Term Structure of Debt and Investment Spikes

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Abstract:

This study examines how the term structure of corporate debt influences the likelihood of a spike in corporate investments. To analyze this issue, we tested the following two hypotheses using a proportional hazards model used in previous studies: The rollover risk hypothesis states that an increase in the short-term debt ratio raises the debt rollover risk, decreasing the likelihood of investment spikes. By contrast, the investment promotion hypothesis states that an increase in the short-term debt ratio decreases the degree of agency problems and improves the efficiency of lending banks' information production, increasing the likelihood of investment spikes. Our sample comprised Japanese listed companies, excluding utilities and financial firms, from FY 2002 to FY 2017. Our results are consistent with the rollover risk hypothesis, and the main results hold even after considering an endogeneity issue. This study indicates that overreliance on short-term debt financing increases rollover risk, which reduces financial flexibility, and that short-term debt financing for large long-term investments restrains future corporate investments.

Keywords: Financial flexibility, term structure of debt, rollover risk, bank loans, large investment

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1. Introduction

This study examines how the term structure of corporate debt influences the likelihood of investment spikes. The literature on financial flexibility (Denis and McKeon, 2012; DeAngelo and Roll, 2015; DeAngelo et al., 2018; Kikuchi and Ito, 2021) argues that securing sufficient financing capacity reduces potential costs arising from failure to make large investments in response to a future rise in investment needs. While the term structure of debt likely affects future financial flexibility (Graham and Harvey, 2001; Almeida et al., 2009), the literature does not agree on the desired mix of debt maturity.

The existing literature expresses two opposing views on the relationship between the term structure of debt and corporate investment. The first group of studies argues that an increase in the short-term debt ratio raises the debt rollover risk, decreasing corporate investment (Rajan, 1992; Froot et al., 1993; Graham and Harvey, 2001; Harford et al., 2014; Chiu and Wang, 2019; Iwaki and Saito, 2022). Rajan (1992) argues that banks tend to have higher negotiation power at the time of debt rollover for firms with a higher proportion of short-term debt, leading to increased holdup costs. Moreover, Graham and Harvey (2001) argue that the financing cost of rolling over debt tends to be higher when the duration of real assets is longer than that of debt, causing decreased future investment.

In contrast, the second group of studies argues that an increase in the short-term debt ratio increases corporate investment (Myers, 1977; Rajan and Winton, 1995; Harvey et al., 2004). Myers (1977) shows that underinvestment problems occur because of the agency problems associated with debt. However, short-term debt reduces the degree of agency problems because of frequent monitoring and increases corporate investment. Rajan and Winton (1995) and Harvey et al. (2004) assert that an increase in the short-term debt ratio increases the efficiency of information production through frequent bank monitoring, lowering a firm's financing costs. Reduced financing costs are likely to increase corporate investments.

Based on these arguments, we propose the following two hypotheses: Hypothesis 1 states that an increased short-term debt ratio decreases the likelihood of investment spikes because of higher rollover risk (hereafter, "the rollover risk hypothesis"). Hypothesis 2 states that an increased short-term debt ratio leads to an increased likelihood of investment spikes because of more frequent monitoring (hereafter, "the investment promotion hypothesis"). To test these hypotheses, we apply a lumpy

investment model that many studies use as an empirical model consistent with the actual behavior of corporate investments (Cooper et al., 1999; Cooper and Haltiwanger, 2006).

The lumpy investment model implies that the likelihood of investment spikes can be increased by reducing adjustment costs, which are assumed to be non-convex (Cooper and Haltiwanger, 2006; Verona, 2014). Whited (2006) and Billett et al. (2011) estimate proportional hazards models for lumpy corporate investments and find that increased financial constraints effect increased adjustment costs, reducing the investment spike probability. Kikuchi and Ito (2021) expand on Whited (2006) and Billett et al. (2011) by considering the opportunity cost arising from failed financing for large investments as part of the adjustment costs. However, these studies do not explicitly examine the effect of the term structure of debt, although it is likely to affect the financing capacity and feasible investment. This study aims to fill this gap in the literature.

Following the literature (Whited, 2006; Billett et al., 2011), this study estimates hazards models to test the proposed hypotheses and finds that the empirical results are consistent with the rollover risk hypothesis. We use two approaches to address an endogeneity issue. First, we apply the instrumental variable (IV) estimation method to linear probability models for the occurrence of investment spikes. Second, we implement a difference-in-differences (DID) method using a propensity-score-matched sample. The results remain qualitatively unchanged after incorporating an endogeneity issue. Thus, the empirical results show that an increase in the short-term debt ratio increases the rollover risk of debt, reducing the degree of financial flexibility required for large investments.

This study contributes to the literature in three ways. First, it adds to the literature on financial flexibility (Graham and Harvey, 2001; Denis and McKeon, 2012; DeAngelo and Roll, 2015; DeAngelo et al., 2018; Kikuchi and Ito, 2021) by showing that the term structure of debt plays an important role in determining financial flexibility. The literature focuses on reducing debt to increase financial flexibility. However, considering that the term structure of debt likely affects a firm's financing capacity (Graham and Harvey, 2001), it predicts that the term structure of debt is likely to be an important determinant of large corporate investment. This study confirms this prediction. Furthermore, in contrast with Almedia et al. (2009), which shows that a longer maturity of corporate bonds affects corporate investment only during the credit reduction period, we show that the

debt term structure affects corporate investment during both normal and credit reduction periods.

Second, it contributes to the debate on how the term structure of debt influences corporate investment by showing that shorter maturity is likely to decrease investment. Rajan (1992) and Harford et al. (2014) argue that an increase in the short-term debt ratio increases the rollover risk of debt, reducing corporate investment. By contrast, Myers (1977) argues that the use of short-term debt decreases the agency cost of debt, leading to larger investments. Furthermore, Rajan and Winton (1995) and Harvey et al. (2004) assert that an increase in the short-term debt ratio increases the efficiency of debtholders' information production on borrowing firms, engendering increased investment. This study empirically supports the argument that a short-term structure decreases corporate investment.

Finally, this study adds to the empirical literature on lumpy investment using hazards models (Whited, 2006; Billett et al., 2011; Kikuchi and Ito, 2021) by evincing that the term structure of debt plays an important role in determining corporate investment. While the term structure of debt likely affects a firm's financing capacity and investment (Rajan, 1992; Graham and Harvey, 2001; Harford et al., 2014; Chiu and Wang, 2019; Iwaki and Saito, 2022), empirical studies (Whited, 2006; Billett et al., 2011; Kikuchi and Ito, 2021) do not consider the term structure of debt when estimating models for investment. This study shows that the term structure of debt is a statistically significant determinant of corporate investment in the context of a lumpy investment model.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature, and Section 3 explains the hypotheses. Section 4 describes empirical methods and data and provides basic statistics for the variables used in this study. Section 5 presents the main results and robustness checks for endogeneity. Finally, section 6 concludes the study.

2. Previous Literature

2.1.Financial flexibility

The literature on financial flexibility focuses on the intertemporal dependence between financing and investment (Gamba and Triantis, 2008; Almeida et al., 2011; DeAngelo et

al., 2011; Denis and McKeon, 2016, Kikuchi and Ito, 2021). Considering that a firm's current financing activities are likely to constrain investment activities in the future, DeAngelo and DeAngelo (2007) and DeAngelo et al. (2011) argue that an important cost related to financing activities and the resulting capital structure is the opportunity cost arising from failed financing for investment when investment needs occur in the future. Specifically, an increase in current financing capacity decreases the probability of financing failure in the future, increasing the likelihood of timely large investments. Graham and Harvey (2001) posit that the costs of frequent debt rollover likely constrain the amount of cash available for future investments, implying that the term structure of debt influences a firm's financial flexibility.

2.2.Term structure of debt and corporate investment

Literature presents two contrasting views on the relationship between the term structure of debt and corporate investment. The first strand of literature argues that an increased short-term debt ratio increases the risk of failure to roll over the debt, reducing the likelihood of future corporate investment (Rajan, 1992; Froot et al., 1993; Graham and Harvey, 2001; Harford et al., 2014; Chiu and Wang, 2019; Iwaki and Saito, 2022). Rajan (1992) states that, when a firm relies greatly on short-term bank debt, the lending bank tends to have greater negotiation power against the firm at the time of debt rollover. Thus, the increased holdup costs discourage large corporate investments. Short-term debt financing tends to generate additional costs, such as unexpectedly high interest rates and failure to rollover at an intended full amount (Froot et al., 1993; Harford et al., 2014; Chiu and Wang, 2019; Iwaki and Saito, 2022). Graham and Harvey (2001) suggest that an increase in short-term debt increases the cost of debt rollover, decreasing future investment.

The second strand of literature states that, when a firm increases the proportion of short-term debt, it increases the likelihood of large investments by decreasing the agency costs of debt and increasing the efficiency of debtor monitoring (Myers, 1977; Rajan and Winton, 1995; Harvey et al., 2004). Myers (1977) argues that long-term debt financing increases the agency costs of debt, whereas short-term debt likely increases corporate investment by mitigating the agency costs of debt. Furthermore, short-term debt financing increases the efficiency of information production by lending banks and other

debt holders (Diamond, 1984; Diamond, 1991). Rajan and Winton (1995) and Harvey et al. (2004) indicate that a firm's increased reliance on short-term debt increases the frequency of bank monitoring, improving the bank's information production and easing the degree of information asymmetry between a firm and its debtholders.

3. Hypotheses

This study examines how the term structure of debt influences the likelihood of investment spikes. Based on the literature, we propose the following two hypotheses:

3.1. Rollover risk hypothesis

An increased short-term debt ratio increases the risk of failure to roll over the debt, reducing the likelihood of future corporate investment (Rajan, 1992; Froot et al., 1993; Graham and Harvey, 2001; Harford et al., 2014; Chiu and Wang, 2019; Iwaki and Saito, 2022).

Hypothesis 1:

The higher the short-term debt ratio, the lower the likelihood of investment spikes.

3.2. Investment promotion hypothesis

When a firm increases its ratio of short-term debt to total debt, it increases the likelihood of large investments by decreasing the agency costs of debt and increasing the efficiency of debtor monitoring (Myers, 1977; Rajan and Winton, 1995; Harvey et al., 2004).

Hypothesis 2:

The higher the short-term debt ratio, the higher the likelihood of investment spikes.

4. Methodology and Data

4.1 Methodology

A lumpy investment model based on non-convex adjustment costs is widely used to examine corporate investment behavior because it predicts the investment spikes observed in actual investment data (Caballero and Engel, 1999; Cooper et al., 1999; Cooper and Haltiwanger, 2006). The characteristics of this investment model are

consistent with those of a hazards model that analyzes the likelihood of events occurring by considering the time until a given event occurs. Thus, many studies adopt a hazards model to examine the likelihood of investment spikes. Whited (2006) and Billett et al. (2011) use a Cox proportional hazards model to estimate the parameters of covariates without specifying the shape of the baseline hazard function.

Following past studies, we employ a proportional hazards model to examine the likelihood of large investments by firms with rollover risk. The proportional hazards model is expressed as follows:

$$\boldsymbol{h(t, X_i) = h_0(t)\exp(\beta X_i)}, \quad (1)$$

where X_i is a vector of covariates and β is a vector of parameters to be estimated. $h(t, X_i)$ is the hazard function associated with large investments and indicates the conditional probability that a firm that has not made a large investment before time t will undertake a large investment at time t. $h_0(t)$ represents the baseline hazard function, which is independent of the covariates X_i and solely dependent on time t. $exp(\beta X_i)$ is the hazard ratio that depends on the covariate X_i. Therefore, a proportional hazards model does not require specific assumptions about the baseline hazard function $h_0(t)$, and the vector of parameters β can be estimated with a partial maximum likelihood estimation. In the estimation results of the hazards model, the $exp(\beta_k)$ for covariate x_k represents its effect on the hazard rate. When β_k is positive (negative), that is, $exp(\beta_k) > 1$ ($exp(\beta_k)<1$), it indicates that the likelihood of large investments increases (decreases) with covariate x_k.

4.2 Data

We use Nikkei's Quick Astra Manager, Nikkei NEEDS, and Nikkei's NEEDS-Financial QUEST data to construct covariates based on firms' financial information. Credit rating information is obtained from publicly available data provided by R&I, a well-known credit rating service in Japan. Our data sample covers the period from FY 2002 to FY 2017. Our data sample comprises Japanese listed companies (including those listed on the OTC market). We exclude firms in the utility and financial industries

because firms in regulated industries are likely to have different investment and financing policies owing to the unique nature of their competitive environments (Whited, 2006; Billett et al., 2011). Additionally, following Whited (2006), we include firms only if they have at least five consecutive years of data. Following previous studies, we define large investments, excluding M&A transactions, as having an investment ratio (total investment amount/total tangible fixed assets) of 0.2 or higher (Cooper et al., 1999; Nilsen and Schiantarelli, 2003; Cooper and Haltiwanger, 2006).[1]

The dataset used to estimate the hazards model does not have information on large investments made before and after the sample period (FY 2002–2017). Therefore, we follow prior studies (Whited, 2006; Billett et al., 2011) to consider data censoring before (left censoring) and after (right censoring) the sample period. Our sample includes firms that made large investments during the sample period. Our sample consists of 33,611 firm-year observations.

4.3 Covariates used in the hazards model

This section describes the covariates used to estimate the hazards model. First, we define the covariates related to our hypotheses and then describe our control variables. The Appendix provides the detailed definitions of these variables.

Covariates related to our hypotheses

Short-term debt / total assets

It is defined as short-term debt divided by total assets[2]. To estimate the empirical model, we use one-year lagged data.

Short-term loan / total assets

It is defined as short-term loan divided by total assets[3]. To estimate the empirical model, we use one-year lagged data.

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[1] Total investment amount was defined as the net increase in tangible fixed assets (current year tangible fixed assets - prior year tangible fixed assets + depreciation). As a robustness check, we change the investment ratio threshold used to define large investments from 0.2 to 0.175 and 0.225 and find that our empirical results are generally unchanged.

[2] The short-term debt is the sum of current portion of borrowings and current portion of bonds (including CP but excluding convertible bonds).

[3] The short-term loan is debt due within one year.

Control variables

First, we construct several variables to control for factors other than the term structure of debt that affect large investments. We create a dummy variable, ***Bank in major shareholders***, which equals 1 if one or more banks are among the firm's top 10 major shareholders and 0 otherwise (Hoshi et.al., 1990b; Prowse, 1990; Morck et.al., 2000). Moreover, we create a dummy variable, ***Director from bank***, which equals 1 if a firm's board of directors includes any individuals from its banks and 0 otherwise (Hoshi et.al., 1990; Prowse, 1990; Morck et.al., 2000).

Second, we consider access to external financial markets. We construct variables that represent ease of access to financing by issuing corporate bonds or equity, which are sources of funding other than bank loans. Yasuda (2005) suggests that, if firms continue to access the corporate bond market, maintaining recognition in that market, it is easier for them to raise funds by issuing bonds. Therefore, we construct a dummy variable, ***Bond***, that equals 1 if there are corporate bonds on a firm's balance sheet and 0 otherwise. Baker and Wurgler (2002) suggest that, when the market value of a firm's equity is relatively high, it can easily raise additional equity capital. Therefore, we use the price-to-book ratio, ***PBR***.

In addition, we create dummy variables that divide the sample firms into quartiles along the debt ratio to control for firms' debt financing capacity, denoted by ***Leverage 1st quartile, Leverage 2nd quartile, Leverage 3rd quartile,*** and ***Leverage 4th quartile.***[4] Each quartile dummy equals 1 if the firm's debt ratio falls in that quartile and 0 otherwise. Referring to Whited (2006), we construct a variable representing a firm's liquidity, ***Cash ratio***, and proxy variables for investment opportunities, ***Sales growth*** and ***Cash Flow (CF) to assets***. Furthermore, we construct ***Log (Total assets)***, ***Log (Age)***, and ***Credit rating*** dummy variables. We use one-year lagged data for explanatory variables. Additionally, we include ***Industry*** and ***Year*** fixed effects.

4.4 Descriptive statistics

[4] The debt ratio is interest-bearing debt divided by total assets. Interest-bearing debt is the sum of bank borrowings, bonds, and commercial paper on the balance sheet. It does not include convertible bonds.

Table 1 presents the descriptive statistics of the main variables used in this study. We winsorize continuous variables at the 1st and 99th percentiles. First, ***Total debt / Total assets*** show that, on average, the interest-bearing debt ratio is approximately 19% in the sample firms. Second, a comparison of the average between ***Total debt / Total assets*** and ***Short-term debt / Total*** assets shows that short-term debt accounts for most interest-bearing debt in the sample firms. Finally, a comparison of the average between ***Short-term debt / Total assets*** and between ***Short-term loan / Total assets*** shows that short-term loans constitute most short-term debt. This indicates that, for debt financing in Japan, bank loans, which are indirect financing, are still preferred over bond issuance, which is direct financing.

For ***Investment rate***, the threshold for defining a large investment is 0.200. The mean and median of the sample are 0.227 and 0.137, respectively. This indicates that certain extreme samples increase the mean. Figure 1 shows the number of large investments and percentage of firms that made large investments during the analysis period. The percentage of firms that made large investments during the analysis period averaged 21% per year. These figures are generally consistent with those in previous studies (Cooper and Haltiwanger, 2006).

Insert Table 1 and Figure 1 about here.

5. Results

5.1 Estimation results for the proportional hazards model

This section estimates a proportional hazards model to examine how the term structure of corporate debt affects the likelihood of a company making large investments. Table 2 shows the estimated coefficients of the model's covariates. Columns (1) and (2) of Table 2 test Hypotheses 1 and 2, focusing on short-term debt and loans as a percentage of total assets. Column (1) shows that the coefficient of ***Short-term debt / total assets*** is less than 1 (0.708) and statistically significant at the 1% level. In addition, the estimation results in Column (2) indicate that the coefficient of ***Short-term loan / total assets*** is less than 1 (0.698) and statistically significant at the 1% level. This indicates that the higher the ratio of short-term debt and loans to total assets, the lower the likelihood that the firm will make a large investment. The results in Columns (1) and (2)

are consistent with Hypothesis 1, which states that an increased short-term debt ratio increases the risk of failure to roll over the debt, reducing the likelihood of future corporate investment.

Insert Table 2 about here.

Furthermore, we briefly describe the estimation results for the coefficients of the control variables. Regarding the variables related to the non-loan channel of information production, the coefficients of ***Director from bank*** are statistically non-significant, while ***Bank in major shareholders*** is less than 1 and statistically significant at the 1% level. These results suggest that, if banks are the major shareholders of firms, the likelihood of large investments decreases. However, firms in which banks are the major shareholders tend to have a longer corporate history. Therefore, this result can be attributed to firm maturity. Regarding the variables related to the ease of access to capital markets, the coefficient of ***Bond*** is statistically non-significant, while the coefficient of ***PBR*** is greater than 1 and statistically significant at the 1% level. These results suggest that, when a firm's equity value is relatively high, it is easier for the firm to raise funds in the equity market, which increases the likelihood of large investments. Regarding the quartile dummies for a firm's debt ratio, ***Leverage 1st quartile, Leverage 2nd quartile,*** and ***Leverage 3rd quartile*** are related to a firm's debt financing capacity. The coefficients of the dummy variable are greater than 1 and statistically significant at the 1% level. This result indicates that firms with debt ratios lower than those in the highest quartile are more likely to undertake large investments.

The coefficient of ***Cash ratio***, a proxy variable for liquidity, is greater than 1 and statistically significant at the 1% level. Moreover, the coefficients of ***Sales growth*** and ***CF to assets***, which are proxy variables for investment opportunities, are greater than 1 and statistically significant at the 1% level. Specifically, the estimation results show a positive correlation between investment opportunities and the likelihood of large investments. ***Log (Age)*** and ***Log (Total assets)***, which we expect to relate to firm maturity, are negatively correlated with the likelihood of large investments. The coefficient of ***Log (Age)*** is below 1 and statistically significant at the 1% level, which is consistent with our expectation. In contrast, the coefficient of ***Log (Total assets)*** is

greater than 1 and statistically significant at the 1% level. We interpret this result to indicate that small firms listed on the OTC market and local exchanges are relatively constrained in financing their investments.

5.2 Robustness check: estimation results of the linear probability model

In Section 5.1, we estimate the likelihood of large investments using covariates representing the term structure of debt. The estimated results are consistent with Hypothesis 1. However, if a firm determines its term structure of debt based on plans for future large investments, reverse causality renders the covariates in the analysis endogenous, biasing the estimation results. To examine whether endogeneity influences the empirical results, we estimate a linear probability model using the IV method, instead of a proportional hazards model. As a linear probability model is estimated using the ordinary least squares method, IV estimation is relatively easy to apply to a linear probability model. The equation estimated using the linear probability model is as follows:

$$\boldsymbol{E}(\boldsymbol{y_{it}}|\boldsymbol{X_{it}}) = \boldsymbol{Pr}(\boldsymbol{y_{it}} = \boldsymbol{1}|\boldsymbol{X_{it}}) = \boldsymbol{\beta'X_{it}}. \quad (2)$$

The dependent variable $\boldsymbol{y_{it}}$ is a dummy variable that takes the value of 1 if a large investment occurs for firm *i* at time *t* and 0 otherwise. The vector of independent variables $\boldsymbol{X_{it}}$ corresponds to the covariates used in the hazards model described above. Additionally, we use dummy variables denoted by ***Duration*** for the amount of time elapsed since the firm's last large investment.

We assume that ***Short-term debt / total assets*** and ***Short-term loan / total assets*** are endogenous. For the instrumental variable associated with ***Short-term debt / total assets*** and ***Short-term loan / total assets***, we use the percentage of loans from large money-center commercial banks relative to total loans in 1995, denoted by ***Large bank share (1995)***. Sasaki and Suzuki (2019) examine the relationship between bank health and firms' cash holding policies. They argue that banks' property loans in Japan in the late 1980s effectuated several non-performing loans in later years, significantly affecting the health of Japan's banks. They adopted the percentage of banks' property

loans (total property loans divided by total assets) during the 1980s as the instrumental variable for current bank health. Following these studies, we posit that ***Large bank share (1995)***, calculated when the effects of the main bank system persisted within corporate loans, affects firms' current borrowing composition. As large money-center commercial banks contribute to corporate growth through long-term loans as the main bank (Aoki and Patrick, 1995; Arikawa and Miyajima, 2015), a negative correlation exists between a ***Large bank share (1995)*** and financing with short-term debt in later years. Although the instrumental variable must correlate with endogenous variables, they should not directly correlate with the dependent variable. As a firm's investment behavior depends on its current business environment and characteristics, we believe that ***Large bank share (1995)***, a value realized many years ago, only indirectly correlates with firms' recent large investment decisions through the recent debt term structure.

Table 3 presents the estimation results of the linear probability models using the IV method. The coefficients of the explanatory variables represent the marginal effects, with positive (negative) coefficients increasing (decreasing) the likelihood of large investments. The estimation results in Column (1) indicate the coefficient of ***Short-term debt / total assets*** as negative and significant. In addition, the estimation results in Column (2) indicate the coefficient of ***Short-term loan / total assets*** as negative and significant. Specifically, the empirical results are generally unchanged, even after considering the potential for endogeneity in the IV method. The results of the endogeneity test reject the null hypothesis that ***short-term debt / total assets*** and ***short-term loan / total assets*** are exogenous variables. The Cragg–Donald Wald F-statistics show that a weak correlation is not a serious concern.

Insert Table 3 about here.

5.3 Robustness check: estimation results of difference-in-differences analysis using the propensity score matching method

We conduct DID analysis using the propensity score matching method to check the robustness of the estimation results. Using the DID analysis, we estimate the average treatment effect, ***ATET***, from the pre- to post-exogenous shocks between the treatment

and control groups. We control for selection bias along observable variables by matching treatment firms with potential control firms using propensity scores.

Following Almeida et al. (2009), who estimate how the maturity structure of long-term debt, mainly corporate bonds, affects firms' investment behavior during the credit crunch using a DID analysis, we focus on the 2008 Lehman shock as an exogenous shock and examine how post-shock investment behavior differs between firms heavily relying on short-term debt (treatment firms) and firms mildly relying on short-term debt during the pre-shock period. We define the three fiscal years from FY2005 to FY2007 as the period before the occurrence of exogenous shocks, ***PRE period***, and the three fiscal years from FY2008 to FY2010 as the period during and after the occurrence of exogenous shocks, ***POST period***. We define treatment firms as firms that consistently had short-term debt ratio above 0.15 across all years for the ***PRE period***[5]. For the outcome variables, we use ***investment rate***, a continuous variable, as an outcome variable in the DID estimation because a positive correlation exists between ***Investment rate*** and the likelihood of large investments. Thus, we examine whether changes in ***Investment rate*** between the ***PRE period*** and ***POST period*** differ between the treatment and control groups.

To control for differences in observable characteristics between the treatment and control groups, we use a propensity score matching method to match treatment and control groups. The propensity score indicates the probability of being assigned to a treatment group using observable covariates. By matching the treatment group with the control group based on propensity scores, we eliminate selection bias among the observables. First, we adopt ***PBR***, ***Cash ratio***, ***Sales growth***, ***CF to assets***, ***Log (Age)***, and ***Log (total assets)*** as the matching covariates. For ***PBR***, ***Cash ratio***, ***Sales growth***, ***CF to assets***, and ***Log (Age)***, we use the average values during the ***PRE period***. For ***Log (Total assets)***, we calculate the average value over the ***PRE period*** and create dummy variables that divide firms into quartiles. Second, we use industry and rating dummy variables as categorical variables. Finally, to meet the parallel trend assumption, we adopt a variable that represents the growth rate of the ***Investment rate*** for the ***PRE***

[5] For the entire sample, the short-term debt ratio is divided into quartiles, with the threshold for the first largest and second largest quartile being 0.148. With reference to this threshold, we define the treatment group as the sample group with a short-term debt ratio consistently above 0.15 over the PRE period.

period, ***Investment rate growth (2005–2007)*** [6]. Based on the propensity scores calculated as described above, we conduct one-to-one nearest neighbor matching with replacement. Consequently, 400 and 308 firms exist in the treatment and control groups, respectively.

Panel A of Table 4 tests for statistically significant differences in the covariates between the treatment and control groups for the ***PRE period***. First, we assess whether the parallel trend assumption is satisfied. If the parallel trend assumption is not satisfied, the control group has no counterfactual validity. We find no statistically significant difference between the treatment and control groups for ***Investment rate growth (2005–2007)***. Second, we find no statistically significant differences between the treatment and control groups for any of the covariates related to other firm characteristics. This indicates that the covariates used to estimate the propensity scores are balanced between the treatment and control groups after matching. In the matching process, we use the quartile dummies of ***Log (Total assets)*** as the variable for firm size. However, to more precisely confirm that firm size is balanced between the treatment and control groups, we also report the results of a test of the difference in ***Log (Total assets)***. No statistically significant difference exists in ***Log (Total assets)*** between the treatment and control groups.

Panel B of Table 4 presents the estimates of ***ATET*** for the outcome variables. The estimation results show that ***ATET*** is significantly negative, indicating that the degree of decrease in ***Investment rate*** of the treatment group is greater than that of the control group after the Lehman shock. Specifically, firms that rely heavily on short-term debt financing are at an increased risk of being unable to refinance owing to the credit crunch and, therefore, their ***Investment rate*** decreases. This estimation result is consistent with the rollover risk hypothesis.

Insert Table 4 about here.

6. Conclusion

[6] We defined ***Investment rate growth (2005–2007)*** as the investment rate in FY 2007 divided by the investment rate in FY2005, minus 1.

This study examines how enhancing financial flexibility along the term structure of debt affects the likelihood of large corporate investments. While past studies indicate that the term structure of debt affects firms' financial flexibility, they do not reach an agreement on the desired mix of short- and long-term debt. Specifically, two opposing groups of the literature show that financing with short-term debt either increases or decreases corporate investments. Rajan (1992), Graham and Harvey (2001), Harford et al. (2014), Chiu and Wang (2019), and Iwaki and Saito (2022) argue that an increased short-term debt ratio increases the risk of failure to roll over the debt, reducing the likelihood of future corporate investment. In contrast, Myers (1977), Rajan and Winton (1995), and Harvey et al. (2004) argue that, when a firm increases the proportion of short-term debt, it increases the likelihood of large investments by decreasing the agency costs of debt and increasing the efficiency of debtor monitoring.

Thus, we propose the following two hypotheses. The rollover risk hypothesis predicts that firms with higher short-term debt ratios are less likely to make large investments, whereas the investment promotion hypothesis predicts that firms with higher short-term debt ratios are more likely to make large investments. We test the hypotheses using a proportional hazards model used in previous studies to estimate the likelihood of large investments. Our sample comprises Japanese listed companies, excluding utilities and financial firms, from FY 2002 to FY 2017. The main empirical results are consistent with the rollover risk hypothesis. Moreover, our results remain largely unchanged even after considering the possibility of endogeneity in the variables related to rollover risk. They suggest that overreliance on short-term debt financing increases rollover risk, reducing financial flexibility. Our empirical results support the survey by Graham and Harvey (2001), which suggests that short-term debt financing for large long-term investments restrains future corporate investments.

Future research should expand the scope of our analysis by including other countries, especially those in which bank loans are the predominant source of financing. In such countries, companies may be more conscious of banks' information production, making the investment promotion effect of short-term debt stronger than that in Japan.

【References】

Almeida, H., Campello, M., Laranjeira, B., Weisbenner, S., 2009. Corporate debt maturity and the real effects of the 2007 credit crisis, Nber working paper series.

Almeida, H., Campello, M., Weisbach, M., 2011. Corporate financial and investment policies when future financing is not frictionless. Journal of Corporate Finance 17, 675–693.

Aoki, M., Patrick, H., Sheard, P., 1995. The Japanese main bank system: an introductory overview. In Aoki, M., Patrick, H. (Eds.), The Japanese main Bank system: its relevance for developing and transforming economies. Clarendon Press, 1-56.

Arikawa, Y., and H. Miyajima. 2015. The relationship between firms and banks: history and prospects. *Organizational Science* 49:19–31.

Baker, M., Wurgler, J., 2002. Market timing and capital structure. Journal of Finance 57, 1–32.

Billett, M., Garfinkel, J., Jiang, Y., 2011. The influence of governance on investment: evidence from a hazard model. Journal of Financial Economics 102, 643–670.

Caballero, R., Engel, E., 1999. Explaining investment dynamics in U.S. manufacturing: a generalized (S, s) approach. Econometrica 67, 783-826.

Chiu, W.-C., Wang, C.-W., 2019. Rollover risk and cost of bank debt: The role of family-control ownership. Pacific-Basin Finance Journal 53, 362–378.

Cooper, R., Haltiwanger, J., 2006. On the nature of capital adjustment costs. Review of Economic Studies 73, 611–633.

Cooper, R., Haltiwanger, J., Power, L., 1999. Machine replacement and the business cycle: lumps and bumps. American Economic Review 89, 921-946.

DeAngelo, H., DeAngelo, L., 2007. Capital structure, payout policy, and financial flexibility. Working paper, USC Marshall School of Business.

DeAngelo, H., DeAngelo, L., Whited, T., 2011. Capital structure dynamics and transitory debt. Journal of Financial Economics 99, 235–261.

DeAngelo, H., Gonçalves. A., Stulz, R., 2018. Corporate deleveraging and financial flexibility. Review of Financial Studies 31, 3122–3174.

DeAngelo, H., Roll, R., 2015. How stable are corporate capital structures? Journal of Finance 70, 373–418.

Denis, D., McKeon, S., 2012. Debt financing and financial flexibility: evidence from proactive leverage increases. Review of Financial Studies 25, 1897–1929.

Denis, D., McKeon, S., 2016. Proactive leverage increases and the value of financial flexibility. Journal of Applied Corporate Finance 28, 17-28.

Diamond, D., 1984. Financial intermediation and delegated monitoring. Review of Economic Studies 51, 393-414.

Diamond, D., 1991. Monitoring and reputation: the choice between bank loans and directly placed debt. Journal of Political Economy 99, 689-721.

Froot, K., Scharfstein, D., & Stein, J., 1993. Risk management: Coordinating corporate investment and financing policies. Journal of Finance 48, 1629–1658.

Gamba, A., Triantis, A., 2008. The value of financial flexibility. Journal of Finance 63, 2263-2296.

Graham, J., Harvey, C., 2001. The theory and practice of corporate finance: evidence from the field. Journal of Financial Economics 60, 187–243.

Harford, J., Klasa, S., Maxwell, W., 2014. Refinancing risk and cash holdings. Journal of Finance 69, 975-1012.

Harvey, C., Lins, K., Roper, A., 2004. The effect of capital structure when expected agency costs are extreme. Journal of Financial Economics 74, 3–30.

Hoshi, T., Kashyap, A., Scharfstein, D., 1990. The role of banks in reducing the costs of financial distress in Japan. Journal of Financial Economics 27, 67-88.

Iwaki, H., Saito, J., 2022. Does rollover risk matter to payout policies? Evidence from Japanese listed firms. Journal of Economics and Business 120, 1-22.

Kikuchi, K., and A. Ito. 2021. Financial flexibility and the likelihood of investment spikes. *Japan Journal of Finance* 41:36–55.

Morck, R., Nakamura, M., Shivdasani, A., 2000. Banks, ownership structure, and firm value in Japan. Journal of Business 73, 539–567.

Myers, S., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147–175.

Nilsen, Ø., Schiantarelli, F., 2003. Zeros and lumps in investment: empirical evidence on irreversibilities and nonconvexities. Review of Economics and Statistics 85, 1021–1037.

Prowse, S., 1990. Institutional investment patterns and corporate financial behavior in the United States and Japan. Journal of Financial Economics 27, 43-66.

Rajan, R., 1992. Insiders and outsiders: the choice between Informed and arm's-length debt. Journal of Finance 47, 1367-1400.

Rajan, R., Winton, A., 1995. Covenants and collateral as incentives to monitor. The Journal of Finance 50, 1113–1146.

Sasaki, T., Suzuki, K., 2019. Bank health and cash holdings: evidence from a bank-centered financial market. Pacific-Basin Finance Journal 57, 1-15.

Verona, F., 2014. Investment dynamics with information costs. Journal of Money, Credit and Banking 46, 1627–1656.

Whited, T., 2006. External finance constraints and the intertemporal pattern of intermittent investment. Journal of Financial Economics 81, 467–502.

Yasuda, A., 2005. Do bank relationships affect the firm's underwriter choice in the corporate-bond underwriting market? Journal of Finance 60, 1259-1292.

Figure 1

Number of large investments and the fraction of the firms that undertake large investments in Japanese listed firms

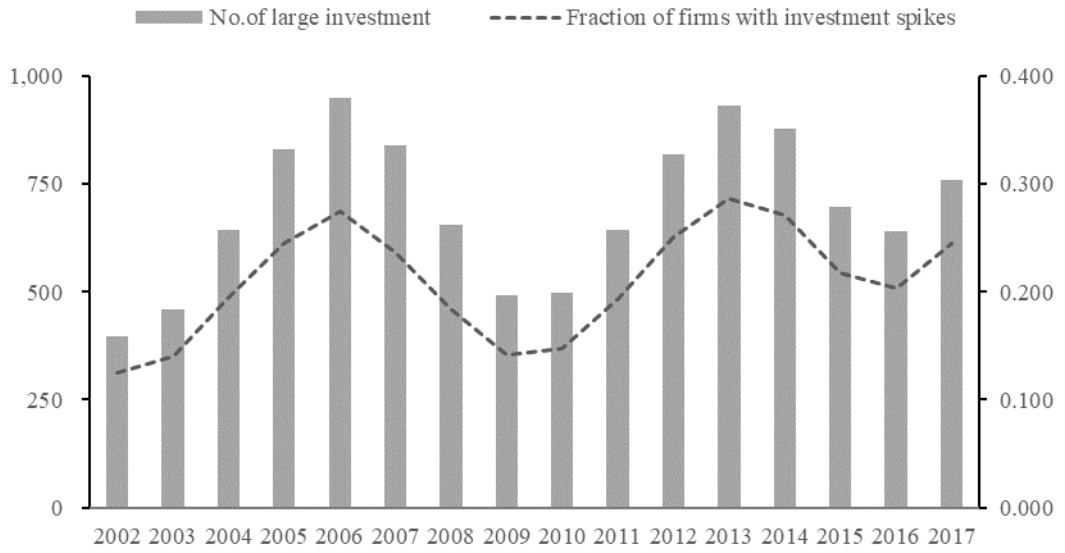

Figure 1 shows the number of large investments measured on the left-hand axis and the fraction of firms undertaking large investments measured on the right-hand axis for each year during the sample period. Based on prior studies, we define the large investment when the investment ratio (total investment/total tangible fixed assets) exceeds 20%. Our definition of investments does not include M&A. We define the total annual investment as the net increase in tangible fixed assets (current year tangible fixed assets − previous year tangible fixed assets + depreciation).

Table 1
Descriptive statistics

Table 1 reports the descriptive statistics for the main variables used in this study. The sample consists of Japanese listed companies (including those on the OTC market). We exclude utilities and financial firms. The sample size is 13,729 firm-years over the FY2002–FY2017. Variable definitions are shown in Appendix. We winsorize continuous variables at the 1st and 99th percentiles. Panel A presents debt characteristics and Panel B presents firm characteristics. Detailed definitions of variables are shown in **Appendix**.

Variables	Mean	Median	Standard deviation	N
Panel A: Debt characteristics				
Total debt / Total assets	0.193	0.149	0.182	33,611
Short term debt / Total assets	0.106	0.073	0.112	33,611
Short term loan / Total assets	0.102	0.068	0.110	33,611
Panel B: Firm characteristic				
Investment rate	0.227	0.137	0.383	33,611
ROA	0.057	0.048	0.072	33,611
PBR	1.616	1.031	1.876	33,611
Cash ratio	0.195	0.155	0.149	33,611
Sales growth	0.051	0.031	0.198	33,611
CF to assets	0.057	0.059	0.073	33,611
Total assets (billions of Yen)	161.275	29.364	459.337	33,611
Age (year)	50.865	54.000	24.209	33,611

Table 2
Impact of the term structure of debt on the likelihood of large investments

Table 2 presents the estimation results of a proportional hazards model. We winsorize continuous variables at the 1st and 99th percentiles: We use one-year lagged data for explanatory variables. The dependent variable is the hazard function associated with large investments, which indicates the conditional probability that a firm that has not made a large investment prior to time *t* will undertake large investment at time *t*. In the estimation results, the coefficient of each covariate represents its effect on the hazard rate. If the coefficient is greater than 1, the likelihood of a large investment increases with the covariate; conversely, if the coefficient is less than 1, the likelihood of a large investment decreases with the covariate. Variable definitions are shown in the **Appendix**.

Variables	**(1)**	**(2)**
Short term debt / total assets	0.708**	
	(0.120)	
Short term loan / total assets		0.698**
		(0.118)
Director from bank	0.990	0.990
	(0.0258)	(0.0258)
Bank in major shareholders	0.914***	0.914***
	(0.0205)	(0.0205)
Bond	0.996	0.991
	(0.0239)	(0.0240)
PBR	1.041***	1.040***
	(0.00418)	(0.00417)
Leverage 1st quartile	1.157***	1.155***
	(0.0547)	(0.0540)
Leverage 2nd quartile	1.168***	1.167***
	(0.0460)	(0.0454)
Leverage 3rd quartile	1.130***	1.130***
	(0.0370)	(0.0369)
Cash ratio	1.762***	1.760***
	(0.132)	(0.132)
Sales growth	1.414***	1.414***
	(0.0560)	(0.0561)
CF to assets	3.820***	3.817***
	(0.503)	(0.503)
Log (Age)	0.880***	0.880***
	(0.0162)	(0.0162)
Log（Total assets）	1.032***	1.032***
	(0.00854)	(0.00852)
Credit rating	Yes	Yes
Industry dummy	Yes	Yes
year	Yes	Yes
Log-likelihood	-76161.762	-76161.604
Observations	33,553	33,553

***, **, * denote significance at the 1%, 5%, 10% levels, respectively.

Table 3
Results of the instrumental variable estimation using linear probability models

We use a linear probability model to examine the robustness of the estimation results to the endogeneity of the term structure of debt. We winsorize continuous variables at the 1st and 99th percentile. We use one-year lagged data for explanatory variables. We assume that error terms are clustered by the firm. Variable definitions are shown in the **Appendix**.

	(1)	(2)
Short term debt / total assets	-4.500**	
	(1.982)	
Short term debt / total assets		-4.091**
		(1.747)
Director from bank	-0.00784	-0.0106
	(0.00873)	(0.00847)
Bank in major shareholders	0.0303*	0.0275**
	(0.0154)	(0.0140)
Bond	-0.0775**	-0.122**
	(0.0364)	(0.0539)
PBR	0.0497***	0.0464***
	(0.0121)	(0.0104)
Leverage 1st quartile	-0.924**	-0.822**
	(0.436)	(0.379)
Leverage 2nd quartile	-0.708**	-0.623**
	(0.338)	(0.292)
Leverage 3rd quartile	-0.369**	-0.321**
	(0.185)	(0.159)
Cash ratio	0.0170	0.0456
	(0.107)	(0.0924)
Sales growth	0.0602	0.0745**
	(0.0394)	(0.0339)
CF to assets	0.0891	0.127
	(0.178)	(0.158)
Log (Age)	-0.0446***	-0.0406**
	(0.0158)	(0.0158)
Log （Total assets）	-0.0137	-0.0119
	(0.0130)	(0.0118)
Duration	Yes	Yes
Credit rating	Yes	Yes
Industry dummy	Yes	Yes
year	Yes	Yes
Constant	1.553***	1.424***
	(0.530)	(0.459)
Test of endogeneity (Prob>F)	0.00	0.00
Cragg-Donald Wald F statistic	14.047	16.856
Observations	15,548	15,548
R-squared	-0.312	-0.233

***, **, * denote significance at the 1%, 5%, 10% levels, respectively.

Table 4

Tests of differences on firm characteristics after matching and estimates of average treatment effect

In panel A of Table 4, we test whether there is a statistically significant difference about the value of covariates for the ***PRE period*** between treatment group and control group after matching. For ***PBR***, ***Cash ratio***, ***Sales growth***, ***CF to assets***, and ***Log (age)***, we use the average value during the ***PRE period***. For ***Log (Total assets)***, we calculate the average value over the ***PRE period*** and create dummy variables that divide firms into quartiles. To confirm more precisely that firm size is balanced between the treatment and control groups after matching, we also report the result of a test of the difference in ***Log (Total assets)***. Panel B of Table 4 presents the estimates of the average treatment effect (***ATET***) for the outcome variables. Detailed definitions of variables are shown in **Appendix**.

Panel A: Tests of differences on firm characteristics after matching

Variables	Treatment	Control	Difference	P-value
Investment rate growth (2005 to 2007)	0.264	0.058	-0.206	0.333
PBR	1.879	1.721	1.799	0.103
Cash ratio	0.105	0.104	-0.001	0.839
Sales growth	0.073	0.061	-0.012	0.156
CF to assets	0.036	0.036	0.000	0.990
Log (age)	3.817	3.847	0.030	0.468
Log (Total assets) 1st quartile	0.290	0.305	0.015	0.643
Log (Total assets) 2nd quartile	0.260	0.275	0.015	0.632
Log (Total assets) 3rd quartile	0.285	0.248	-0.038	0.231
Log (Total assets) 3rd quartile	0.165	0.173	0.007	0.777
Log (Total assets)	10.334	10.432	0.098	0.339

Panel B: Estimates of average treatment effect

	Treatment	Control	Difference (***ATET***)	P-value
Difference in ***Investment rate***	-.0386	-.0186	-.01997	0.085

Appendix
Definition of variables

Variables	Definition
Short term debt / total assets	Short-term debt (the sum of current portion of borrowings and current portion of bonds (including CP but excluding convertible bonds)) divided by total assets
Short term loan / total assets	Short-term loan (debt due within one year) divided by total assets
Director from bank	A dummy variable which takes a value of 1 if a firm has directors from banks among its board members, and 0 otherwise.
Bank in major shareholders	A dummy variable which takes a value of 1 if banks are among the top 10 major shareholders of a firm, and 0 otherwise.
Bond	A dummy variable which takes a value of 1 if there is a balance of corporate bonds on firm's balance sheet, and 0 otherwise.
PBR	Market capitalization of equity divided by net assets.
Leverage 1st quartile	A dummy variable which takes a value of 1 if debt ratio is below the 25th percentile, and 0 otherwise.
Leverage 2nd quartile	A dummy variable which takes a value of 1 if debt ratio is above the 25th percentile and below the 50th percentile, and 0 otherwise.
Leverage 3rd quartile	A dummy variable which takes a value of 1 if debt ratio is above the 50th percentile and below the 75th percentile, and 0 otherwise.
Leverage 4th quartile	A dummy variable which takes a value of 1 if debt ratio is above the 75th percentile, and 0 otherwise.
Cash ratio	Cash and deposits divided by total assets.
Sales growth	(Sales in the current year divided by sales in the previous year) − 1.
CF to assets	Operating CF in the CF statement divided by total assets.
Log (Total assets)	The logarithm of total assets.
Log (Age)	The logarithm of operating years.
Investment rate	Total investment (current year tangible fixed assets − previous year tangible fixed assets + depreciation) divided by total tangible fixed assets.
ROA	Operating profit divided by total assets at the beginning of the period.
Credit rating	Dummy variables for each credit rating.
Industry	Dummy variables for each industry to which the company belongs.
Year	Dummy variables created for each fiscal year.