Internal Funding and Investment: Analysis by Corporate Size Based on Financial Statements Statistics of Corporations by Industry

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Abstract

This paper conducted an empirical analysis on investment's relationship with internal funding and with external funding costs that differ depending on corporate size, using survey slip data for Financial Statements Statistics of Corporations by Industry covering from small to large enterprises.

The analysis confirmed a U-shaped relationship between investment and internal funding, meeting the results of earlier empirical studies using US and UK corporate data. Meanwhile, the estimation results of the investment function confirmed a fixed effect in which smaller enterprises invest more when internal funding is positive, conflicting with a traditional theory that smaller enterprises hold down investment due to stronger exogenous liquidity constraints.

The analysis also found that information such as the short-term loan share and negative net worth has a statistically significant effect on investment and that there is a close relationship between the magnitude of the effect and enterprise size. The finding indicates that the identification of excellent borrowers in the capital market is important for explaining external funding cost gaps between enterprises.

Keywords: Capital investment, internal funding, asymmetric information, external funding costs

JEL Classification: G31, G32, D82

I. Introduction

Prior empirical work on the relationship between corporate investment and internally generated funds treats the internal funds as an exogenous variable and examines its effect on investment (e.g., Fazzari et al. 1988; Vogt 1994; Gilchrist and Himmelberg 1995; Kaplan and Zingales 1997; Erickson and Whited 2000). Most studies find that firms' cash flow, a proxy variable for the internal funds, has a positive effect on investment suggesting the existence of liquidity constraints.

When there is information asymmetry between borrowers and lenders in capital markets, firms' internal cash plays an important role in reducing agency cost, leading to the positive relation between cash flow and investment (cf. Hubbard 1998; Stein 2003). All else being equal, firms with abundant cash can invest more than firms with less cash. Jaffee and Stiglitz (1990) and Greenwald and Stiglitz (1990) illustrate that external financing costs should bear a risk premium and agency costs. Information related capital-market imperfections likely create a wedge between internal and external financing costs (e.g., Gale and Hellwig 1985; Froot et al. 1993). Firms with sufficient internal cash can accomplish the first-best level of investment to maximize the firm value. On the other hand, firms with insufficient cash need to borrow funds to invest in their projects and may choose a lower level of investment than the first-best level because of the higher external financing costs. Examples of empirical papers that examine how external financing costs vary across Japanese firms include Hoshi et al. (1991), Asako et al. (1991) and Fukuda et al. (1999).

Most prior studies use cash flow for the proxy of internal funds to examine the relationship between liquidity constraints and investment. Empirical studies using cash flow provide conflicting predictions with respect to how internal funds impact investment. Fazzari et al (1998) show that cash flow tends to have a greater effect on investment of firms more likely to face liquidity constraints. On the contrary, Kaplan and Zingales (1998) and Cleary (1999) find that investment is more sensitive to cash flow for firms facing less liquidity constraints.

Most of the literature since Fazzari et al. (1998) has similarly focused on cash flows to explain the effect of liquidity constraints on investment, despite the lack of theoretical underpinning. Erickson and Whited (2000) demonstrate that the empirical finding that investment of liquidity constrained firms is excessively sensitive to cash flow may be due to a measurement error in investment opportunities. They show that cash flow sensitivities disappear when the measurement error in Tobin's Q is treated. Gomes (2001) and Alti (2003) also demonstrate that investment-cash flow sensitivities can be generated by an economic context without liquidity constraints. Thus, the sensitivity of investments to cash flow does not necessarily indicate the presence of liquidity constraints.

Instead of cash flow, several studies use liquid assets as an alternative proxy for internal funds. Kim et al. (1998), Povel and Raith (2001) and Cleary et al. (2007) provide theoretical background to explain how liquid assets are linked to a firm's investment choice. Kim et al. (1998) develop a model where firms invest in liquid assets to reduce the need to finance future profitable investment opportunities with costly external funds. The model predicts that firms facing a higher premium on external funds invest more in liquid assets. Povel and Raith (2001) and Cleary et al. (2007) further clarify how liquid assets affect a firm's capital investment choice. Both papers show that the optimal investment is a U-shaped function of internal liquid funds. Empirical results provided by Allayannis and Monzumdar (2004), Bhagat et al. (2005), Cleary et al. (2007) and Guariglia (2008) support the U-shaped relation between internal funds and investment. Using firm-level data, these papers show that, when cash flow or cash assets are negative, they have a negative and significant relationship with investment.

In this paper, I examine the U-shaped relation between internal funds and investment using Japanese firm data. Cleary et al. (2007) present empirical evidence of a U-shaped relation between internal funds and investment using large US firm data. In contrast, the emphasis here is on linking the degree of information asymmetry with the U-shaped investment curve. Cleary et al. (2007) argue that severe information asymmetry may change the shape of investment curve. This question is still unanswered empirically. I try to shed light on this missing link.

The cost of raising external funds depends on the degree of information asymmetry. In particular, if firms are small and private, creditors such as banks are likely to have difficulty in obtaining information of firms' investment and outcome. Investment of small and private firms are predicted to suffer from asymmetric information problems more than large and public firms. This paper employs Japanese firm data in all sizes provided by the Ministry of Finance. I use the Annual Survey for the Financial Statements Statistics of Corporations, which contains financial statements of both private and public firms.

II. Analytical Model and Its Predictions

The empirical analysis in this paper is motivated by the theoretical work of Jaffee and Stiglitz (1990), Greenwald and Stiglitz (1990), Povel and Raith (2001) and Cleary et al. (2007). Povel and Raith (2001) and Cleary et al. (2007) propose a model of non-monotonic investment with respect to internal funds. They employ a continuation probability for a firm in default, which is a function of the firm's debt repayment. It is made for convenience to solve the expected value of the firm. My model does not use the continuation probability.

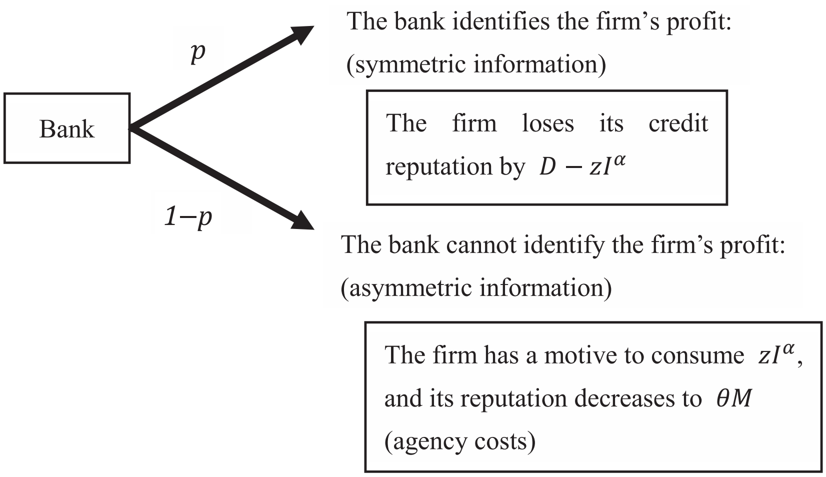
The model is as follows. Following Povel and Raith (2001) and Cleary et al. (2007), a firm has an investment opportunity and obtains a stochastic profit of zI^{α}, where $0<\alpha<1$ and z follows a uniform distribution $U[0,H]$. As in Gale and Hellwig (1985) and Froot et al. (1993), the firm has internal funds W. If the firm wants to invest $I>W$, it borrows $I-W$ from a risk-neutral bank.

The bank screens and identifies the investment opportunity of the firm zI^{α} and decides whether to lend $I-W$ to the firm. Thus, the investment opportunity and the stochastic property of z are symmetric information between them. I assume a zero discount rate and a competitive lending market. The bank earns zero profit and requires a contractual repayment D to the firm. This setup is similar to the models of Jaffee and Stiglitz (1990) and Greenwald and Stiglitz (1990).

I depart from Povel and Raith (2001) and Cleary et al. (2007) by assuming a different information asymmetry and agency costs. I assume that the bank monitors the firm's investment and observes the realization of zI^{α} in the case where $D\leq zI^{\alpha}$. However, I also assume that when the firm defaults due to $D\equiv\hat{z}I^{\alpha}>zI^{\alpha}$, where $\hat{z}$ denotes the default threshold, a financial turmoil caused by the default incident brings information asymmetry between them. With probability p, the bank can distinguish the true realization of zI^{α}, while with probability $1-p$ it cannot verify the true value. I assume that screening and monitoring costs are zero.

The firm has a nontransferable value M, i.e., its credit reputation. When the firm repays D

Figure 1. Penalty for Default



to the bank, the reputation continues to be the same. Meanwhile, when the firm defaults, the repayment of the debt is made by $zI^{\alpha} < \hat{z}I^{\alpha}$. The capital market stigmatizes the defaulted firm and the firm loses a portion of the reputation value. This concept is close to the idea of bankruptcy costs argued in Greenwald and Stiglitz (1990). I assume that with probability p where the bank confirms zI^{α}, the firm pays zI^{α} to the bank and loses the reputation by $D - zI^{\alpha}$. Meanwhile, with probability $1-p$, as the bank cannot confirms zI^{α}, the firm may have an incentive to consume zI^{α} privately. I assume that this agency problem reduces the reputation to θM ($0 \leq \theta \leq 1$). These assumptions are summarized in Figure 1.

The expected value of the firm conducting investment is expressed as

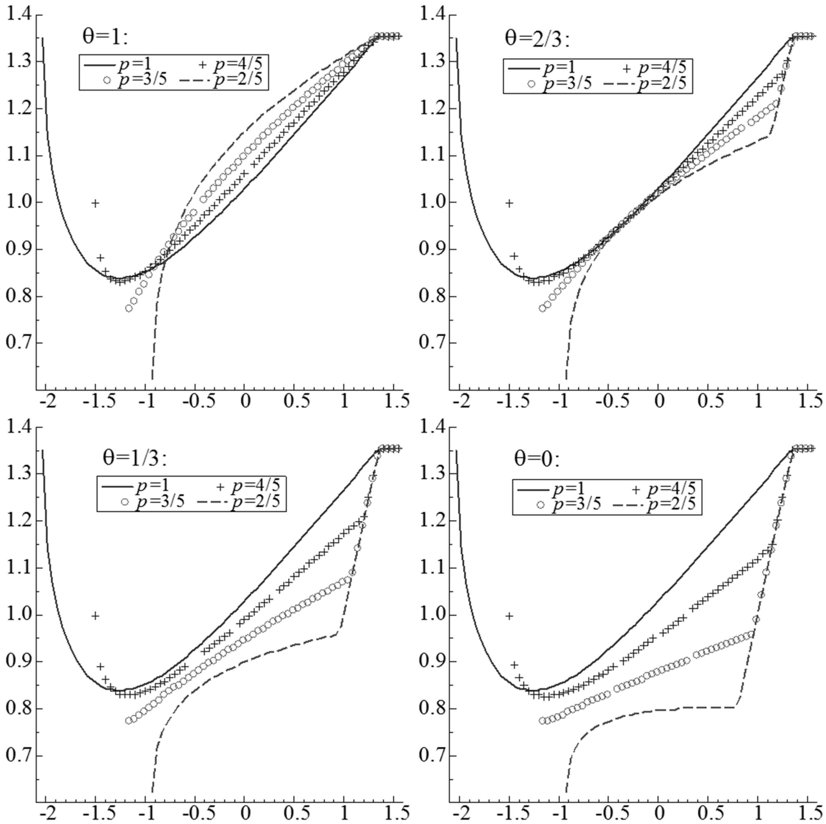
$$V = \begin{cases} \max\limits_{I} \mathbb{E}[zI^{\alpha} - I + W + M], if\ I \leq W \\ \max\limits_{I} \mathbb{E}[(z - p\hat{z})I^{\alpha} + \{\theta + (1-\theta)p\}M | z < \hat{z}]\dfrac{\hat{z}}{H} + \mathbb{E}[(z - \hat{z})I^{\alpha} + M | z \geq \hat{z}]\left(1 - \dfrac{\hat{z}}{H}\right), \\ if\ I > W \end{cases}$$

The firm must satisfy the following constraint: the bank need to break even,

$$p\mathbb{E}[zI^{\alpha} | z < \hat{z}]\frac{\hat{z}}{H} + \hat{z}I^{\alpha}\left(1 - \frac{\hat{z}}{H}\right) = I - W$$

Figure 2 shows the numerical solution of investment with respect to internal funds. By setting parameters as $H = 6$ and $\alpha = .4$, Figure 2 illustrates the relationship between investment and internal funds for different values of p and θ. As p decreases, the firm and the bank face greater information asymmetry. As θ decreases, the value of the nontransferable asset diminishes more when the firm defaults. There is a minimum required level of internal funds

Figure 2. Numerical Solution of Investment with Respect to Internal Funds for Different Values of p and θ (Vertical axis: I, horizontal axis: W)

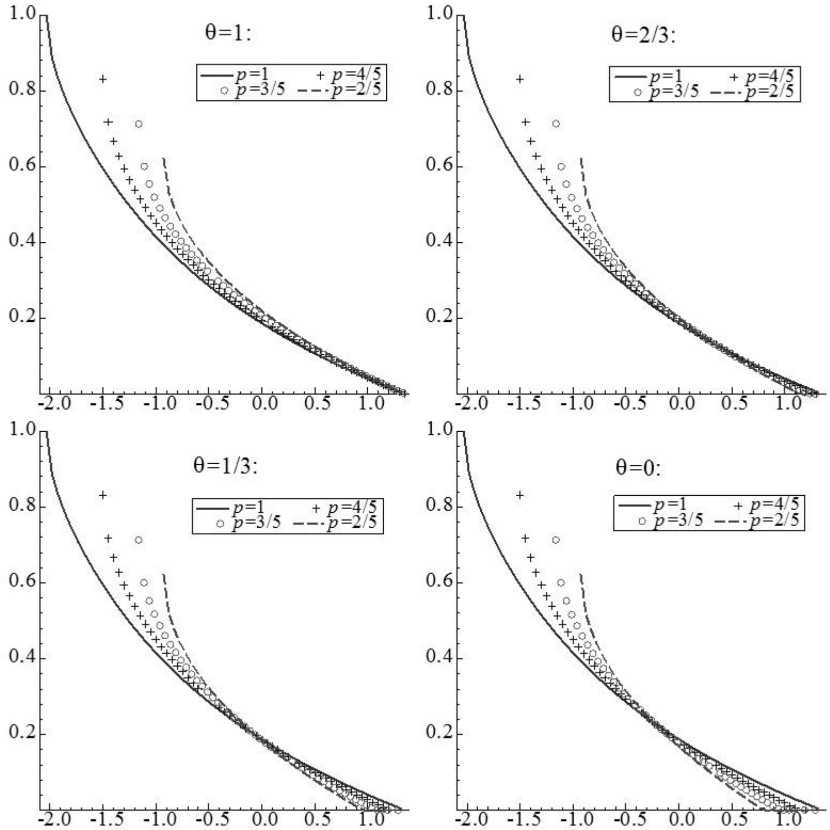


to make the debt contract due to the break-even constraint for the bank. The left ends of investment curves move downwards and rightwards with the decrease of p.

When the value of p is high, investment is a U-shaped function of W for any θ. In contrast, when p is relatively small, investment monotonically increases with W. The U-shaped relation between investment and internal funds disappears when the firm faces severe information asymmetry. In other words, the U-shaped relation between investment and internal funds can be observed when information asymmetry is less severe. For $\theta = 1$, when investment exhibits a positive sensitivity to internal funds, the firm is likely to invest more as p decreases. However, for other cases such as $\theta < 1$, lower p decreases investment. For $\theta < 1$, investment curves kink when W is close to the first-best level of investment because the firm is better off without debt.

Figure 3 depicts the default probability $F(\hat{z})$. The default probability increases as W decreases. For the case of $\theta = 1$, the default probability rises with the increase of p. Meanwhile, for $\theta < 1$, the default probability curves cross at a point and the cross point moves to the left

Figure 3. Default Probability Derived from Optimal Investment and Internal Funds
(Vertical axis: $F(\hat{z})$, horizontal axis: W)



as θ becomes smaller. This implies that when the firm is liquidity constrained but has relatively high internal funds, it may choose less risky investment under greater information asymmetry.

III. Empirical Evidence

I examine the predictions of the above model and the link between the degree of information asymmetry and the U-shaped investment curve using data of Japanese firms of different sizes. The data set is from the Annual Survey for Financial Statements Statistics of Corporations by Industry provided by the Japanese Ministry of Finance, which contains financial statements of both private and public firms in Japan. I construct the data set of Japanese firms in non-financial industries over the 1991 to 2010 fiscal year period.

The Annual Survey for the Financial Statements Statistics of Corporations covers private and public firms of all sizes in almost all the industries. It uses different sampling methods depending on firms' stated capital size. For instance, firms with stated capital of 600 million yen or more are included in the sampling frame every year, while firms with a stated capital of less than that amount are randomly sampled. For this reason, I construct a pooled cross-section data set from the Annual Survey, treating all firm-year observations as independent.

Several papers point out that firm size may affect the degree of information asymmetry. Using US public firm data, Fazzari et al. (1998) shows that firms with low dividend payout ratios have higher cash flow sensitivity of investment and that dividend payout ratios are positively correlated with firm size. Gualiglia (2008) reports that smaller firms tend to have greater investment-cash flow sensitivities using UK private firm data.

The Annual Survey covers roughly 30,000 firms each year. It classifies the sample firms according to the stated capital size and each firm is assigned a capital size code as follows: 1–under 2 million yen; 2–2 to 3 mil. yen; 3–3 to 5 mil. yen; 4–5 to 10 mil. yen; 5–10 to 20 mil. yen); 6–20 to 50 mil. yen; 7–50 to a 100 mil. yen; 8–a 100 mil. to a billion yen; 9–a bil. yen or more. In this study, I use this classification code to segment the sample firms into six distinct size groups.

Six sub-samples representing different size groups (A through F) are as follows: (A) Firms with stated capital less than 10 million yen (code 1 to 4), (B) Firms with stated capital of 10 to 19 mil. yen (code 5), (C) Firms with stated capital of 20 to 49 mil. yen (code 6), (D) Firms with stated capital of 50 to 99 mil. yen (code 7), (E) Firms with stated capital of 100 to 999 mil. yen (code 8), and (F) Firms with stated capital of 1 billion yen or more (code 9).

The firm-level variables are as follows. Following Hayashi and Inoue (1991) and Lewellen and Badrinath (1997), for firm i at year t, investment I_{it} is constructed as

$$I_{it} = EOPK_{it} - BOPK_{it} + D_{it},$$

where $BOPK_{it}$ is beginning-of-period net fixed assets, $EOPK_{it}$ is end-of-period net fixed assets and D_{it} is depreciation expense. Following Cleary et al. (2007), I use a firm's net liquid assets W_{it} as a proxy variable for internal funds. W_{it} is constructed as

$$W_{it} = CA_{it} - CL_{it},$$

where CA_{it} is beginning-of-period current assets excluding inventories (the sum of cash, cash equivalents, accounts receivables and marketable securities) and CL_{it} is beginning-of-period current liabilities. I_{it} and W_{it} are deflated by beginning-of-period net fixed assets. I denote the resulting variables by $IK_{it} = I_{it}/BOPK_{it}$ and $WK_{it} = W_{it}/BOPK_{it}$.

The model in the previous section predicts that the risk premium of external financing is positively related to the degree of information asymmetry. Since the risk premium is unobservable, I use two choices of proxy variables for the risk premium. The first one is an effective interest rate paid by a firm. The second one is an insolvency indicator dummy. The effective interest rate R_{it} is calculated by

$$R_{it} = \frac{IP_{it}}{(BOPB_{it} + EOPB_{it})/2 + EOPN_{it}},$$

where IP_{it} is interest payment, $BOPB_{it}$ is beginning-of-period interest-bearing debt, $EOPB_{it}$ is end-of-period interest-bearing debt and $EOPN_{it}$ is notes receivable discounted. I construct the insolvency indicator $INSOL_{it}$, which takes one if the firm's net worth (assets minus liabilities) is negative, otherwise zero.

IK_{it} and WK_{it} are trimmed at the upper and lower one-percentiles to mitigate the effect of outliers and avoid the contamination of the data with errors. Observations with missing values in sales or total assets are also deleted. The remaining sample consists of 445,119 firm-year observations for the pair of IK_{it} and WK_{it}. On the other hand, R_{it} is trimmed at the upper one-percentiles and observations with non-positive values in R_{it} are deleted. The remaining sample consists of 346,575 firm-year observations for the pair of R_{it} and WK_{it}.

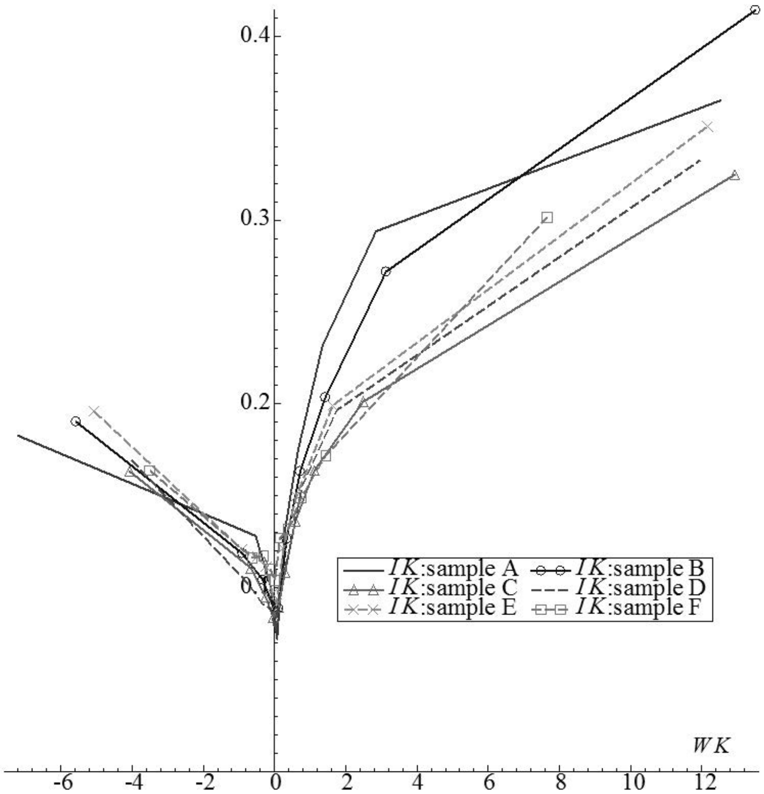
III-1. Relation between investment and internal funds

Following Cleary et al. (2007) and Guariglia (2008), I split the observations of IK_{it} and WK_{it} into deciles of WK_{it} separately for sub-samples, and compute the mean of IK_{it} for each decile. Figure 4 shows the relations between investment and net liquid assets for each size group. The plots show U-shaped investment curves against net liquid assets. Regardless of firm size, investment seems to be monotonically decreasing at low levels of net liquid assets and increasing at higher levels. When net liquid assets are positive, investment tends to have positive sensitivities to net liquid assets. This is consistent with the common empirical finding that investment is positively correlated to internal funds, suggesting a possible link between internal funds and liquidity constraints (e.g., Fazzari et al. 1998; Kaplan Zingales 1997).

Meanwhile, investment has a negative correlation with net liquid assets when net liquid assets are negative in Figure 4. This tendency is contrary to the common view and a different explanation is needed to account for the negative relation between investment and internal funds when internal funds are negative. Using US public firm data, Allayannis and Mozumdar (2004), Bhagat et al. (2005) and Cleary et al. (2007) report that investment decreases with internal funds when internal funds are negative using firm data. Guariglia (2008) reports the same result using UK private firm data. The empirical findings regarding negative sensitivities of investment to internal funds support the relevance of the model presented in the previous section.

If firm size is the adequate proxy to measure the difference of agency costs or information asymmetry, the shape of investment curve changes according to firm size, such as illustrated in Figure 2. Sub-sample (A) consisting of the smallest firms, and sub-sample (B) which is the next smallest size group have larger investments than other groups. This tendency is similar to the property shown in the upper left panel of Figure 2. However, the overall rank-order of investment curves does not follow the firm size order. The results seen in Figure 4 do

Figure 4. Mean Investment Rate for Deciles of Net Liquid Assets by Firm Size, Bundle Plot
(Vertical axis: mean *IK*, horizontal axis: mean *WK*)



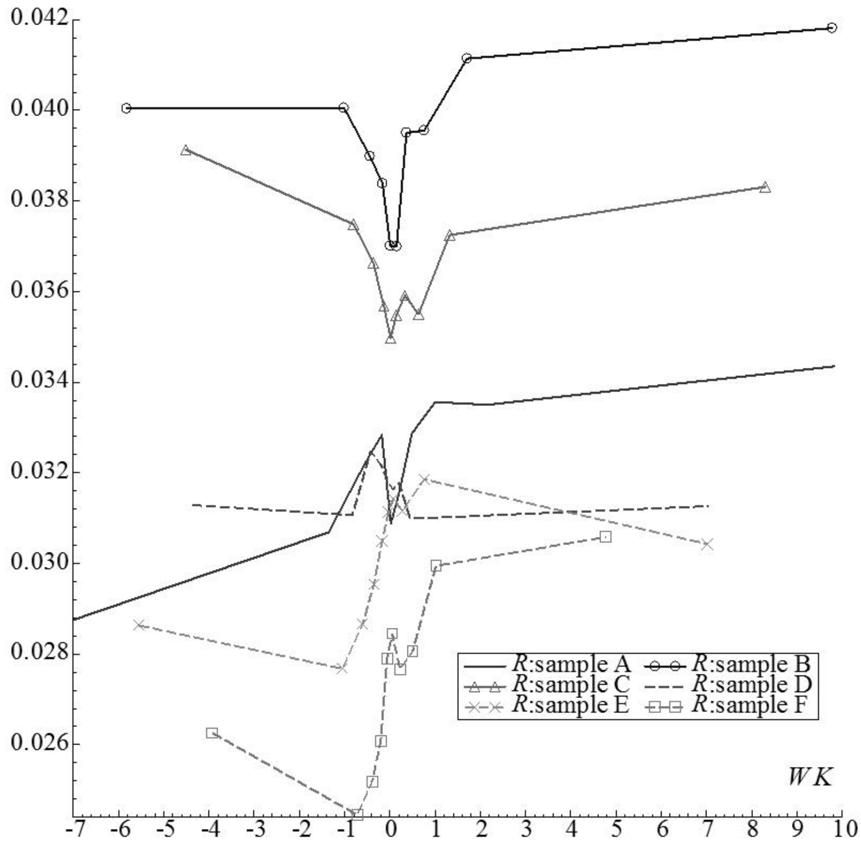
not support the theoretical predictions regarding the relation between firm size and the degree of information asymmetry.

III-2. Relation between the risk premium and internal funds

Figure 5 plots the relation between the effective interest rate and net liquid assets by splitting the observations of R_{it} and WK_{it} into deciles of WK_{it}, and computing the mean of R_{it} for each decile. The underpinning theory suggests that regardless of firm size, lower internal funds lead to a higher risk premium. Figure 5 does not show any negative relation between the effective interest rate and net liquid assets. The results are not consistent with the theoretical prediction. Meanwhile, the overall rank-order of the effective interest rate curves against net liquid assets follow the firm size order except sub-sample (A). This may suggest that firm size affects the risk premium.

Figure 6 plots the relation between the insolvency indicator and net liquid assets by

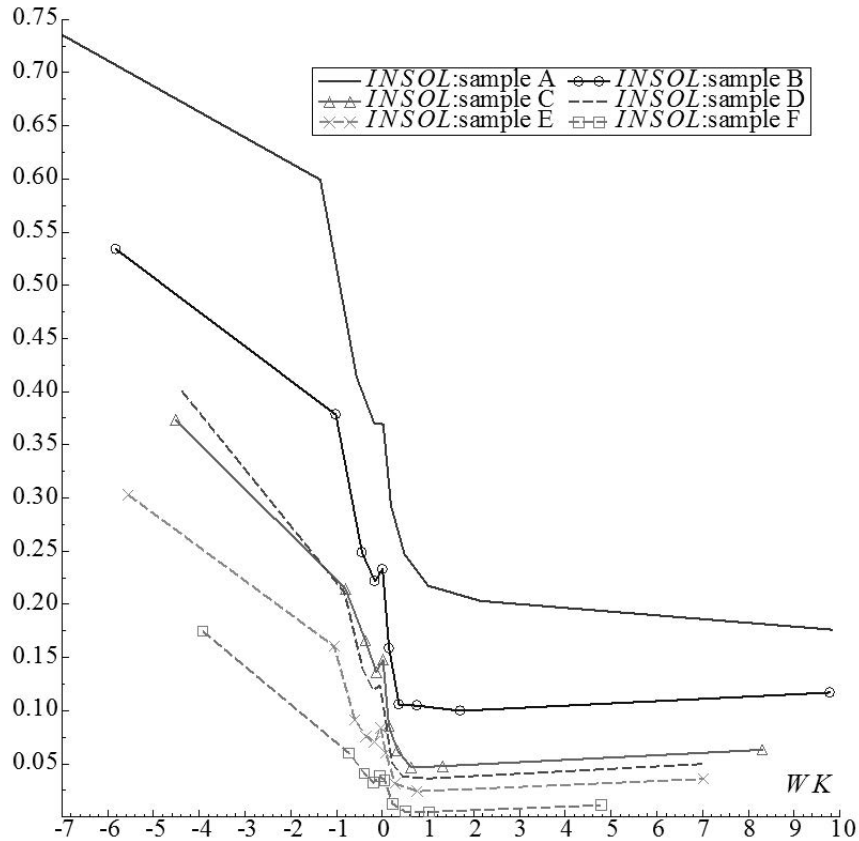
Figure 5. Mean Effective Interest Rate for Deciles of Net Liquid Assets by Firm Size, Bundle Plot (Vertical axis: mean R, horizontal axis: mean WK)



splitting the observations of $INSOL_{it}$ and WK_{it} into deciles of WK_{it}, and computing the mean of $INSOL_{it}$ for each decile. The plots for each size group show that firms with positive internal funds have a relatively low probability of insolvency while firms with negative internal funds have a high probability of insolvency. The negative relation between the probability of insolvency and net liquid assets is consistent with the model's prediction. I also find a positive relationship between firm size and the probability of insolvency.

The effective interest rate and insolvency indicator dummy are used as proxies for the risk premium. The results suggest that probability of insolvency is negatively related to net liquid assets. In contrast, the effective interest rate shows no negative relation with net liquid assets. For most size groups, the effective interest rate suddenly drops near zero net liquid assets. When net liquid assets become close to zero, the effective interest rate drops and the probability of insolvency rises sharply. Sheard (1994) reports that large Japanese public firms survive with the support of their main bank when they are in financial distress. He argues that the Japanese main bank plays an important role in helping firms work out of financial distress.

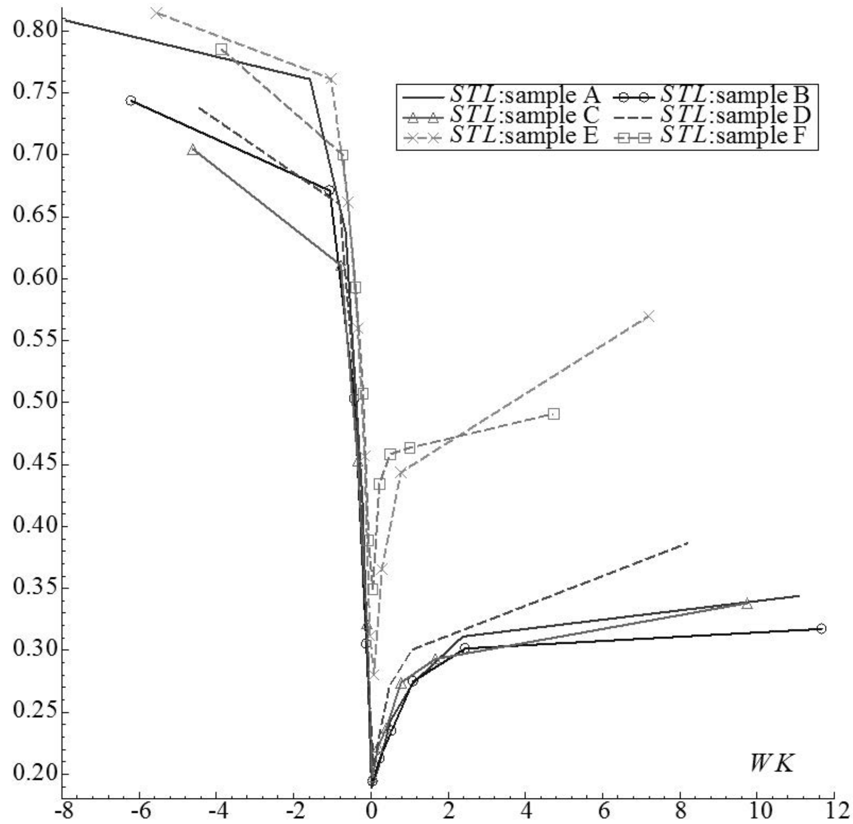
Figure 6. Insolvency Ratio for Deciles of Net Liquid Assets by Firm Size, Bundle Plot
(Vertical axis: mean *INSOL*, horizontal axis: mean *WK*)



By collecting information regarding main bank involvement with financially distressed firms from newspaper articles, he provides evidence that, as a financially distressed firm cannot meet their contracted obligations, deferrals or exemptions of interest payments may be granted for a specified period by its main bank. Although it is not observable whether financially distressed firms in the sample are granted deferrals or exemptions of interest payments, temporary interest payment reductions may be a clue to explain the ambiguous relation between the effective interest rate and net liquid assets.

The effective interest rate with positive net liquid assets are on average higher than that with negative net liquid assets. Another possibility to explain the positive relation between internal funds and the risk premium might be a firm's debt maturity choice. Bolton and Scharfstein (1990) argue that banks may terminate a firm's funding if its performance is poor to ensure that the firm doesn't divert resources to itself at the expense of banks. Banks can be benefited by offering a short-term lending contract which mitigates managerial incentive problems. On the other hand, Diamond (1991) studies the relationship between a firm's debt

Figure 7. Mean Short-Term Loan Ratio for Deciles of Net Liquid Assets by Firm Size, Bundle Plot (Vertical axis: mean STL, horizontal axis: mean WK)



maturity choice and default risk and shows that debt maturity is a non-monotonic function of default risk. In both models, a firm with high default risk prefers short-term debt over long-term debt. As long as the yield curve has a positive slope, debt with shorter maturity has a lower interest rate.

Following these theoretical predictions, I examine the relationship between firms' debt maturity, interest payments and internal funds. Debt maturity STL_{it}, indicating the short-term loan ratio, is constructed as

$$STL_{it} = \frac{BOPSL_{it}}{BOPSL_{it} + BOPLL_{it}},$$

where $BOPSL_{it}$ is beginning-of-period short-term loan and $BOPLL_{it}$ is beginning-of-period long-term loan and corporate bond. Figure 7 plots the relation between debt maturity and net liquid assets by splitting the observations of STL_{it} into deciles of WK_{it}. The short-term loan

Table 1. Summary Statistics

Size Group:	(A)	(B)	(C)	(D)	(E)	(F)
Upper row	Mean	Mean	Mean	Mean	Mean	Mean
Lower row	Std. Dev.	Std. Dev.	Std. Dev.	Std. Dev.	Std. Dev.	Std. Dev.
WK_{it}	1.005	1.340	1.375	1.100	.859	.617
	6.434	6.215	6.025	5.988	6.069	4.493
IK_{it}	.182	.180	.151	.147	.162	.153
	.490	.463	.394	.368	.370	.312
R_{it}	.032	.039	.037	.032	.030	.027
	.026	.024	.023	.021	.022	.021
STL_{it}	.432	.388	.372	.402	.529	.519
	.413	.379	.351	.350	.352	.329
DA_{it}	.955	.827	.744	.745	.719	.611
	.560	.459	.373	.364	.339	.301
$INSOL_{it}$	.334	.200	.120	.115	.083	.038
ROA_{it}	-.017	.004	.016	.020	.021	.021
	.146	.117	.093	.092	.092	.085
Observations						
WK_{it}	75658	49609	57385	38468	145039	94989
IK_{it}	73481	47058	55492	37545	144234	94351
R_{it}	54287	29967	42652	30571	117772	80407
STL_{it}	70271	46376	50998	33425	121709	81904
DA_{it}	78153	53060	59772	39871	150045	96451
$INSOL_{it}$	78153	53060	59772	39871	150045	96451
ROA_{it}	78076	53392	59896	39895	149775	96318

Notes: Columns (A) to (F) represent the size groups: Firms with stated capital of (A) less than ¥10 million, (B) ¥10 to 19 mil., (C) ¥20 to 49 mil., (D) ¥50 to 99 mil., (E) ¥100 to 999 mil., and (F) ¥1 billion or more.

ratio has a non-monotonic relationship with net liquid assets: the short-term loan ratio increases with positive net liquid assets while decreases with negative net liquid assets. STL_{it} is relatively high in the negative net liquid assets region. The above results suggest that firms with low net liquid assets chose short-term debt maturity and have a higher probability of insolvency.

Table 1 shows the summary statistics based on the trimmed firm-year observations over the period 1991-2010. Other than the variables used above, DA_{it} is debt/asset ratio and ROA_{it} is pre-tax profits/asset ratio. First, firms with larger stated capital are likely to have lower internal funds. However, the smallest size group has relatively low internal funds. Second, firms with smaller stated capital tend to invest more, suggesting that investment opportunities are related to firm size. Third, debt/asset ratio and the probability of insolvency decrease with firm size. Fourth, the mean of ROA_{it} is positively related with firm size but its standard deviation is negatively related with size. This implies that smaller firms are likely to bear higher risk premium than larger firms. Finally, the short-term loan ratio has a U-shaped curve with respect to firm size. The evidence that firms in both the highest and lowest risk groups choose shorter debt maturity is consistent with Diamond (1991).

III-3. Investment Regressions

The U-shaped relation between investment and internal funds is observed in Japanese firm data. On the other hand, the results so far do not suggest any link between the degree of information asymmetry and the U-shape investment curve. Several factors may affect a firm's investment choice. For instance, investment opportunities vary by firms, so that the U-shaped investment curve moves according to the heterogeneity of firms' investment opportunities. To control for the possible effect of factors other than internal funds, I employ a regression model in which investment is regressed on several relevant variables along with net liquid assets.

Following the standard investment regressions, investment is expressed as a linear function of investment opportunity. In addition, following Aivazian et al. (2005), STL_{it} and $INSOL_{it}$ are added to the investment regression as these variables are likely to be related to external financing costs. If banks recognize the heterogeneity of firms regarding their investment risks, firms regarded as riskier borrowers would be charged higher risk premium to compensate the risk of banks. The information on whether the firm is insolvent or not may serve as a signal of credit risk. As argued by Flannery (1986) and Diamond (1991), both the credit risk and debt maturity choice are considered as important variables affecting firms' investment choice. Following Cleary et al. (2007) and Guariglia (2008), I distinguish positive and negative net liquid assets to examine the non-monotonic effect of internal funds to investment.

I estimate investment regressions for each size group to test whether net liquid assets have a different impact on firms' investment with different degree of liquidity constraints. The investment function to be estimated is as follows:

$$IK_{it} = a_1 Neg_{it} + a_2 Pos_{it} + a_3 Neg_{it} WK_{it} + a_4 Pos_{it} WK_{it} + a_5 MV_{it} + a_6 STL_{it} + a_7 INSOL_{it} + \epsilon_{it},$$

where Neg_{it} is a dummy variable which takes one if WK_{it} is negative and otherwise zero, Pos_{it} is a dummy variable such that $Pos_{it} = 1 - Neg_{it}$ and MV_{it} is a proxy for investment opportunities. Tobin's Q is used as a proxy for investment opportunities in the standard literature. It is calculated using the market value of a firm. Since firms included in the Annual Survey for the Financial Statements Statistics of Corporations are mostly private, no information on market values of firms is collected in the survey. Instead, I calculate the following profit spread, denoted by MV_{it}:

Table 2. Investment Regressions by Firm Size

	(A)	(B)	(C)	(D)	(E)	(F)
Neg_{it}	.1040	.0966	.0918	.0795	.0841	.1076
	(.0056)***	(.0062)***	(.0044)***	(.0044)***	(.0022)***	(.0023)***
Pos_{it}	.1809	.1502	.1280	.1172	.1214	.1318
	(.0037)***	(.0042)***	(.0031)***	(.0032)***	(.0019)***	(.002)***
$NegWK_{it}$	-.0099	-.0123	-.0105	-.0091	-.0124	-.0113
	(.001)***	(.0012)***	(.001)***	(.0011)***	(.0004)***	(.0006)***
$PosWK_{it}$	.0149	.0168	.0135	.0137	.0104	.0150
	(.0006)***	(.0007)***	(.0005)***	(.0006)***	(.0003)***	(.0004)***
MV_{it}	.0692	.1941	.1752	.1212	.2283	.2661
	(.017)***	(.0275)***	(.0234)***	(.0249)***	(.0119)***	(.0129)***
STL_{it}	.0827	.0744	.0429	.0505	.0491	.0127
	(.0066)***	(.0086)***	(.0063)***	(.0063)***	(.003)***	(.0031)***
$INSOL_{it}$	-.0535	-.0502	-.0265	-.0361	-.0277	-.0088
	(.0047)***	(.0064)***	(.0057)***	(.006)***	(.0034)***	(.0051)*
$\bar{R}^2$	.0309	.0421	.0266	.0326	.0324	.0317
Obs.	46,602	26,666	38,956	28,077	108,344	75,751

Notes: Columns (A) to (F) represent the size groups: Firms with stated capital of (A) less than ¥10 million, (B) ¥10 to 19 mil., (C) ¥20 to 49 mil., (D) ¥50 to 99 mil., (E) ¥100 to 999 mil., and (F) ¥1 billion or more. Standard errors are in parentheses. The asterisks *** and * indicate statistical significance at the 1% and 10% levels, respectively.

$$MV_{it} = ROA_{it} - R_{it},$$

where ROA_{it} represents the firm's return while R_{it} represents the lender's risk-adjusted return.

Table 2 shows the estimation results. All coefficients on Neg_{it} WK_{it} and Pos_{it} WK_{it} are significant and have expected signs. The positive net liquid assets have a positive effect on investment and negative net liquid assets have a negative effect, suggesting a U-shaped investment curve with respect to internal funds. The magnitude of estimated coefficients across different size groups do not increase or decrease monotonically with size. The results are not consistent with the predictions of the model in the previous section. Thus, I do not find strong evidence to support the link between firm size and the degree of information asymmetry by judging from the sensitivities of investment to negative or positive internal funds.

Neg_{it} constant dummies are all significant and show no tendency to change monotonically with firm size. Meanwhile, Pos_{it} dummies tend to decrease with firm size. This result suggests that smaller firms invest more than larger firms when they have the same level of internal funds, which is inconsistent with the conventional assumption that smaller firms are more financially constrained and invest less. One of the solutions derived from the model in the previous section illustrates that firms with more severe information asymmetry invest more.

On the other hand, all coefficients on MV_{it} are positive and significant. The estimated coefficients on MV_{it} in general increase with firm size. The results suggest that larger firms invest more than smaller firms when they have the same investment opportunities. All coefficients on STL_{it} are positive and significant. The effect of choosing shorter debt maturity on investment tends to decrease with firm size. Meanwhile, the coefficients on $INSOL_{it}$ are all negative and significant. The effect of insolvency on investment varies by firm size. It is much greater for smaller firms.

Choosing shorter debt maturity may mitigate the asymmetric information problem and reduce agency cost. Flannery (1986) suggests that firms may use short debt maturity to send a signal of firm quality to the imperfect capital market. In table 2, the negative relationship between the magnitude of the estimated coefficients of STL_{it} and firm size indicates that choosing short maturity debt increases investment more for smaller firms. As seen in table 1, the ratio of insolvent firms to total firms is negatively related to firm size. In table 2, the negative sensitivity of investment to $INSOL_{it}$ tends to rise with firm size. When banks are less informed than firms about investment opportunities, they are likely to rely on the average quality of investment opportunities that similar firms have (e.g., Myers and Majluf 1984). The average insolvency ratio in each size group may represent the average credit risk of the group. Then, the magnitude of the estimated coefficients of $INSOL_{it}$ can be interpreted as a risk discount measure priced by banks, reducing firms' investment.

IV. Conclusion

This investigation is intended to provide better insight into the relationships between investment, internal funds and firm size. The investigation was conducted using a pooled sample of large and small, public and private Japanese firms extracted from the Annual Survey for the Financial Statements Statistics of Corporations over the period 1991 - 2010. Using the data set, I find strong evidence that investment is U - shaped in net liquid assets. Meanwhile, I find little evidence of a direct link between firm size and liquidity constraints on investment suggested by a large amount of corporate finance literature.

Other results in this study offer some insights into how agency costs are generated in imperfect capital markets. Flannery (1986) and Diamond (1991) focus on how a bank infers the risk of the firm's investment project. They argue that firms regarded as riskier borrowers would be charged higher risk premium to compensate the risk of banks. The information on whether the firm is insolvent may serve as a signal of credit risk. The results indicate that firms' insolvency and debt maturity have significant effects on investment. Firm size tends to mitigate the negative insolvency effect on investment. That is, larger firms reduce investment less than smaller firms when they are insolvent. On the other hand, the short - term loan ratio increases investment and this maturity - choice effect on investment is negatively related to firm size. Debt maturity choice and solvency of firms may work as a signal of firm quality to the imperfect capital market. The results obtained in this study generally support the ideas of Flannery (1986) and Diamond (1991).

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