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The Case of Unlisted Japanese Firms

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Discussion Paper 06-24

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Abstract

The literature maintains the statistical significance of cash flow in the investment equation. One criticism against the financing constraint interpretation of cash flow is that cash flow may be picking up information on the future profitability of a firm which Tobin's Q fails to capture. We confine ourselves to the investment behavior of unlisted automobile parts suppliers, and use the sales of large automobile makers as an exogenous instrument. Despite the various criticisms against the financing constraint interpretation of cash flow, our statistical evidence does not disagree with the hypothesis.

Keywords: Tobin's Q, Investment Equation, Cash Flow, Financing Constraint, Japanese Unlisted Firms

JEL classification: E22, G31

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1. Introduction

Hayashi (1982) argues that average Q is a sufficient statistic for the firm's investment opportunities under a certain set of conditions. However, many studies have found that cash flow variable is statistically significant in their investment equations. Fazzari, Hubbard and Petersen (1988) divide their samples into two groups—those firms with a higher dividend and those with a lower dividend—and find that severely financially constrained firms react more sensitively to cash flow. They also demonstrate that firms are not indifferent in their use of internal and external funds in their investment decision. Hoshi, Kashyap and Scharfstein (1991) also divide their samples into groups—those firms with main banks and those without—and estimate their respective investment equations separately. Finding that the coefficient estimate of the cash flow variable for those firms with main banks is significantly smaller than the corresponding estimate of those firms without main banks, Hoshi et al. (1991) argue that main banks mitigate the asymmetric information problem and reduce the agency cost in lending. From this viewpoint, cash flow is an important part of internal funds, and the agency cost of internal funds is lower than that of external funds. The investment behavior by firms is then sensitive to the volume of internal funds.

However, there is some criticism against the above financing constraint interpretation of cash flow variable. First, Tobin's Q, constructed using data on stock prices, may be a poor proxy for the future profitability of the firm, and cash flow variable may then pick up information of the future profitability of the firm which Tobin's Q fails to capture. See, for example, Sims (1988), and Cummins, Hassett and Oliner (2006). The latter proposes a 'real Q' rather than a Tobin's Q constructed with stock prices.

Second, if we specify that the production function of a firm is subject to exogenous technology shocks, all three variables—investment, Tobin's Q, and cash flow—become functions of technology shocks. Two difficult problems then emerge. The first is that both Tobin's Q and the cash flow variables on the right-hand side of the investment equation become endogenous and appropriate measures should be taken to deal with simultaneous equations bias. The second is that since Tobin's Q and the cash flow variables share the same information associated with technology shocks, the statistical significance of the cash flow variable does not directly imply that the firm in question is financially constrained. The statistical significance of the cash flow variable may then be simply picking up the information on technology shocks. To test whether or not the firm is financially constrained, it is therefore necessary to divide the sample into a supposedly financially constrained group of firms and a less financially constrained group of firms, estimate their respective investment equations, and test whether or not the coefficient estimates of cash flow variable are statistically different. See, Hayashi and Inoue (1991), and Hayashi (2000) for details.

To absorb the information of the future profitability of a firm, which Tobin's Q fails to capture, Fazzari et al. (1988), Hoshi et al. (1991), and others include the sales–capital ratio of a firm, in addition to Tobin's Q and the cash flow variables, in the right-hand side of the investment equation, and attempt to interpret the cash flow variable as a financing constraint. However, as Hall (1988) correctly points out, the causality between the sales of a firm and its investment is both ways and the sales–capital ratio is endogenous.

In this paper, we confine ourselves to the investment behavior of unlisted automobile parts suppliers, and propose to use a better instrument—the sales of large automobile makers—to control for the future profitability of a firm. The sales of large automakers is exogenous to auto suppliers, and adding this exogenous demand variable to the right-hand side of the investment equation makes it easier to interpret the cash flow variable as a financing constraint.

Indeed, we find that addition of the sales–capital ratio of large automakers to the right-hand side of the investment equation of suppliers makes the t-value of Tobin's Q smaller, while throughout our empirical investigation it keeps the t-value of cash flow virtually unchanged. This finding at least suggests the cash flow variable plays the role of a financing constraint in the investment equation.

The organization of the paper is as follows. In Section 2, we provide some preliminary observations on our sample, and present some intuition on the issue using our sample. In Section 3, we explain our baseline investment equation to estimate and report our statistical results. To reconfirm our results, we extend our baseline model to switching regression models and report our statistical evidence in Section 4. In Section 5, we summarize the contributions of this paper.

2. Some Casual Observations

Figure 1 shows the frequency distribution of annual data on the ratio of the amount of investment to that of cash flow for Japanese unlisted automobile parts suppliers over the period 1975 to 2004. The total number of observations is 1,260.

[Figure 1 around here]

If the ratio of the amount of investment to that of cash flow is less than one, we might roughly take it as indicating that the firm in question makes investment within the limit of internal funds. Stiglitz (1988) also points out that if the firm is facing a financing constraint, the amount of investment is expected to cluster around the financing constraint. Of course, there might be cases in reality where firms just happen to undertake investment within the limits of internal funds, not because firms face financing constraints, but because firms foresee the lack of future demand for their products. In addition, there may be other cases where firms happen to hold other liquid assets other than cash flow and use these for investment. Therefore, we need to be careful about interpreting the ratio of the amount of investment to that of cash flow. However, if the ratio of a firm is far from one, we may take it as indicating that the firm is not facing financing constraints.

Figure 1 shows that more than 60% of the sample falls within the range of 0.5 and 1.5 of the investment–cash flow ratio. This suggests that many firms may be facing some financing constraints. We now turn to the more formal analysis in the remaining sections.

3. Baseline Investment Equation

Under the assumption of perfect competition, constant returns, and capital as the only quasi-fixed factor, Hayashi (1982) finds that marginal Q equals average Q (the ratio of the market value of the firm to the replacement cost of the capital stock) and that average Q is a sufficient statistic for the firm's investment opportunities. When cash flow variable is added to the investment equation in empirical work, however, its coefficient is found to be almost always significant.

There are two competing hypotheses for this empirical finding. The first hypothesis is that cash flow captures information on the future probability of each firm which average Q fails to explain. The second hypothesis is that cash flow is a source of internal funds, and that the price of internal funds differs from external funds due to imperfections in the capital market. Cash flow then represents the degree of tightness in the financial constraints firms face.

Many studies, including Fazzari et al. (1988, 1996), Hoshi et al. (1991), added the sales–capital ratio to the investment equation to control for the future profitability of a firm. As Hall (1988) correctly points out, however, the sales–capital ratio is endogenous in the investment equation, which may introduce a simultaneous equation bias in estimation. To avoid this simultaneous equation bias, we choose a sample of unlisted companies which supply parts of automobiles to large automobile makers, and investigate whether their cash flow variable represents a true financial constraint or merely captures future profitability unexplained by Tobin's Q. We select this particular group of parts suppliers in the auto industry because the sales of large automobile makers captures information on the future profitability of parts suppliers, while the sales of large automobile makers is unaffected by the investment decisions of parts suppliers. That is, the amount of sales for large automakers is exogenous to the investment decision of parts suppliers. Our base line equation is:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \beta Q_{i,t} + \gamma \frac{CF_{i,t-1}}{K_{i,t-1}} + \delta \frac{AS_{i,t}}{AK_{i,t-1}} + u_{i,t} \tag{3.1}$$

Subscript i,t denotes firm i at time t. I , Q , CF , K denote investment, Tobin's Q, cash flow, and capital stock, respectively. (i=1,2,…,N, t=1,2,…,T). AS and AK are the sales and capital stocks of large automobile companies, respectively, to which each firm supplies its products. Equation (3.1) is standard except for the fourth term on the right-hand side.

Most authors use the stock price of each firm to construct data on Tobin's Q, but we do not. We adopt a different approach. See subsection 2 of Appendix 1 for the data construction of marginal Q.

In general, the smaller the size of the firm, the greater the probability that the firm is financially constrained ceteris paribus, because the smaller firm is more likely to have smaller assets and thus lower collateral. All of our samples consist of unlisted small firms, and so are suitable for testing whether or not firms face financial constraints. In addition, note that we cannot use stock price data, because our sample comprises unlisted firms.

We use the one-year lagged cash flow to avoid the simultaneous equation bias problem. Polk and Sapienza (2004) also employed the one-year lagged cash flow.

In the fixed effects model, we estimate the following equation:

$$\frac{I_{i,t}}{K_{i,t-1}} = \mu_i + \beta Q_{i,t} + \gamma \frac{CF_{i,t-1}}{K_{i,t-1}} + \delta \frac{AS_{i,t}}{AK_{i,t-1}} + v_i + u_{i,t} \quad , \tag{3.2}$$

where $\mu_i = E[\alpha_i | other \quad right-hand \quad side \quad \mathrm{var} iables \quad]$, and $v_i = \alpha_i - \mu_i$ are independently and identically distributed random variables with mean zero and variance σ_υ^2. v_i, and $u_{i,t}$ are assumed to be uncorrelated. We apply ordinary least squares (OLS) to equation (3.2) with N-1 individual effect dummy variables. This estimator is called the fixed effects estimator (FEE). It is well known that FEE numerically equals the within-group estimator (WGE). See, for example, Arellano (2003, pp. 14–18). We use WGE throughout the paper unless otherwise stated.[1] We call equation (3.2) our baseline equation.

As for variable (AS/AK), we consider two alternative versions ASK and $ASK2$ because of the following reasons. We use the ratio of the amount of sales of an automaker in real terms to the book value of the total tangible assets (excluding land) at the beginning of the period as a variable representing demand for the product. When an automaker is reported in "Kaisha Soukan (Unlisted Firm Version)", we simply take the AS–AK ratio of that maker. When multiple automakers are reported, we take the simple average of the ratios. Variable ASK denotes the averaged ratios. Variable $ASK2$ denotes the ratio of the single most important automaker. When we cannot identify which automaker is the single most important, we use the averaged ratios, even in variable $ASK2$.

In this industry, the relationship between parts suppliers and automakers is sometimes that of a pyramid type with three stories. The bottommost parts suppliers supply their products to the middlemost parts suppliers ("Denso" is one such middle parts supplier), and the middlemost parts suppliers in turn sell their intermediate goods to automakers (for example, "Toyota"). In such a case, we take the sales–capital ratio of automakers of final goods.

Since there are many missing data in the sample, we use an unbalanced panel estimation method. As a result, it is difficult to include time dummy variables to capture the typical booms and slumps of business cycles. However, recall that Within-Group Estimation numerically equals OLS applied to data in deviations-from-time-means. Hence, variable ASK or $ASK2$ in deviations-from-time-means picks up the information on the booms and slumps of business cycles, and plays a similar role to time dummy variables.

In the estimation, we have discarded outliers with extreme values exceeding ± five standard deviations from the mean in any component throughout the paper, to obtain robust estimates.

Table 1 reports the estimates of our baseline equation.

[Table 1 around here]

In Table 1, the comparison of column (5) with column (6) or column (7) shows that the t-values of cash flow CFK are virtually unchanged when the demand variable ASK or $ASK2$ is included, while the t-value of Q falls from 8.60 to 7.56 in column (6) or 7.59 in column (7). All of these results suggest that variable cash flow CFK has some information content completely independent of the demand for the product or the future profitability of the firm. This does not conflict with the hypothesis that the cash flow variable represents the financial constraints of the firm.

Some may argue that the installment of newer, more efficient machines certainly increases the profitability of a firm, and that Tobin's Q is endogenous in equation (3.2). To cope with this criticism, we estimated the same equation (3.2) with Tobin's Q replaced with the one-period-lagged Tobin's Q. The resulting estimates are reported in Table 2.

[Table 2 around here]

Although the coefficient estimates in Table 2 are somewhat different from those in Table

1, the central message remains the same.[2] That is, the addition of the demand variables ASK or $ASK2$ does not lower the t-value of the cash flow variable CFK, but does lower the t-value of the lagged value of Tobin's Q. The estimated results with the data including lagged Tobin's Q also suggests that cash flow works as a financing constraint.

4. Switching Regression Models

To check the robustness of the findings in the previous section, we take a different approach. Following Hu and Schiantarelli (1998), we use switching regression models. We take into account the possibility that those firms that are more financially constrained may behave differently from those which are less constrained.

Although Hu and Schiantarelli (1998) select a set of balance sheet variables as an indicator of financial strength, these variables are not necessarily available for Japanese unlisted firms. Rather, we select two variables as an indicator of financial strength: the lag of total assets at the beginning of the period $LK(-1)$, and a dummy variable, B, indicating whether the firm in question has issued corporate bonds. Variable B takes a value of one when the firm issued bonds in the past, and zero otherwise. Those firms which issued corporate bonds in the past, ceteris paribus, are expected to have greater credibility and more likely to be less financially constrained. Thirty-eight firms of a total of 82 are found to have issued corporate bonds in the past. For variable $LK(-1)$, the larger total assets, ceteris paribus, the greater the credibility of the firm.

Making use of these indicator variables, we break the sample into two groups: a more financially constrained group and a less financially constrained group. We can actually test whether or not this breakup of the sample into two groups is appropriate.

The switching regression model is as follows.

Regime 1: $\dfrac{I_{i,t}}{K_{i,t-1}} = X_{i,t}\beta_c + u_{1,i,t} \quad iff \quad y^*_{i,t} < 0$, (4.1)

Regime 2: $\dfrac{I_{i,t}}{K_{i,t-1}} = X_{i,t}\beta_{uc} + u_{2,i,t} \quad iff \quad y^*_{i,t} \geq 0$, (4.2)

where $X_{i,t} = [Q_{i,t}, (CF_{i,t-1} / K_{i,t-1}), ASK_t]$ and $ASK_t = AS_t / AK_{t-1}$ (version 1).

Indicator Equation: $y^*_{i,t} = Z_{i,t}\theta + \varepsilon_{i,t}$, (4.3)

where $Z_{i,t} = [LK_{i,t-1}, 1]$ (4.4)

or $Z_{i,t} = [LK_{i,t-1}, B_{i,t}]$, (4.5)

where $LK_{i,t-1}$ denotes the log of total assets of firm i at the beginning of the period t, $B_{i,t}$ is a dummy variable which takes a value of one when firm i issued bonds in the past, and zero otherwise, β_c, β_{uc}, θ are vectors of corresponding parameters. $u_{1,i,t}$, $u_{2,i,t}$, and $\varepsilon_{i,t}$ are error terms.

When firm i has the smaller amount of total assets, the value of $LK_{i,t-1}$ in (4.4) becomes smaller. Assuming that the coefficient of the variable $LK_{i,t-1}$ is positive, a smaller value of $LK_{i,t-1}$ in (4.3) leads to a smaller value of $y^*_{i,t}$. Although $y^*_{i,t}$ also depends on the random variable $\varepsilon_{i,t}$, the smaller value of $LK_{i,t-1}$ tends to increase the probability that an inequality $y^*_{i,t} < 0$ holds. Therefore, the smaller value of $LK_{i,t-1}$ is associated with the tendency for the sample to fall into Regime 1 in (4.1). Parameter β_c then denotes the parameter of those firms that are more likely to be financially constrained; β_{uc} in equation (4.2) is the parameter of those firms that are less likely to be constrained.

We consider two versions of the indicator equations. The first version is equation (4.4), which includes the log of total assets and a constant. The second version is equation (4.5), which includes both total assets LK and the bond dummy variable B. Firms that issued bonds in the past are likely to have greater credibility when borrowing, and less likely to be financially constrained.

We assume that the vector of error terms in the investment and indicator equations $(u_{1,i,t}, u_{2,i,t}, \varepsilon_{i,t})'$ is jointly normally independently distributed with mean zero and covariance matrix Σ, where:

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1\varepsilon} \\ \sigma_{21} & \sigma_2^2 & \sigma_{2\varepsilon} \\ \sigma_{\varepsilon 1} & \sigma_{\varepsilon 2} & \sigma_\varepsilon^2 \end{bmatrix}.$$

With the assumption of the joint normality of error terms, we estimate the above model (4.1) through (4.5) by maximum likelihood estimation.

The probability that sample $(I_{i,t} / K_{i,t-1})$ falls into Regime 1 is given by:

$$\begin{aligned} Prob(y_{i,t}^* < 0) &= Prob(Z_{i,t}\theta + \varepsilon_{i,t} < 0) \\ &= Prob(\varepsilon_{i,t} < -Z_{i,t}\theta) \\ &= \Phi(-Z_{i,t}\theta). \end{aligned} \tag{4.6}$$

The probability that $(I_{i,t} / K_{i,t-1})$ falls into Regime 2 is given by:

$$\begin{aligned} Prob(y_{i,t}^* \geq 0) &= Prob(Z_{i,t}\theta + \varepsilon_{i,t} \geq 0) \\ &= Prob(\varepsilon_{i,t} \geq -Z_{i,t}\theta) \end{aligned}$$

$$= 1 - \Phi(-Z_{i,t}\theta). \tag{4.7}$$

The likelihood function for each observation $l_{i,t}$ is a weighted conditional density function of $u_{1,i,t}$ and $u_{2,i,t}$ with weights $Prob(\varepsilon_{i,t} < -Z_{i,t}\theta)$ and $Prob(\varepsilon_{i,t} \geq -Z_{i,t}\theta)$.

$$l_{i,t} = \phi(u_{1,i,t} \mid \varepsilon_{i,t} < -Z_{i,t}\theta)\Phi(-Z_{i,t}\theta) + \phi(u_{2,i,t} \mid \varepsilon_{i,t} \geq -Z_{i,t}\theta)[1 - \Phi(-Z_{i,t}\theta)]$$

$$= \phi(u_{1,i,t}, \sigma_1)\Phi\left(\frac{-Z_{i,t}\theta - \frac{\sigma_{1\varepsilon}}{\sigma_1^2}u_{1,i,t}}{\sqrt{1 - \frac{\sigma_{1\varepsilon}^2}{\sigma_1^2}}}\right)$$

$$+ \phi(u_{2,i,t}, \sigma_2)\left[1 - \Phi\left(\frac{-Z_{i,t}\theta - \frac{\sigma_{2\varepsilon}}{\sigma_2^2}u_{2,i,t}}{\sqrt{1 - \frac{\sigma_{2\varepsilon}^2}{\sigma_2^2}}}\right)\right], \tag{4.8}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ denote the normal density and the cumulative distribution functions, respectively. $\phi(u_{j,i,t} \mid \cdot)$ for j=1,2 is the conditional density and $\phi(u_{j,i,t}, \sigma_j)$ for j=1,2 is the marginal density. The second equality sign is due to Hu and Schiantarelli (1998, pp. 470), who use bivariate normal properties and the fact that a joint density equals the product of the conditional density and the marginal density.

For a panel of N firms with T_i observations for firm i, the log-likelihood function for all observations is given by:

$$L = \sum_{i=1}^{N}\sum_{t=1}^{T_i}\log(l_{i,t}). \tag{4.9}$$

We maximize equation (4.9) with respect to the parameters β_c, β_{uc}, θ, and Σ.

We may also obtain an estimate of the probability that each observation falls either into Regime 1 or Regime 2. The ex ante probability does not take into account the information about investment, ($I_{i,t}/K_{i,t-1}$), and is simply given by either

$Prob(y^*_{i,t} < 0)$ in (4.6) or $Prob(y^*_{i,t} \geq 0)$ in (4.7). Given the information of $(I_{i,t} / K_{i,t-1})$, the ex post probability takes this information into account and updates the ex ante probability according to Bayes' rule. Hu and Schiantarelli show that the ex post probability that the observation $(I_{i,t} / K_{i,t-1})$ falls into Regime 2 is given by:

$$Prob(\varepsilon_{i,t} \geq -Z_{i,t}\theta \,|\, (I_{i,t} / K_{i,t-1})) = \frac{B}{A+B}, \tag{4.9}$$

where $A = \phi(u_{1,i,t} \,|\, \varepsilon_{i,t} < -Z_{i,t}\theta)\Phi(-Z_{i,t}\theta)$ and

$$B = \phi(u_{2,i,t} \,|\, \varepsilon_{i,t} \geq -Z_{i,t}\theta)[1-\Phi(-Z_{i,t}\theta)].$$

Table 3 reports the estimates of the switching regression model (4.1), (4.2), (4.3), and (4.4), where we use the current Q variable in the right-hand side of regression equations (4.1) and (4.2), and the log of total assets of firm i, at the beginning of the period t, $LK_{i,t-1}$, and a constant in the right-hand side of indicator function (4.4). Panel A in Table 3 shows the estimates in the case including only the cash flow variable, CF, with Tobin's Q in the right-hand side of regression equations (4.1) and (4.2), while Panel B provides estimates in the case where the cash flow variable, CF, and the demand for the product, ASK, are included with Tobin's Q.

[Table 3 around here]

First, the larger the total firm assets, the more credible the firm is as a borrower, because larger firms, ceteris paribus, tend to be older, more diversified, less prone to bankruptcy, with greater collateral, and a better known track record. Table 3 shows that the estimates of the coefficient of variable $LK(-1)$ are both positive and significant, indicating that Regime 2 is more likely to occur when the total assets of a firm are large.

Hu and Schiantarelli (1998, pp. 471–473) essentially obtained a negative sign on the estimates of the size of the firm, a result opposite to that found in this analysis. We argue that this difference comes from the nature of the samples used: namely, all firms in Hu and Schiantarelli (1998) are listed firms, while the firms in the present study are unlisted. One reason why we obtained a positive sign on the estimate of the coefficient $LK(-1)$, as against Hu and Schiantarelli (1998), is because unlisted firms are truly small, and more likely to face severe agency and information problems.

In Table 3A, the coefficient estimate of the cash flow variable, 0.92, in Regime 1 is much larger than the corresponding estimate, 0.12, in Regime 2. The t-value of cash flow variable, 5.2, in Regime 1 is also much higher than the corresponding t-value, 2.5, in Regime 2. Firms belonging to Regime 1 are those whose total assets are smaller, and accordingly they react more sensitively to the cash flow variable.

Second, when we add the demand variable ASK to the right-hand sides of regression equations (4.1) and (4.2), we obtain the estimates in Table 3B. A comparison of the respective coefficient estimates between panels A and B shows that the addition of the demand variable ASK has little effect on the t-values of the cash flow variable CF, although it greatly reduces the t-values for Tobin's Q. This suggests that variable ASK picks up information on the future profitability of the firm that variable Tobin's Q fails to capture, and that cash flow variable CF has independent information on the demand variable or information on the financing constraint. With respect to robustness, throughout the empirical results, the t-values of the cash flow variable are virtually unchanged by the addition of the demand variable ASK to the right-hand sides in regression equations (4.1) and (4.2).

To guard against a criticism that the Tobin's Q variable is endogenous, we replace Tobin's Q variable by its one-year-lagged values, and obtain Table 4.

[Table 4 around here]

Although the respective coefficient estimates are affected by the replacement of Tobin's Q with its lagged value, our main findings remain unaffected. First, the t-values of the cash flow variable in Regime 1 are higher than the corresponding t-values in Regime 2, suggesting that the investment behavior of those firms that are more financially constrained is greatly affected by the cash flow variable. Second, the addition of the demand variable ASK to the investment equation changes virtually nothing in the t-values of the cash flow variable, suggesting that the cash flow variable has an independent piece of information on the demand variable, or the information on the financing constraint.

[Table 5 and 6 around here]

Table 5 reports the estimates of the switching regression model with the indicator equation (4.4) replaced by (4.5). Table 6 is then the same as Table 5 except that Tobin's Q is replaced by its one-year lagged variable.

In Tables 5 and 6, we find that all of our estimates on the coefficient of variable B display a positive sign, suggesting that firms that issued bonds in the past tend to have the larger value of $y_{i,t}^{*}$ in equation (4.3). Therefore, these firms are more likely to fall into Regime 2 in equation (4.2).

Although the estimates vary slightly depending upon the model specification, our main results stand solid throughout Tables 3, 4, 5, and 6. First, the investment is significantly affected by the cash flow variable in Regime 1, where firms are more financially constrained, but less affected by the cash flow variable in Regime 2, where firms are less financially constrained. Second, the addition of the demand variable to the investment equation does not reduce the significance of the t-values of the cash flow variable, suggesting that the cash flow variable contains a piece of information independent of the future profitability of the firm.

5. Concluding Remarks

When we include cash flow, profits, or other internal fund variables on the right-hand side of the corporate investment equation, we almost always find that these variables are statistically significant. Fazzari et al. (1988), among others, argue that this statistical significance is evidence that internal funds affect investment as a binding constraint. However, there are alternative interpretations on the significance of the internal fund variables. First, Cooper and Ejarque (2001) argue that allowing the profit function at the firm level to be strictly concave reflecting, for example, market power, is sufficient to replicate Q theory-based regression results where profits are a significant variable affecting investment.

Second, as shown by Hayashi (1982), average Q equals marginal Q only under select conditions. In addition, the market value of the firm equals its stock price only if the stock market is efficient. None of these conditions are likely to hold. There is always then the potential for measurement error in the variable Q. See, for example, Erickson and Whited (2000). Because of errors in measuring marginal Q, we may find that investment by financially constrained firms responds strongly to cash flow.

Third, there is the possibility that our econometric specification may be incorrect, which may wrongly lead to the statistical significance of the cash flow variable. Both Tobin's Q and cash flow variable in the right-hand side of the investment equation are endogenous. Applying ordinary least squares and using the current values of these variables may then introduce a simultaneous equation bias to the resulting parameter estimates. There is also reason to believe that the investment function is nonlinear. See, for example, Abel and Eberly (1994), Barnett and Sakellaris (1998), and Honda and Suzuki (2000). The linear specification included in this analysis may then also potentially introduce serious bias in the resulting estimates.

We do not suggest that we have presented conclusive statistical evidence that these alternative interpretations are incorrect; rather we argue that our statistical results do not disagree with the financial constraint hypothesis of cash flow. First, recall that we have collected our sample only from automobile parts suppliers. Since they supply parts to large automobile makers such as Toyota, they are unlikely to be able to exert market power, contrary to the postulation in Cooper and Ejarque (2001). In addition, earlier work investigates the case of listed firms. However, it is questionable whether these studies have appropriately addressed the question because listed firms tend to be large and may be less likely to be financially constrained. Contrary to this literature, our sample consists of smaller unlisted firms. These should be more appropriate for testing purposes.

Second, most empirical studies make use of stock prices as a proxy for the market value of the firm. Since all of the firms in our sample are unlisted, stock prices are not available. We use a different proxy for the market value of the firm from the standard literature, and obtain statistical evidence that does not disagree with the financial constraint hypothesis. Our findings then add yet another piece of evidence to support the financial constraint hypothesis. In addition, the results in this analysis are robust with respect to changes in the proxy for Tobin's Q. This implies that our supportive evidence for the financial constraint hypothesis is robust, not only to changes in the proxy variables, but also against the criticism of possible simultaneous equation bias.

Finally, we also estimated switching regression models and found that our main findings are robust, suggesting that our results hold even in nonlinear specifications.

Appendix 1. Data Construction

1. Data Source

The sample data are selected from the financial statements of 82 unlisted corporations that produce automobile parts. These data are compiled by Tokyo Shoko Research (TSR). The Kaisha-Sokan (Corporation-List) is used to identify automobile parts suppliers. We attempted to include all suppliers; however, the TSR database fails to cover some firms. Our final sample comprises 82 corporations.

The potential sample period is from 1974 to 2004, or 31 years. However, there are few firms that cover the entire sample period. Indeed there are only 28 corporations that have more than 15-year consecutive data. Even when they have more than 15 years of data, at least some lack a few years. For example, some firms have data from 1974 to 1985 and from 1987 to 2004, but lack data for 1986. Others have data from 1975 to 1996 and from 1998 to 2004, but lack data for 1997. Therefore, we are obliged to employ an unbalanced panel of data.

The fact that most of our sample consists of data with missing observations hampers use of the perpetual inventory method as in Hoshi and Kashyap (1990) and Hayashi and Inoue (1991), and poses some difficulties in the construction of data on the replacement cost of capital stock, a necessary component to obtain data on marginal Q. Hence, we follow Kaplan and Zingales (1997), Carpenter and Petersen (2002), and Polk and Sapienza (2006) and use the book value of nominal capital stock or total assets.

2. Marginal Q

Under the assumptions of constant returns-to-scale and perfect competition, we can derive marginal Q_t as:

$$Q_t = \frac{1}{p_{K,t}} E_t \left[\sum_{j=0}^{\infty} \beta_{t+j} (1-\delta)^j \frac{\pi_{t+j}}{K_{t+j-1}} \right], \tag{A.1}$$

where $p_{K,t}$, π_{t+j}, K_{t+j-1}, δ, and E_t denote the price of capital goods at time t, gross profit at time t+j, real capital stock at the beginning of time t+j, depreciation rate, and the expectation operator based on the information set at time t, respectively. β_{t+j} is defined as $\beta_{t+j} = \prod_{i=1}^{j} (1+r_{t+i})^{-1}$ (j=1,2,・・・), $\beta_t \equiv 1$, where r_{t+j} denotes the discount rate at time t+j. (See, for example, Ogawa(2003, pp. 97–101.)

Assuming that both the gross profit rate (π_{t+j} / K_{t+j-1}) and the discount rate r_{t+j} follow independent random walks, we can rewrite (A.1) as:

$$\begin{aligned} Q_t &= \frac{\pi_t / K_{t-1}}{p_{K,t}} \left[1 + \frac{(1-\delta)}{(1+r_t)} + \frac{(1-\delta)^2}{(1+r_t)^2} + \cdots \right] \\ &= \frac{\pi_t / K_{t-1}}{p_{K,t}} \left[\frac{(1+r_t)}{(r_t+\delta)} \right] \\ &= \frac{\pi_t (1+r_t)}{(r_t+\delta)} / p_{K,t} K_{t-1}. \end{aligned} \tag{A.2}$$

Following Hayashi (2000), we define gross profit π_t as $\pi_t = (1-\tau_t) \times$ operating income + depreciation, where τ_t denotes the corporate tax rate at time t.

Because our sample consists of unlisted firms, we calculate the cost of capital ($r_t + \delta$) as $r_t + \delta = (1-\tau_t)\rho_t + \delta$, where ρ_t, τ_t, and δ is the rate of return on ten-year government bonds, the corporate tax rate, and the depreciation rate, respectively. Data on ρ_t and τ_t are the same across firms, but not δ. Accordingly, we calculate the depreciation rate as the sample average of each firm over time.

As for $p_{K,t} K_{i,t-1}$, we use the book value of capital stock.

3. Corporate Investment

We improve the method of data construction on investment. All previous studies, including Hayashi and Inoue (1991), constructed the investment data based on the definition:

I_{HI} = Current Installed Capital Investment

= Tangible Fixed Assets at time t

− Tangible Fixed Assets at time (t-1)

+ Depreciation,

where Tangible Fixed Assets are defined as the sum of Building, Structures, Machinery and Equipment, Tools, Furniture and Fixtures, and Vehicles and Other Transportation Equipment.

However, the true current capital expenditure, denoted by I, should be defined as:

I = Current Capital Expenditure

= Current Capital Expenditure booked under the account of Tangible Fixed Assets

+ Current Capital Expenditure booked under the account of Construction in Progress.

Therefore, the true Current Capital Expenditure should be:

I = I_{HI}

− Transfer from Construction in Progress to Tangible Fixed Assets

+ Current Capital Expenditure booked under the account of Construction in Progress

= I_{HI} + Account of Construction in Progress at time t − Account of Construction in Progress at time (t-1).

In the present paper, we use I instead of I_{HI} as the data on investment.

Finally, in this section, we keep a record on how we handled those exceptional firms that switched accounting periods during the sample period. For illustrative purposes, suppose that a firm in question switched its accounting period from January 1 to December 31, 1996 to April 1, 1996 to March 31, 1997. If data on March 1996 are available, Investment I at year 1996 should be defined as:

I (1996)

= Tangible Fixed Assets at March 1997

＋ Account of Construction in Progress at March 1997

－ Tangible Fixed Assets at March 1996

－ Account of Construction in Progress at March 1996

＋ Depreciation for the period from April 1996 to March 1997.

However, March 1996 data are, in fact, unavailable for some firms. Therefore, we define Investment at year 1996 as follows.

I (1996)

= Tangible Fixed Assets at March 1997

＋ Account of Construction in Progress at March 1997

－ Tangible Fixed Assets at December 1995

－ Account of Construction in Progress at December 1995

＋ Depreciation for the period from April 1996 to March 1997.

For those firms whose data are available for Depreciation for the period January 1996 to March 1996, we added it to the value of Depreciation from April 1996 to March 1997.

4. Cash Flow

We define Cash Flow as the sum of Depreciation and Net Income after Income Taxes. The cash flow rate at time t, CF_t, is the ratio of the one-year lagged Cash Flow to the one-year lagged book value of the total tangible assets (excluding land). Our definition of Cash Flow includes dividends because firms are assumed to make decisions on real investment first, and then formulate dividend policy. This follows suggestions by Fazzari et al. (1988). As in Polk and Sapienza (2006), we use the one-year lagged Cash Flow in CF_t to avoid the simultaneous equation bias problem.

5. Capital Stock

We use the book value of total tangible assets excluding land as capital stock K. Because the absolute value of K is extremely large for large automobile makers such as Toyota, we divide K by 10^6 for large auto makers, which specifies the unit of measurement as a billion yen. To obtain the data LK in (4.4) or (4.5), we simply take the natural logarithm of K.

Appendix 2. Firms Included in Samples

Corporation	Periods Included in Samples	
Gunma Seiki	1992–1998	2001–2004
Chiyoda Seisakusho	1981–2004	
Shoda Seisakusho	1986–1990	1996–2004
Sakamoto Kougyo	1974–1985	1995–1997
Kurita Arumi Kougyo	2002–2004	
Mie Giken Kougyo	1974–2003	
Seiken Kagaku Kougyo	1974–1984	1998–2004
Kiipar	1974–2004	
Nihon Bureki Kougyo	1987–1989	
Nihon Thermostat	1980–1982	1988–1999
Mets	1976–1987	
Nihon Wiper Bureido	1974–1992	
T Estick	1977–2004	

Asumo	1975–2004			
Ho Seimitsu Kougyo	1974–1976	1983–1984	1987–1992	1995–2004
Yanagawa Seiki	1974–2004			
TGK	1975–1983	1985–1998	2002–2004	
Oi seisakusho	1991–2002			
Waizu	2000–2004			
Yokohama Kikou	1980–2004			
Techno Hirata	1977–1986	1990–1993	1998–2004	
Central Jidousha	1975–2004			
Horie Kinzoku Kougyo	1987–1989	1991–1995		
Yajima	1986–2001			
Aishin Kakou	1975–2004			
Matsukawa Tekkosho	1974–1989			
Sango	1991–2001			
Ogasawara Kougyo	1986–1988	1997–1999		
Izumi Kougyo	1977–2004			
Arakawa Kougyo	1992–2003			
Chuo Seiki	1974–2004			
Shimizu Kougyo	1982–1990	1994–2004		
Ohashi Tekkou	1974–1994	1998–2003		
Aichi Kikou	1984–1987	1990–1991	1993–1999	
Ohara Jushi Kougyo	1975–1996	1998–2004		
Ansei	1974–1985	1987–2004		
Aishin Koukyu	1983–1989			
Kyohô Seisakusho	1974–1987	1993–1994	1998–2004	
Yahagi Sangyo	1975–1989	1991–2001		
NT Techno	1997–2003			
Kyowa Sangyo	1977–1980	1982–2004		
Sindai	1974–2004			
Tsuda Kougyo	1985–1990	1999–2004		
Aishin Kikou	1989–1990	1993–2003		
Aichi Hikaku Kougyo	1982–1988			
Fuji Press	1975–1981			
Housei Bureki Kougyo	1975–1987	1991–1993	1996–2003	
Kotobuki Giken Kougyo	2000–2004			
GS Eletech	1982–2002			

Jounan Seisakusho	1986–2004			
Totsuku Seisakusho	1977–1988	1990–1994	1996–1998	2000–2002
Asama Giken Kougyo	2000–2004			
NE	1986–1988	1991–2000		
Shizuoka Denso	1993–1997			
Usui Kokusai Sangyo	1975–1983	1985–2003		
Biyonzu	1982–2004			
Kanae Kougyo	1985–1987	1995–2004		
Toyo Densan	1980–1992	1995–2004		
Enkei	1978–1986	1988–1998		
Kaneda Kougyo	1977–1982			
Katsuyama Fain Tech	1977–2004			
Tokai Seiko	1975–1989			
Rizumu	1985–1989			
Pajero Seizou	1985–1995			
Gifu Shatai Kougyo	1983–1985			
Tokitsu Sangyo	1988–2000			
Asahi Forji	1992–2003			
Shinnichi Kougyo	1999–2004			
Kokusan Buhin Kougyo	1981–1985	1989–1994	1996–1997	1999–2004
Aoi Kikai Kougyo	1982–1987	1993–2003		
Tsukiboshi Seisakusho	1978–2003			
Nisshin Seisakusho	2001–2004			
Heian Seisakusho	1989–2003			
Mie Kougyo	1977–1979	1981–1986	1991–1994	1998–2003
Takao Kinzoku Kougyo	1977 1982	1984–1995	2000–2003	
Asahi Aluminium	1978–1990	1992–1999	2001–2004	
Sanyo Haidorikku Kougyo	1993–1995	2001–2003		
Souja Kougyo	1977–1979	1995–2004		
Sanjyo Kougyo	1975–1983	1985–2004		
Mizushima Kikou	1977–1979	1994–2004		
Ihara Seiki	1997–2004			
Yoshiwa Kougyo	1981–1988	1999–2004		

Footnote

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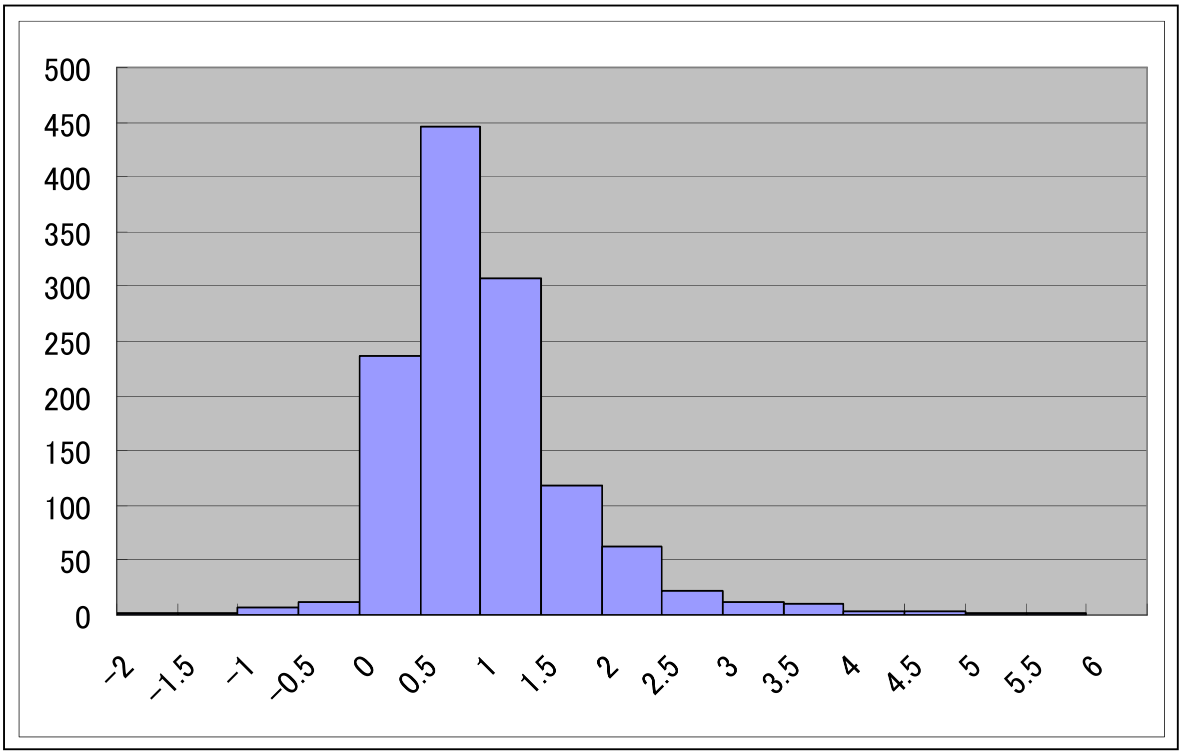
1. An obvious alternative estimator is the generalized method of moments (GMM). However, our sample contains many missing observations, and the use of lagged data as an instrument in GMM makes the samples too small to obtain reliable estimates. For example, if we include a two period-lagged variable as an instrument in GMM estimation, we cannot use the sample with observation data available at t and t-1, but missing at t-2. The sample includes many such missing values.
2. The comparison of Table 2 with Table 1 shows that the replacement of Tobin's Q by its lagged value makes the t-values of cash flow variable CFK smaller. We interpret this as follows. We use one-period lagged value of cash flow for data CFK, and the use of the lagged Tobin's Q instead of the current Tobin's Q makes the correlation between the two variables higher. The higher correlation between the lagged Tobin's Q and CFK in turn makes the t-values of CFK smaller.

Figures

Figure 1 Frequency Distribution of Investment / Cash Flow Ratio



Note. This graph shows the frequency distribution of the ratio of corporate investment to cash flow.

Tables

Table 1 Estimates of the Investment Equation (WITHIN)

Current Q model : Dependent Variable = $\frac{I_{i,t}}{K_{i,t-1}}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Q	0.1810				0.1473	0.1303	0.1310
	(12.120)				(8.597)	(7.560)	(7.591)
CFK		0.6316			0.3267	0.3165	0.3178
		(9.755)			(4.595)	(4.539)	(4.547)
ASK			0.0290			0.0158	
			(8.316)			(5.080)	
ASK2				0.0279			0.0146
				(8.088)			(4.733)
Adjusted R-squared	0.1762	0.1070	0.0663	0.0630	0.1981	0.2153	0.2131
Observations = 1260							

Note. Numbers in parentheses denote t-values based on heteroskedastic– consistent standard errors.

Table 2 Estimates of the Investment Equation (WITHIN)

Lagged Q model : Dependent Variable = $\frac{I_{i,t}}{K_{i,t-1}}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Q(-1)	0.1537				0.1195	0.0976	0.0986
	(10.818)				(5.245)	(4.256)	(4.313)
CFK		0.6194			0.2075	0.2161	0.2101
		(8.685)			(1.834)	(1.953)	(1.886)
ASK			0.0304			0.0212	
			(8.074)			(5.908)	
ASK2				0.0297			0.0203
				(7.983)			(5.691)
Adjusted R-squared	0.1258	0.0977	0.0680	0.0668	0.1298	0.1598	0.1580
Observations = 1131							

Note. Numbers in parentheses denote t-values based on heteroskedastic– consistent standard errors.

Table 3 Estimates of the Switching Regression Model

Current Q model： $Z_{i,t} = [LK(-1), A]$

A. Without Demand Variable ASK

Number of observations=1260	Log likelihood=496.372	Schwarz B.I.C.=−460.678
(investment equation)		
	regime 1	regime 2
Q	0.1360 (4.463)	0.1466 (14.055)
CF	0.9171 (5.207)	0.1182 (2.478)
σ_i	0.2814 (21.338)	0.1331 (23.194)
$\sigma_{i,\varepsilon}$	−0.1077 (5.428)	−0.0869 (5.666)
ex post probability	0.2101	0.7899
(switching equation)		
$LK(-1)$	0.2414 (3.024)	
A	0.6395 (5.804)	

B. With Demand Variable ASK

Number of observations=1260	Log likelihood=512.353	Schwarz B.I.C.=−469.520
(investment equation)		
	regime 1	regime 2
Q	0.1234 (4.053)	0.1282 (11.743)
CF	0.8020 (4.969)	0.1175 (2.431)
ASK	0.0199 (1.741)	0.0131 (4.884)
σ_i	0.2721 (23.353)	0.1294 (21.744)
$\sigma_{i,\varepsilon}$	−0.1013 (5.224)	−0.0864 (5.923)
ex post probability	0.2372	0.7628
(switching equation)		
$LK(-1)$	0.2684 (3.347)	
A	0.5310 (4.798)	

Notes. A is a constant, 'ex post probability' refers to the estimate of the ex post probability that each observation falls into Regime 1 or 2 given the information on investment value.

Table 4 Estimates of the Switching Regression Model

Lagged Q model： $Z_{i,t} = [LK(-1), A]$

A. Without Demand Variable ASK

Number of observations=1131	Log likelihood=399.851	Schwarz B.I.C.=−364.697
(investment equation)		
	regime 1	regime 2
$Q(-1)$	0.0174 (0.283)	0.1398 (8.534)
CF	0.9135 (3.340)	−0.0358 (0.492)
σ_i	0.3085 (17.249)	0.1335 (21.875)
$\sigma_{i,\varepsilon}$	−0.0940 (4.124)	−0.0773 (4.671)
ex post probability	0.2097	0.7903
(switching equation)		
$LK(-1)$	0.2509 (2.910)	
A	0.6363 (5.058)	

B. With Demand Variable ASK

Number of observations=1131	Log likelihood=426.024	Schwarz B.I.C.=−383.839
(investment equation)		
	regime 1	regime 2
$Q(-1)$	0.0113 (0.215)	0.1166 (6.912)
CF	0.8581 (3.694)	−0.0358 (0.479)
ASK	0.0207 (1.797)	0.0205 (6.777)
σ_i	0.2917 (19.958)	0.1262 (20.833)
$\sigma_{i,\varepsilon}$	−0.0867 (4.256)	−0.0759 (5.204)
ex post probability	0.2475	0.7525
(switching equation)		
$LK(-1)$	0.2990 (3.538)	
A	0.4796 (3.972)	

Notes. A is a constant, ‘ex post probability’ refers to the estimate of the ex post probability that each observation falls into Regime 1 or 2 given information on its investment value.

Table 5 Estimates of the Switching Regression Model

Current Q model： $Z_{i,t} = [LK(-1), BOND]$

A. Without Demand Variable ASK

Number of observations=1260	Log likelihood=489.319		Schwarz B.I.C.=−453.625	
(investment equation)				
	regime 1		regime 2	
Q	0.1584	(7.742)	0.1294	(10.959)
CF	0.6283	(5.754)	0.1118	(2.116)
σ_i	0.2476	(33.318)	0.1231	(21.221)
$\sigma_{i,\varepsilon}$	−0.0946	(5.494)	−0.0858	(7.550)
ex post probability	0.3600		0.6400	
(switching equation)				
$LK(-1)$	0.2061	(2.814)		
$BOND$	0.3566	(2.836)		

B. With Demand Variable ASK

Number of observations=1260	Log likelihood=508.682		Schwarz B.I.C.=−465.849	
(investment equation)				
	regime 1		regime 2	
Q	0.1508	(7.095)	0.1047	(8.781)
CF	0.5688	(5.421)	0.1202	(2.279)
ASK	0.0161	(2.109)	0.0146	(5.156)
σ_i	0.2436	(34.684)	0.1185	(20.712)
$\sigma_{i,\varepsilon}$	−0.0925	(5.611)	−0.0858	(8.118)
ex post probability	0.3769		0.6231	
(switching equation)				
$LK(-1)$	0.2152	(3.154)		
$BOND$	0.2640	(2.255)		

Notes. 'BOND' is a dummy variable indicating whether the firm has issued bonds in the past, 'ex post probability' refers to the estimate of the ex post probability that each observation falls into Regime 1 or 2 given information on its investment value.

Table 6 Estimates of the Switching Regression Model

Current Q model： $Z_{i,t} = [LK(-1), BOND]$

A. Without Demand Variable ASK

Number of observations=1131	Log likelihood=391.652		Schwarz B.I.C.=−356.498	
(investment equation)				
	regime 1		regime 2	
$Q(-1)$	0.0857	(2.232)	0.1255	(6.631)
CF	0.5192	(3.258)	0.0043	(0.049)
σ_i	0.2690	(28.169)	0.1215	(20.936)
$\sigma_{i,\varepsilon}$	−0.0737	(4.036)	−0.0686	(5.791)
ex post probability	0.3508		0.6492	
(switching equation)				
$LK(-1)$	0.2859	(3.374)		
$BOND$	0.2838	(2.044)		

B. With Demand Variable ASK

Number of observations=1131	Log likelihood=421.711		Schwarz B.I.C.=−379.526	
(investment equation)				
	regime 1		regime 2	
$Q(-1)$	0.0540	(1.419)	0.1052	(5.830)
CF	0.6287	(3.898)	−0.0286	(0.353)
ASK	0.0177	(2.139)	0.0227	(7.126)
σ_i	0.2647	(28.603)	0.1167	(21.454)
$\sigma_{i,\varepsilon}$	−0.0765	(4.322)	−0.0705	(6.285)
ex post probability	0.3522		0.6478	
(switching equation)				
$LK(-1)$	0.3252	(4.128)		
$BOND$	0.2405	(1.845)		

Notes. 'BOND' is a dummy variable indicating whether the firm has issued bonds in the past, 'ex post probability' refers to the estimate of the ex post probability that each observation falls into Regime 1 or 2 given information on its investment value.

References

Abel, Andrew B., and Janice C. Eberly, 1994, "A Unified Model of Investment under Uncertainty", *American Economic Review,* Vo1.84, pp. 1369–1384.

Arellano, Manuel, 2003, Panel Data Econometrics, Oxford University Press, New York.

Barnett, Steven A., and Plutarchos Sakellaris, 1998, "Nonlinear Response of Firm Investment to Q: Testing a Model of Convex and Non-convex Adjustment Costs", *Journal of Monetary Economics,* Vol.42, October, pp. 261–288.

Carpenter, Robert E. and Bruce C. Petersen, 2002, "Is the Growth of Small Firms Constrained by Internal Finance?", *The Review of Economics and Statistics,* Vol. 84, May, pp.298–309.

Cooper, Russell and João Ejarque, 2001, "Exhuming Q: Market Power vs. Capital Market Imperfections", *NBER Working Paper* 8182.

Cummins, Jason G., Kevin A. Hassett and Stephen D. Oliner, 2006, "Investment Behavior, Observable Expectations, and Internal Funds", *American Economic Review*, Vol.96, No.3, June, pp.796-810.

Erickson, Timothy and Toni M. Whited, 2000, "Measurement Error and the Relationship between Investment and q", *Journal of Political Economy,* Vol.108, pp. 1027–1057.

Fazzari, Steven, Glenn Hubbard, and Bruce Petersen, 1988, "Financing Constraints and Corporate Investment", *Brooking Papers on Economic Activity 1,* pp. 141–195.

———, 1996, "Financing Constraints and Corporate Investment", NBER

Working Paper 5462.

Hall, Robert, 1988, "Comments and Discussion" in Fazzari, Steven, Glenn Hubbard, and Bruce Petersen, "Financing Constraints and Corporate Investment", *Brookings Papers on Economic Activity 1,* pp. 205.

Hayashi, Fumio, 1982, "Tobin's Marginal q and Average q: A Neoclassical Interpretation", *Econometrica,* Vol.50, pp. 213–224.

Hayashi, Fumio, 2000, "The Main Bank System and Corporate Investment: An Empirical Reassessment", In Finance Governance and Competitiveness in Japan, M.Aoki and G. Saxonhouse eds, Oxford University Press, pp. 81–97.

Hayashi, Fumio, and Toru Inoue, 1991, "The Relation between Firm Growth and Q with Multiple Capital Goods: Theory and Evidence from Panel Data on Japanese Firms", *Econometrica,* Vol.59, pp. 731–753.

Honda, Yuzo, and Kazuyuki Suzuki, 2000, "Estimation of the Investment Thresholds of Large Japanese Manufacturers", *Japanese Economic Review*, Vol.51, No.4 (December), pp. 473–491.

Hoshi, Takeo, and Anil Kashyap, 1990, "Evidence on Q and Investment for Japanese Firms", *Journal of Japanese and International Economies*, Vol.4, pp. 371–400.

Hoshi, Takeo, Anil Kashyap, and David Scharfstein, 1991, "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Panel Data", *Quarterly Journal of Economics,* Vol.106, February, pp. 33–66.

Hu, Xiaoqiang and Fabio Schiantarelli, 1998, "Investment and Capital Market Imperfections: A Switching Regression Approach Using U.S. Firm Panel Data", *Review of Economics and Statistics,* Vol.80, pp. 466–479.

Kaplan, Steven N., and Luigi Zingales, 1997, "Do Investment – Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?", *Quarterly Journal of Economics*, Vol.112, February, pp. 169–215.

Ogawa, Kazuo, 2003, Economic Analysis on Great Recession, Nihon Keizai Shinbunsha, Tokyo, (in Japanese).

Polk, Christopher, and Paola Sapienza, 2006, "The Stock Market and Corporate Investment: A Test of Catering Theory", Northwestern University Working Paper, March.

Sims, Christopher, 1988, Comment on "Financing Constraints and Corporate Investment", *Brooking Papers on Economic Activity 1*, pp. 141–195.

Stiglitz, Joseph, 1988, Comment on "Financing Constraints and Corporate Investment", *Brooking Papers on Economic Activity 1,* pp. 141–195.