investment on performance is long-term. This characteristic happens to match the Japanese sample with main bank system which dominates almost 71% of outstanding shares (Sheard, 1994). This concentrated and stable ownership structure promotes efficient monitoring and long-term performance without needing to worry about the short-term pressures. Hence, using Japanese data including main bank system in exploring R&D issue may have less conflict between manager and creditors comparing with highly individual ownership market (Aoki, 1990).

Traditionally in Japan, banks normally maintain multidimensional ties with their clients, such as security, insurance, or banking services. This approach of banking has come to be commonly known as *Keiretsu* (or main bank) style of banking. From a positive view point, a main bank gathers proprietary information through the financing process. This inside information (and hence the quality of the firm) is then signaled to the market by way of a financing decision. Specifically, if the main bank is willing to continue financing, a signal of firm quality is conveyed to outside investors. It is through this mechanism that affiliation with main banks creates value. Moreover, due to lower agency cost induced by significant equity holdings of main banks, a higher level of performance is expected. From a negative point of view, some high-tech intensive firms may not prefer to interact with a main bank because of the potential main bank activity may inadvertently reveals a firm's prospects to its competitors. Additionally, in the case of financial distress, managers may expect the main bank to solve their financial shortcomings leading to the moral hazard problem of managers that increase the propensity for bankruptcy. Therefore, main bank relationship may exacerbate firm problems and reduce their performance. Extant literature has not revealed a consistent finding regarding whether main banks help increase or decrease firm value. Given that main banks serve simultaneously as the internal governance (board) and external monitoring (principal creditor), more research designed to clarify the relationship between main banks and their influence on firms values is warranted.

Our paper differs from the existing literature in a number of ways. First, we use Quantile regression instead of conventional OLS to add additional evidence that helps explain the empirical puzzle concerning the effects of R&D expenditure, leverage and main bank relationships on firms' value. Since there were a great deal of bubble internet stocks in the high-tech industry during 1990s in Japan, the average Tobin's Q would be overestimated by using conventional OLS. To avoid this upward bias resulting from including extremely high Tobin's Q firms, a more realistic view may be gained by using lower quantiles as the target point. Our data from 1994 to 2004 covers the whole internet evolution period illustrating again the advantage of using quantile approach. Second, we include the presence of main bank relationships into a model of firm value in order to capture the impact of this relationship and its ability to reduce asymmetric information and enhance firm value. Third, besides the independent effects of R&D and main bank, we examine all the interaction effects of R&D with leverage and with main bank relationship on firm value. Extant literature treats these characteristics as independent effects, thus failing to test for possible interaction effects of these variables. Fourth, industry dummies are being controlled for in order to avoid any biases resulting from industry characteristics. Fifth, our data set is unique in that we are able to merge a number of sources of data (such as COMPUSTAT Global and Emerging Markets database and PACAP database) allowing for a through examination by way of quantile estimators of the impact of *Keiretsu* style banking on firm value.

We find that R&D investment, financial leverage, and *Keiretsu* style main banking all have quantile effects. The impact of R&D investment, financial leverage, and *Keiretsu* style banking on firm value varies with the various Tobin's Q quantile of the firms rather than firm size as suggested by Acs and Isberg (1996). These results are robust after controlling for industry type. Additional findings include, but are not limited to: (a) Firms' advantages with high (low) R&D investment over low (high) R&D monotonically increase with firm value for high (low) Q firms; (b) Tobin's Q is monotonically increasing (decreasing) with leverage for low (high) Q firms; (c) for low Q firms, R&D investment and leverage compliment each other to create value; for high Q firms, R&D investment and leverage substitute each other ; (d) main bank relationships play a significant role in adding value only for low to median Q firms whereas, in contrast, the main bank effect turns out to be negative with firms staying at extremely high Q; (e) finally, we find that R&D efforts from the industry itself do not have a systematic positive or negative impact on firms' value. Instead, most of the firms in higher quantiles gain from industry effects while lower quantile firms suffer negative effects.

The paper is organized as follows. A review of the extant literature is provided in Section II. Section III presents the data and Sample. Section IV reports the methodology and results, Section V concludes.

2. Literature Review

The effect of R&D investments on Tobin's Q and the relationship between R&D investments and debt financing is explored in numerous studies (Szewezyk et al., 1996; Zantout, 1997; Vincente-Lorente, 2001; O'Brien, 2003). However, their findings are inconsistent. Some findings document that debt has a positive impact on R&D investment; others document a negative effect, while still others find no effect at all. These inconsistencies are not surprising. From one point, debt can act as a positive influence on managerial behavior by motivating managers to invest in projects with positive net present value. Thus R&D investments undertaken in a high debt ratio regime are expected to positively enhance value. This helps explain why the relationships between stock returns and R&D investments announcements is positive only in firms with relatively high debt ratio (Zantout and Tsetsekos, 1994).

From another point, R&D investments have been viewed as high risk and intangible so that managers may not be interested in firms with higher debt ratios. In such cases, underinvestment (or asset substitution) may occur more easily than other physical investments leading to negative impacts reflected in debt ratios. Hence, Bhagat and Welch (1995) suggest a negative relationship between R&D investments (witnessed through debt ratios) and firm value -- Bradley, Jarrel, and Kim (1984) and Long and Malitz (1985) originally link leverage and R&D expenditures. Thereby, high-leverage firms are supposed to invest less in R&D than other physical assets. Acs and Isberg (1996) address the additional issue of growth opportunities finding financial leverage's and R&D investment's influence on growth opportunities depends on firm size and the industry structures.

As we know, agency cost and information asymmetry problems are likely to negatively influence the benefits of a highly-leveraged firm from its R&D investments. Daniel and Titman (2006) suggest asymmetric information reduces the attractiveness of R&D projects to outside investors (debt holders) with managers keeping "know-how" for competitive reasons. This problem renders debt financing of R&D projects more expensive and less preferred. Daniel and Titman (2006) document stock returns are positively related to price-scaled variables such as the book-to-market ratio (BM) and suggest the book-to-market ratio can forecasts stock returns because it is a good proxy for the intangible return. Daniel and Titman (2006) provide an argument for why high book-to-market value firms realize high future returns and find that future returns are unrelated to the accounting measures of past performance (tangible information), but are negatively related to future performance (intangible information). Among different types of intangible information, R&D is the most crucial when it comes assessing future performance. We measure firms' future performance by Tobin's Q ratio as reported in the extant studies (Lang et al., 1989, 1991; Doukas, 1995; Szewczyk et al., 1996 etc.) [2] Chan et al. (1990) and Zantout and Tsetskos (1994) conclusions suggest that R&D investment by firms with promising growth opportunities are basically worthy of inclusion into any model of firm value.

Due to the potential uncertainty caused by the presence of an asymmetry of information between firms and investors and the unobservable nature of management, R&D is likely to be discounted in high-leverage firms. Said another way, asymmetric

[2] The theoretical Tobin's Q is the ratio of the market value to the replacement cost of the assets. Because some data is not available, it has been often estimated by a simple measure of Q (the 'pseudo Q): market value to book value of the total assets.

information problems and agency costs may render debt financing of R&D investments more expensive than other options. Support for this argument is found in Bhagat and Welch (1995), which find a negative relationship between debt ratios and R&D investments on firm value; and Kamien and Schwartz (1982), which find that investors value a firm's investments in R&D when they use their own funds.

In addition to asymmetric information and agency, transaction cost economics may explain part of the evidence about the types of investments made by managers. Williamson (1988) points out that the choice of project financing depends on the characteristics of the assets. Titman and Wessels (1988) also postulate that "debt level is negatively related to the uniqueness of a firm's line of business". Therefore, firms with higher degrees of firm-specific assets are found to have less debt (Williamson, 1988; Balakrishnan and fox, 1993; Vincente-Lorente, 2001; O' Brien, 2003).

3. Data and Sample

3.1 Data Source and Sample Selection

To construct the sample for the proposed study, two different databanks are employed: (a) COMPUSTAT Global and Emerging Markets database and (b) PACAP (Pacific-Basin Capital Markets) database. The financial data for Japanese listed companies is obtained from PACAP database. Starting with an original sample of 3,499 non-financial firms listed on the Tokyo Stock Exchange and after eliminating the firms with reported data that are not creditable, an effective sample of 40,575 year-firm observations is derived from an original sample of 41,470 observations.[3] [4]

[3] The financial firms were excluded from the overall sample as the financial firms exhibit different balance sheet items from those of the non-financial firms.
[4] For example, some firms are characterized by negative debt or negative sales without proper

The sample is next classified into eight industries based on industry classifications as proposed by the Chan, Lakonishok, and Sougiannis (2001). Specifically, our samples is comprised of transportation (SIC=37), communications (SIC=48), electronic equipments (SIC=36), measuring instruments (SIC=38), computer and office equipment (SIC=357), drugs and pharmaceuticals (SIC=283), and computer programming and software (SIC=737) firm-year observations. Table 1 presents some summary statistics of the final sample. The drug and pharmaceutical industry shows the highest R&D inputs (10%) with the lowest leverage (0.38), followed by the measuring instruments, computers, and office equipment sectors. Communication shows the highest Tobin's Q, followed by the computer programming. Additional data, such as firm R&D, is taken from the *Toyo Keizai's Tokei Geppo Statistics Monthly*.

3.2 *Keiretsu* Style Main Bank

The *Keiretsu* data comes from *Industrial Groupings in Japan*[5]. This handbook provides the data for each company belonging to specific *Keiretsu* and its relationship strength with the *Keiretsu*. The relative relationship levels between a company and its *Keiretsu* is further defined from this data allowing for additional analysis of *Keiretsu* efficacy.

Our analysis of main bank is operationally defined as each firm's top bank on its trading bank list in *Kaisya Shikiho (the Japan Company Handbook*). Hence, a firm's main bank is its largest lender as well as the top shareholder among banks with the firm. In addition, the share of stable shareholders will be measured by calculating the

---

explanations in footnotes.

[5] There are six commonly recognized horizontal *keiretsu*: Mitsubishi, Mitsui, Sumitomo, Fuji, Sanwa, and Dai-Ichi-Kangyo. Estimates place 89 of the 200 largest Japanese firms as having strong ties with one of several keiretsu groups (Hoshi et al., 1991).

share of financial institutions plus the share of non-financial institutions minus the share of trust banks. This data is collected from *Toyo Keizai's Kigyou Keiretsu Soran* (*the Japanese Keiretsu Handbook).* Industrial Groupings in Japan provides information about the amount of loans provided by each bank for *Keiretsu* members. Finally, data and names of lenders are obtained from the J*apan Company Handbook*. The handbook discloses the major sources of funding for each Japanese listed company. The names of principal banks were obtained from the reference list.

3.3. Empirical Model

3.3.1 Quantile Model

Our quantile model is specified as equation (1):

$$\begin{aligned} TobinsQ_{it} &= \beta_0 + \beta_1 RD\_TA_{it} + \beta_2 LEV_{it} + \beta_3 MB\_D_{it} + \beta_4 LOG\_TA_{it} + \beta_{5it} CAPEX\_TA \\ &+ \beta_6 CF\_TA_{it} + \beta_7 EBIT\_VOLA_{it} + \beta_8 DIV\_TA_{it} + \beta_9 LEV * RD\_TA_{it} \\ &+ \beta_{10} MB * RD\_TA + \beta_{11} - \beta_{17} INDUSTRY_{it}\_D_{1-7} + \varepsilon_{it} \end{aligned} \quad (1)$$

The definition of each variable is in footnote 6.[6]

We measure firm performance by Tobin's Q as in prior studies (Lang et al., 1989; Howe et al., 1992; Doukas, 1995; Szewczyk et al, 1996 etc.) Following Chan, Martin, and Kensinger (1990), R&D intensity is measured by R&D expenditure divided by total assets. Firm size is included because large firms may be more successful in developing new technology (Chauvin and Hirschey, 1993) resulting in different Q scores. We also control for free cash flow to explain cross sectional differences

---

[6] *Tobin's Q* is the market-to-book ratio of (the book value of total assets minus the book value of equity plus the market value of equity) to the book value of total assets; *SIZE* is firm size measured by the logarithm of the market value of assets, where the market value of assets is the sum of the market value of equity plus the book value of debt; *AGE* is the number of years since the firm was first incorporated; *LEV* is the leverage ratio of total liabilities divided by total assets; *CAPEX_TA* is the capital expenditure ratio, which is capital expenditure divided by total assets; *RD_TA* is the R&D expenditure ratio, which is research and development expenditure divided by the total assets of the firm; *CF_TA* is cash flow ratio measured by cash flow divided by total assets; *DIV_TA* is dividend ratio, measured by total cash dividends divided by total assets; MB_D is the *Keiretsu* style main bank dummies and INDUSTRY_D is the industries dummies.

among firms. R&D investment for low-free-cash-flow firms increases the probability of these firms seeking external financing. Leverage ratio and dividend yields are included as alternative measures of free cash flow (Jensen, 1986) and investment opportunity (Smith and Watts, 1992), respectively. Gugler (2003) finds an inverse relationship between payout ratios and R&D investments. Therefore, we hypothesize that financial leverage may play an ambiguous role in influencing a firm's benefits from R&D investments as a result of the interaction between the positive effects of its disciplinary role and the negative impact stemming from asymmetric information problems. The main bank dummy variables measure the impacts of bank monitoring on managers (Jensen and Meckling, 1976) and information signaling (Leland Pyle, 1977). Interaction effects of main bank and R&D expenditure are also included. The details about how to measure the main bank is discussed in details in the next section. Earnings growth volatility, as a proxy for controlling observable credit risk (Johnson, 1997) is also controlled for in the model

Thus, firms with *Keiretsu* style main bank relationships are expected to have lesser issues with asymmetric information and benefit from stronger monitoring efficiency resulting in lower costs. Furthermore, firms with main bank relationships are less sensitive to cash flow problems thus avoiding any risk premium associated with capital rationing. Therefore, ceteris paribus, R&D funding should be able to be acquired from main banks without any discounts for agency, capital rationing, and asymmetric information problems, resulting in superior Q scores.

4. Empirical Results

4.1 Sample Description[7]

The average and median summary statistics for the full sample are reported in Table 1. Table 1 reveals that the average RD_TA in Japan is 2.0%, a little higher than firms in the U.S. with average scores of 1.2% (Chan et al., 1990). However, these averages are both far below current levels of American firms of 10.2-16% (Ho et al., 2006; Cui and Mak, 2002). Figure 1 (a) also shows that the time trend of average RD_TA rose from 1.915% in 1994 to 2.003% in 2004, an increase of only 0.105%. In the full sample, the median of RD_TA is 0.00, meaning the distribution of RD_TA is dominated by firms with higher RD_TA. The median of RD_TA is 0.13% in 1994 and 0.11% in 2004, a surprising decrease of 0.02%, implying the sample is gradually dominated by lower RD_TA firms. Both sources of information reveals there is no significantly increasing R&D investment in Japan during our sample period. The average Tobin's Q of Japanese listed firms is as high as 8.012. This finding may be attributable to the Asian Financial Crisis during 1997-98 with the economy bubbling and the dramatic volatility of high tech stocks in 1999. This value is notably higher than the average value o f 2.89 in America (Cui and Mak, 2002). Figure 1 (b) shows the time trend of average Tobin's Q rose from 10 in 1994 to 66 in 2004, an increase of six times of the value in 1994.[8] Leverage on average shows an extreme high of 59.6% comparing with firms in America of 15.8- 25% (Ho et al., 2006 and Johnson, 1997), implying Japanese firms tend to use heavy financial leverage. Furthermore, among these leverages, the long-term debt ratio is only 11.6% which is lower than those of

[7] To avoid the bias from extremely value, we drop the sample less than 1% and larger than 99%.
[8] The time trend includes all sample without deleting the outliers, the summary statistics in Table 1 uses the sample being deleting Q of less than 1% or larger than 99%.

USA firms of 18% (Aivazian et al., 2005), revealing another unhealthy debt structure, especially since most of the leverages are short-term debts. Figure 1 (c) shows the time trend of average LEV falls from 61.4% in 1994 to 53.8% in 2004. *Keiretsu* style main bank ratio (MB_D) is only 19.5%, meaning only one fifth of listed firms are affiliated with *Keiretsu* style banking.

Average log size (LOG_TA) is 4.3, lower than American firms of 17.89 (Cui and Mak, 2002), indicating smaller capitalization when compared to U.S. firms. The Capital expenditure rate on average is 1.5%, a little lower than American firms. The Net cash flow ratio, on average, is 1.224% with a wide range and bigger variance, implying a larger deviation among the listed firms. Earnings volatility (EBIT_VOL) is 5.309%, similar to American firms of 4.79% (Jonhson, 1998). Dividend payout ratio (DIV_TA) on average is only 0.5%, which is low when compared to U.S. firms (Johnson, 1998).

4.2 Quantile Regression and Bootstrapping Analysis

Quantile regression is originally proposed by Koenker and Bassett (1978). The general form of equation is $y_i = \beta_q^{'} x_i + u_{qi}$. This equation implies that the coefficients differ by quantile. Mean-based procedures such as ordinary least squares are more sensitive to outliers than median-based quantile estimators. The quantile estimator places less weight on outliers than do OLS estimators. Therefore, the bias should be smaller using a median-based quantile estimator.

The target for quantile regression estimates is a parameter specified before estimation. Letting e_{it} be the residuals and q representing the target quantile from the distribution of the residuals. Quantile parameter estimates are the coefficients that minimize the following objective function in equation (2):

$$\sum_{eit>0} 2q \mid e_{it} \mid + \sum_{eit<=0} 2(1-q) \mid e_{it} \mid \quad (2)$$

If q = 0.5, equal weighting is given to positive and negative residuals, and the parameters are estimated to minimize the sum of absolute errors. Depending on the quantile varying weights are assigned to the residuals to lessen the impact of outliers. This result differs from ordinary least squares where the only constraint on the residuals is that their sum equals zero. Thus this methodology is often employed to further investigate the differing relationships, if any, among varying quantiles. More specifically, our model's coefficients in 10%, 25%, 50%, 75% and 90% quantiles are estimated. The results of a set of boot-strapping experiments are presented in the next section.

4.3 Results and Analysis of Quantile Regression

Our quantile regression estimates are based on 20 replications of a boot-strapping algorithm at target quantiles of q= .05, .25, .50, .75 and .95. Table 2 reports the results of quantile regression and conventional OLS. The OLS results in models (1) and (2) show that neither R&D investment (RD_TA) nor leverage (LEV) or main bank relationships (GP_D0) significantly affect a firm's Tobin's Q. However, the results in quantile models (3) – (7) reveals that R&D investment, leverage, main bank relationships all have significant quantile effects on Q scores. We find that for firms with higher quantiles (q=.50 -- .95), RD_TA is monotonically increasing with firm value (positive coefficients of 20.53, 110.3, and 579.4 at q= .50, .75, and .95, respectively). However, for lower quantile firms (q=.05- .25), R&D investment is monotonically decreasing in Tobin's Q and destroys firm value (negative coefficient values of -.000003 and -.712 at q=.05 and .25, respectively). The use of leverage (LEV) exhibits the opposite signs as R&D across various quantiles. LEV is monotonically decreasing with firm value for high Q firms (with coefficients of -2.507, -5.874 and -12.30 at q=.50, .75, and .95, respectively) and creates firm value for low Q firms (q=.05 -- .25). This result may be explained by optimal capital structure theory.

The interaction effect of R&D investment and leverage (LR_RDTA) is significantly negative for high quantiles firms, and positive for low quantiles firms, suggesting that leverage and R&D substitute each other in high Q firms; but compliment each other in low Q firms. Main bank effect (GP_D0) significantly add value for lower quantiles firms (q=.05- .25), positively influence firm values at q=.50, and begin to destroy value in higher quantiles (q=.75). Thus, main bank relationships help reduce asymmetric information and create value for firms with relatively lower Q scores. The interaction effect of R&D investment and main bank effect (GP_RDTA) is increasing with firm value for firms in the medium range of quantiles (q=.25- .50), implying that main bank relationships may contribute value with increasing R&D investment for firms with median Q. However, in the presence of main bank relationships and extremely low or high quantile (q=.05 or q=.95), firm value is destroyed with increasing R&D investment. This is also reasonable, for firms with an extremely high Q, the sensitivity of R&D on firm value should be extremely high as well. Therefore, information leakage costs (or conflict costs) between banks and stockholders from R&D expenditure may outweight the benefit of the main bank relationship.

LOG_TA has significantly positive impact for lower quantile firms (q=.05- .50); but significantly negative effects for higher quantiles firms (q=.75- .95), meaning the size effect is positive in low Q firms but negative in high Q firms. This finding is different from most of the extant literature, which documents a negative relationship by way of the more traditional OLS approach. Capital expenditure (CAPEX_TA) positively influences Tobin's Q in higher quantiles but is insignificant in lower quantiles. Higher dividend payout (DIV_TA) adds value for high quantiles firms (q=.50- .95) but destroys value in lower quantile firms (q=.25). Finally, Table 2 models (3)-(7) show the true intercept is higher at higher quantiles because errors are positive on average at q=0.5, 0.75 and 0.95. The graph of quantile effects of all variables on firms' Tobin's Q are also exhibited in Figure 2.

4.4 Analysis of Industries Quantile Effects

Table 2 shows that industries (IND_D1-D7) do have quantile effects. The coefficients of IND_D1-D7 show that most of the industry effects turn from negative for firms in lower quantiles of Q to positive for firms in higher quantiles, implying the impact of industry effects on firm value depends on a particular firm's quantile membership rather than the industry itself. High Q firms have stronger momentum in generating higher Q scores regardless of industry type. This finding is different from Acs and Isberg (1996) that documents the impact of R&D on growth opportunity depends on industry type. We formally document that industry quantile effect is larger than the industry effect itself.

5. Conclusion and Discussion

The quantile approach has advantages over conventional mean-based approach in estimating the effects of R&D, leverage, and main bank relationship on Tobin's Q. The targeting quantiles from middle of the error distribution can reduce the outlier bias and improve the sample description based on targeted quantiles. Our results in quantile models (3) – (7) show RD_TA, LEV, and GP_D0 all have significant quantile effects on a firm's Tobin's Q.

When taken as a whole, our results also have implications for understanding the effects of *Keiretsu* style banking or industry characteristics on borrowers within the economy. First, recent studies find that the impact of R&D investment on firm performance depends on industry characteristics (see e.g., Ho et al, 2006) and size (Acs and Isberg, 1996). Our findings that systematic (or consistent industry) effects do not always exist, most of the firms in our study gain from industry effects while in higher quantile Q, provides policy guidance for governments in their attempts to stimulate R&D. Second, our finding that the presence of main banking relationships do not always lead to higher Q scores suggest a segmented role for *Keiretsu* style banking and helps explain why only 20% of the sample firms actually participate in this type of banking. Additionally, the impact of main bank on firm performance depends on firm's performance itself rather than main bank itself.

References

Acs, Z. J., and S. C. Isberg, 1991, Innovation, firm size and corporate finance: An initial inquiry, *Economic Letters* 35, 3, 323-326.

Aoki, M,, 1990, Toward an economic model of the Japanese firm, *Journal of Economic Literature* 8, 1 –27.

Acs, Z. J., and S. C. Isberg, 1996, Capital structure, asset specificity and firm size: A transaction cost analysis, ed. in Behavior norms, technological progress, and economic dynamics: Studies in Schumpeterian economics, ed. by E. Helmstadter and M. Pertman, University of Michigan Press.

Balakrishnan, S., and I. Fox, 1993, Asset specificity, firm heterogeneity and capital structure, *Strategic Management Journal* 14, 1, 3-16.

Bhagat, S. and I. Welch, 1995, Corporate research and development investment: International comparisons, *Journal of Accounting and Economics* 19, 2-3, 443-70.

Chan, S.H., J. Martin, and J. Kensinger, 1990, Corporate Research and Development Expenditures and Share Value, *Journal of Financial Economics*, (Aug), 255-276.

Daniel, K., and S. Titman, 2006, Market reactions to tangible and intangible information, *Journal of Finance* 61, 4, 1605-1643.

Doukas, J., 1995, Overinvestment, tobin's q and gains from foreign acquisitions, *Journal of Banking and Finance* 19, 7, 1285-1303.

Gugler, K., 2003, Corporate governance, dividend payout policy, and the interrelation between dividends, R&D, and capital Investment, *Journal of Banking & Finance,* 27, 1297–1321.

Jensen, M., 1986, Agency costs of free cash flow, corporate finance and takeovers, *American Economic Review*, 323-329.

Johnson, S. A., 1997, An Empirical Analysis of the Determinants of Corporate Debt Ownership Structure, *Journal of Financial and Quantitative Analysis,* 32, 1, 47-69.

Kamien, M. I., and N. L. Schwartz, 1982, Market structure and innovation, New York:

Cambridge University Press.

Kee, Y., YH Ho, and M. Tjahjapranata, and C.M. CY Yap, 2006, Size, Leverage, Concentration, and R&D Investment in Generating Growth Opportunities, *Journal of Business* 79, 2, 851-876.

Koenker, R. and G. Bassett, 1978, Regression Quantiles, *Econometrica* 46, 33-50.

Koenker, R. and K. Hallock, 2001, Quantile Regression, *Journal of Economic Perspectives* 15, 143-156.

Lang, L., R. Stulz, and R. Walking, 1989, Managerial Performance, Tobin's q, and the Gains from Successful Tender Offers, *Journal of Financial Economics*, 137-154.

Lang, L., R. Stulz, and R. Walking, 1991, A test of the free cash flow hypothesis: The case of bidder returns, Journal of Financial Economics 29, 315-335.

Long, M., and Malitz L, 1985, The investment-financing nexus: some empirical evidence from UK, *Midland Corporate Finance Journal*, 234-257.

O'Brien, J., 2003, The capital structure implications of pursuing a strategy of innovation, *Strategic Management Journ*al 24, 5, 415-31.

Sheard, P., 1994, Interlocking shareholdings and corporate governance. In: Aoki M, Dore M, editors. The Japanese firm: the sources of competitive strength. Oxford: University Press, 310–49.

Szewczyk, S. H., G. P. Tsetsekos, and Z. Zantout, 1996, The valuation of corporate R&D expenditures: Evidence from investment opportunities and free cash flow, *Financial Management* 25, 1, 105-10.

Titman, S., and R. Wessels, 1988, The determinants of capital structure choice, *Journal of Finance* 43, 1, 1-19.

Vincete-Lorente, J. D., 2001, Specificity and opacity as resource-based determinants of capital structure: Evidence for Spanish manufacturing firms, *Strategic Management Journal* 22, 2, 57-77.

Williamson, O., 1988, Corporate finance and corporate government, *Journal of Fiance* 43, 3, 567-91.

Woolridge, J.R., 1988, Competitive Decline and Corporate Restructuring: Is a Myopic Stock Market to Blame? *Journal of Applied Corporate Finance*, 26-36.

Zantout, Z. Z., 1997, A test of the debt-monitoring hpothesis: The case of corporate R&D expenditures, *Financial Review* 32, 1, 21-48.

Zantout, Z. and G. Tsetsekos, 1994, The wealth effects of Announcements of R&D Expenditure Increase, *Journal of Financial Research*, 205-216.

Table 1 Descriptive Statistics and Industry Distribution

For sample period from 1994 to 2004, Panel A presents the basic statistics and all firms classified into industries based on SIC codes (Panel B). $TobinQ_t$ is the sum of market value of firms' equity and book value of total liabilities divided by total assets; RD_TA is R&D expenditure divided by total assets; $RD\_S_{i,t}$ is R&D expenditure divided by sales; LEV is total debt divided by total assets; MB_D is the *Keiretsu* style main bank relationship which is given a 1 or 0; $LOG\_TA_{i,t}$ is the log of firm's total assets; CAPEX_TA is capital expenditure divided by total assets; CF_TA is the ratio of net cash flow to total assets; EBIT_VOLA he volatility of earnings before interest and taxes, is the standard deviation of first differences of earnings before interest and tax (EBIT) divided by total assets; DIV_TA is the cash dividend payout ratio. $Industry\_D_{i,t}$ is dummy variable of industries, Ind_D1 denotes transportation equipment, Ind_D2 denotes communications industry, Ind_D3 denotes electrical equipment excluding computers, Ind_D4 denotes measuring instruments, Ind_D5 denotes computers and office equipment, Ind_D6 denotes drugs and pharmaceuticals industries, Ind_D7 denotes computer programming, software, and services industries, Ind_D8 denotes the others industries.

Panel A: Full Sample

Variable	Obs	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
TobinQ	35990	8.012	49.931	0.140	899.830	12.376	170.184
RD_TA	16352	0.020	0.023	0.000	0.245	2.677	14.699
LEV	35990	0.596	0.243	0.010	12.693	2.544	76.526
MB_D	35990	0.195	0.396	0.000	1.000	1.545	3.388
LOG_TA	35990	4.306	0.686	0.477	6.197	-0.597	3.843
CAPEX_TA	32983	0.015	0.071	-1727.963	2.707	6.672	111.638
CF_TA	35364	1.224	101.776	-1241.993	14036.360	109.505	14029.470
EBIT_VOLA	24561	5.309	197.581	0.002	21357.830	102.804	10984.180
DIV_TA	35990	0.005	0.007	-0.007	0.289	8.527	199.591

Panel B: Selected Industries

Industry	SIC	Obs	TobinQ	RD_S	LEV
Transportation equipment	37	1146	5.80	0.01	0.61
Communications	48	192	520.91	0.01	0.52
Electrical equipment	36	2384	25.33	0.03	0.54
Measuring instruments	38	771	14.11	0.04	0.53
Computers and office	357	345	67.00	0.04	0.51
Drugs and pharmaceuticals	283	503	28.04	0.10	0.38
Computer programming,	737	1348	165.60	0.02	0.41
Others	-	29948	28.46	0.01	0.60

Table 2 Results of OLS and Quantile Regression

This table presents the OLS and quantile results from 1994 to 2004. Dependent variable is Tobin's Q which is measured by the sum of market value of firms' equity and book value of total liabilities divided by total assets; RD_TA is R&D expenditure divided by total assets; $RD\_S_{i,t}$ is R&D expenditure divided by sales; LEV is total debt divided by total assets; MB_D is the *Keiretsu* style main bank relationship which is given a 1 or 0; $LOG\_TA_{i,t}$ is the log of firm's total assets; CAPEX_TA is capital expenditure divided by total assets; CF_TA is the ratio of net cash flow to total assets; EBIT_VOLA he volatility of earnings before interest and taxes, is the standard deviation of first differences of earnings before interest and tax (EBIT) divided by total assets; DIV_TA is the cash dividend payout ratio.

COEFFICIENT	(1) OLS	(2) OLS	(3) q5	(4) q25	(5) q50	(6) q75	(7) q95
RD_TA	437.7	1128	-0.0000326	-0.712	20.53***	110.3***	579.4***
	(4635)	(4838)	(0.00023)	(0.68)	(6.60)	(40.2)	(210)
LEV	-209.3	-66.43	1.000***	0.680***	-2.507***	-5.874***	-12.30***
	(258)	(261)	(0.000016)	(0.10)	(0.19)	(0.42)	(3.14)
MB_D	-53.36	-29.86	0.0000247***	0.0993***	0.0456	-0.0264	0.658
	(143)	(144)	(0.0000051)	(0.024)	(0.036)	(0.074)	(0.58)
LOG_TA	-39.95	-22.60	0.0000297***	0.176***	0.131***	-0.104***	-3.379***
	(66.7)	(67.2)	(0.0000098)	(0.024)	(0.021)	(0.033)	(0.72)
CAPEX_TA	0.165	0.174	0.000115	-0.000707*	-0.000771	0.000394	0.0131
	(2.25)	(2.25)	(0.000080)	(0.00036)	(0.00054)	(0.00080)	(0.018)
CF_TA	0.161	0.108	-0.000208	-0.000515	-0.00139*	-0.00108	0.00171
	(1.76)	(1.76)	(0.00020)	(0.00048)	(0.00072)	(0.00084)	(0.0092)
EBIT_VOLA	0.00306	-0.00154	-0.00000236**	-0.00000717	0.0000542	0.000227	0.000269
	(0.17)	(0.17)	(0.0000012)	(0.000022)	(0.00014)	(0.00023)	(0.0024)
DIV_TA	9495	9151	0.000297	-1.025**	17.51***	24.94*	357.1*
	(8057)	(8078)	(0.00052)	(0.51)	(6.53)	(12.8)	(186)
LEV_RDTA	2532	-247.6	0.000310	2.339*	-27.86***	-142.6***	-681.0**
	(8552)	(8740)	(0.00039)	(1.38)	(8.53)	(35.4)	(321)
MB_RDTA	-2843	-2656	-0.000656***	14.14***	10.07***	1.750	-83.83
	(5101)	(5129)	(0.00022)	(1.09)	(1.80)	(6.28)	(74.3)
IND_D1		-29.00	-0.00000420	0.000875	0.0640	0.0783	-2.237***
		(201)	(0.000012)	(0.052)	(0.064)	(0.85)	(0.47)
IND_D2		433.3	-0.00000546	0.0776	9.146	1055***	2475***
		(526)	(0.000017)	(0.88)	(23.3)	(368)	(665)
IND_D3		360.4**	0.0000107***	-0.0501***	0.181***	0.988	9.220*
		(147)	(0.0000032)	(0.019)	(0.058)	(0.86)	(5.30)
IND_D4		-28.72	-0.00000597	-0.0141	0.150	-0.0570	10.17
		(235)	(0.0000045)	(0.031)	(0.11)	(1.04)	(8.44)
IND_D5		35.58	-0.0000138***	-0.0525	0.558**	0.675	137.4
		(344)	(0.0000051)	(0.039)	(0.22)	(1.18)	(565)
IND_D6		-80.36	-0.00000369	0.936***	1.207***	2.617	-2.220
		(297)	(0.0000060)	(0.16)	(0.27)	(2.16)	(2.48)
IND_D7		650.8***	-0.00000724	-0.0973***	-1.177***	1.746**	616.2***
		(201)	(0.0000079)	(0.029)	(0.17)	(0.69)	(181)
Constant	351.6	129.1	-0.000113***	-0.473***	2.670***	7.155***	31.47***
	(344)	(351)	(0.000036)	(0.049)	(0.17)	(0.39)	(3.95)
Observations	13674	13674	13674	13674	13674	13674	13674
R-squared	0.001	0.001	.0.0027	0.0009 .	0.0014	0.0068.	.0.0294

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

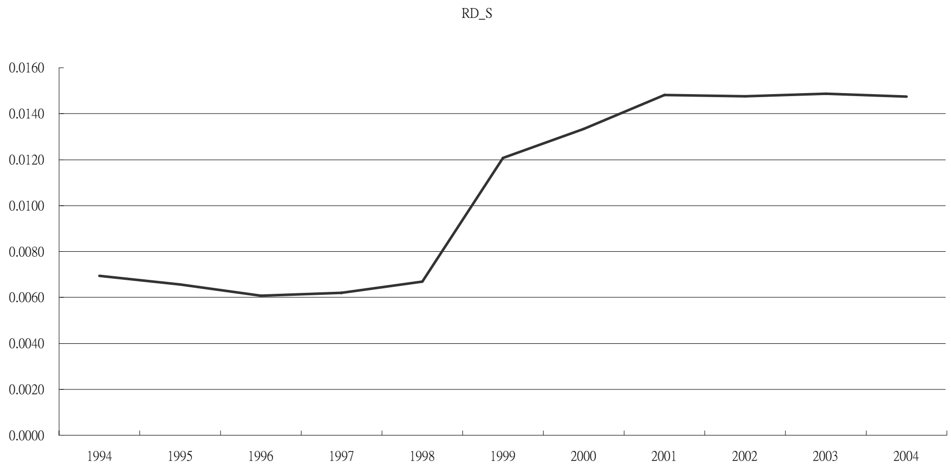

Figure 1(a) The R&D Investment Time Trend of Japanese Firms during 1994-2004

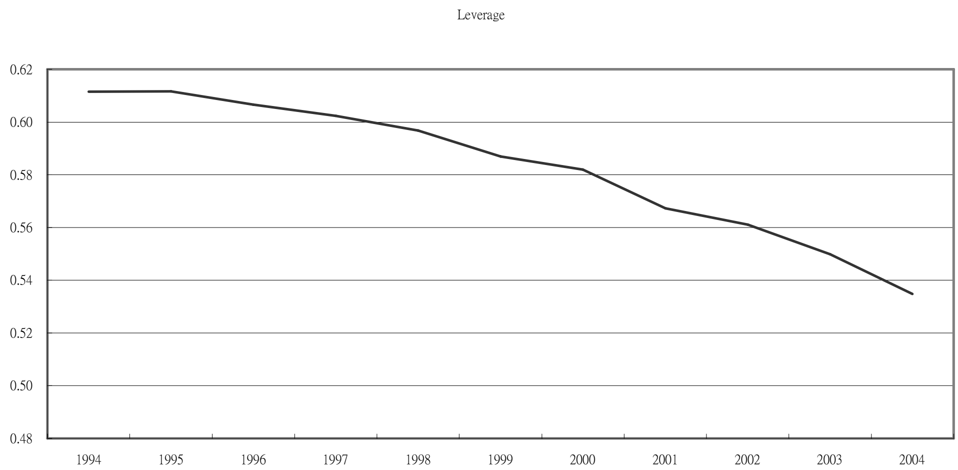

Figure 1(b) The Leverage Ratio Time Trend of Japanese Firms during 1994-2004

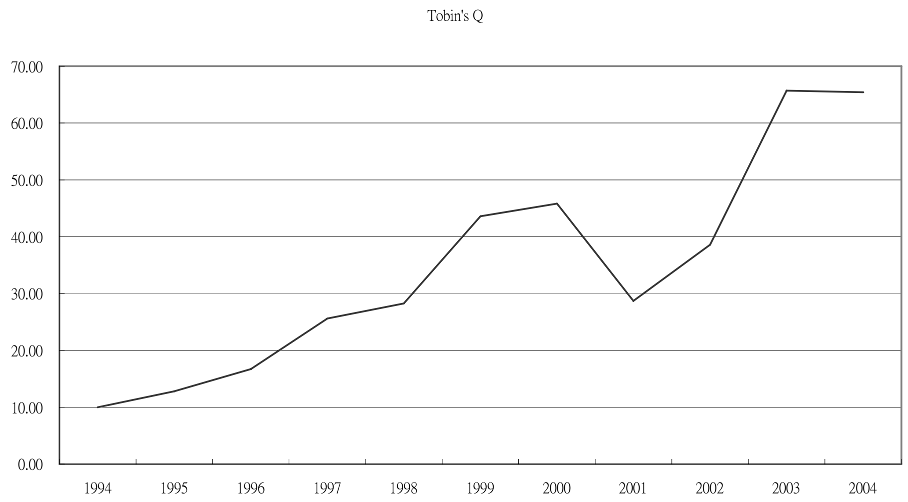

Figure 1(c) The Tobin’s Q Time Trend of Japanese Firms during 1994-2004

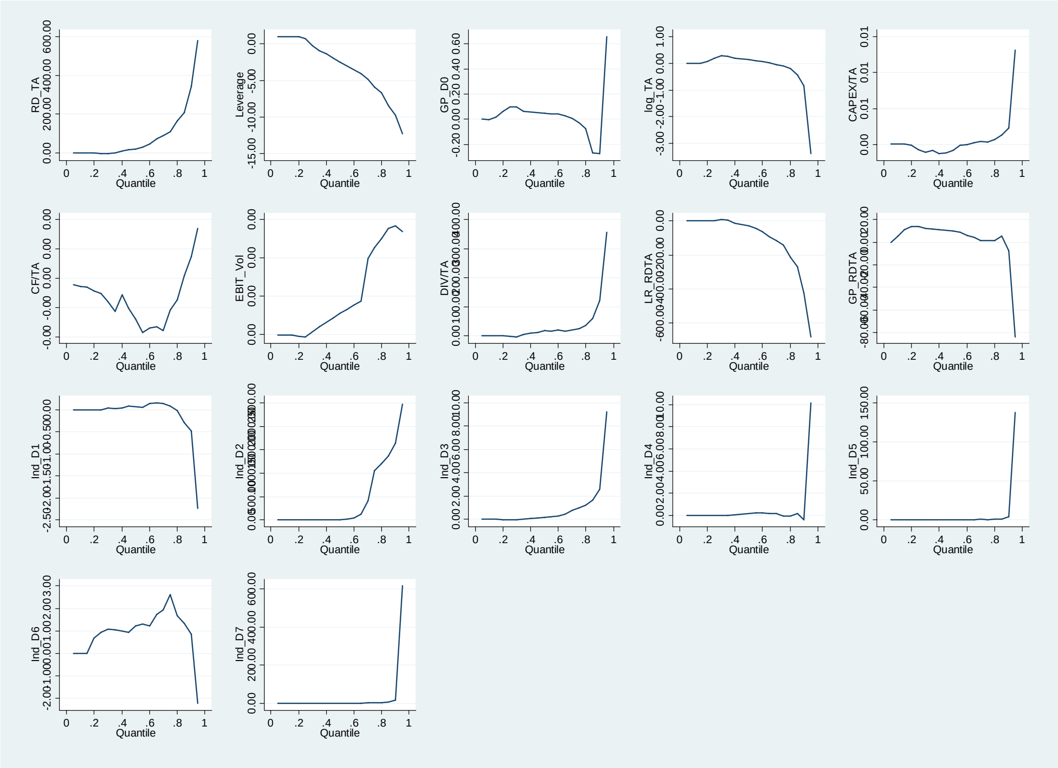

Figure 2 The Quantile effects of all variables on firms' Tobin's Q