The Time Has Come for Banks to Say Goodbye: New Evidence on Banks' Roles and Duration Effects in Relationship Terminations

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The Time Has Come for Banks to Say Goodbye: New Evidence on Banks' Roles and Duration Effects in Relationship Terminations *

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Abstract. Using a loan-level matched sample of Japanese banks and firms, we examine what factors determine the termination of the bank-firm relationship. We find that terminations are mainly driven by bank factors, but such bank-driven terminations increase when banks' capital conditions worsen. The constraints on bank capital in the Japanese banking crisis increased terminations, implying the presence of a capital crunch. Moreover, "flight-to-quality" behavior prevailed instead of "evergreening" in relationship terminations because of lowly capitalized banks' motives to reduce agency costs. We also find that a longer relationship duration decreased the probability of termination substantially when Japan's banking system was stable, but such duration effects weakened when the system was fragile. Japan's banking system cultivated bank-firm relationships over many decades to lower agency costs gradually, but this system malfunctioned partially in the flight to quality, whereby many banks could not afford to maintain relationships with distressed borrowers irrespective of duration.

JEL classification: G01, G21, G28.

Keywords: matched lender–borrower data, bank-firm relationship, capital crunch, evergreening, flight to quality, duration effect, long-term contract.

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1. Introduction According to microeconomic banking theory emphasizing inside information obtained from long bank-firm relationships (Sharpe (1990), Rajan (1992), and Von Thadden (1995)), maintaining relationships mitigates asymmetric information problems between banks and borrowing firms, but raises the problem of distortions in firms' incentives to exert effort because of the banks' information monopoly. Therefore, if a bank maintains a bank-firm relationship for a long period, in order to obtain a stream of rents over time, the bank needs to control the firm's incentives through measures such as monitoring so that the firm exerts appropriate effort.[1] Against this theoretical backdrop, previous empirical studies obtained two opposite conclusions; one emphasizes the hold-up problem (e.g. Ongena and Smith (2001), Degryse and Ongena (2005), and Ioannidou and Ongena (2010)) and the other focuses on how relationship-specific assets can mitigate asymmetric information problems (e.g. Berger and Udell (1995), Brau (2002), Miyakawa (2010), and Sakai et al. (2010)).

Despite the coexistence of the two views, the increase in relationship terminations during the Japanese banking crisis period in the late 1990s in Figure 1 suggests the importance of lender-side factors in the termination of relationships with firms. Furthermore, the low growth rate of the Japanese economy suggests that the relationship terminations affected the real economy through the destruction of the relationship-specific assets, which had been cultivated by the banks' commitment to continue their relationships.

The literature on microeconomic banking theory demonstrates that the relationship-specific asset—an information-based implicit property right not available from outside lenders—can help lower the agency cost for the inside bank, which helps it control the borrower's projects through monitoring and obtain rents over time. In addition, the literature shows that the relationship-specific assets drive a wedge between the effects of terminating relationships and adjusting bank loans within relationships; put differently, the mechanism of terminating relationships should be different from adjusting loans within continuing relationships. This is because the inside bank will abandon the relationship-specific assets

[1] Concerning the evasion of the hold-up problem in long-term relationships, Sharpe (1990) emphasized the role of implicit contracts based on the bank's reputation and propensity to keep its promises, while Rajan (1992) focused on the role of the firm's portfolio choice of borrowing sources. Von Thadden (1995) pointed out the importance of the bank's efficient monitoring within the long-term relationships.

that can produce rents through the continuation of relationships, and the borrower as well as the bank must again bear non-trivial costs associated with the initial pre-loan evaluation of the borrower's risk to reconstruct the relationship-specific assets in the banking system (Lummer and McConnel (1989) and Nakashima and Takahashi (2018)).[2] Moreover, the effect of relationship terminations should well reflect the characteristics of a banking system in the economy as the degree and types of financial frictions differ depending on the system. In this paper, using a large sample of Japanese matched bank-firm lending data, we examine the determinants of relationship terminations, which have received little attention in the literature, particularly by focusing on the roles of bank-side factors and duration of relationships.

More concretely, we empirically examine the determinants of relationship terminations by addressing two questions: 1) what factors drive relationship terminations and which hypothesis is more plausible for explaining a bank's decision to terminate a relationship; and 2) when and how does the duration of bank-firm relationships affect relationship terminations. To this end, we use a loan-level matched sample of Japanese lending banks and their borrowing firms over a period of 20 years. Our matched data allow us to track when a bank-firm relationship terminated and how long it continued.[3] Our analysis also exploits the fact that the Japanese banking sector fell into a severe financial crisis in the late 1990s and the early 2000s. Such drastic changes in financial conditions affect banks' and firms' decisions on whether to terminate their existing relationships. Hence, the inclusion of sample periods both before and after the late 1990s and the early 2000s enables us to uncover the characteristics of bank-firm relationships by conducting a comparative analysis

[2] Lummer and McConnel (1989) conducted an event study for borrowing firms' equity returns and found no abnormal returns following the announcement of the establishment of new relationships. Negative responses occur when a bank initiates relationship terminations. Their results suggest that banks do not produce information upon first contact with a borrower; rather, the bank obtains information about the borrower through the continuation of the relationship, and thus terminations can signal negative changes in firm value to capital markets. Nakashima and Takahashi (2018) empirically examined the effects of relationship termination on firm investment. They found that the effects on firm investment through reductions in bank lending change due to relationship terminations would be more significant than those through decreases in bank lending within continuing relationships.

[3] The calculation of relationship duration is based on matched data from 1978 to 2010. Although we use data from 1990 for the analysis of the terminations, data from 1978 are used for the calculation of duration.

of sample periods, including those that overlap with the financial crisis. Our large dataset from 1990 to 2010 allows us to more comprehensively isolate the occurrence of relationship terminations.[4]

To address the first question, we begin by examining the association between banks' capital conditions and relationship terminations in terms of three non-mutually exclusive explanations for the lending behavior of banks with impaired capital: the capital crunch, evergreening, and the flight-to-quality hypothesis.[5] In the face of Japan's financial crisis in the late 1990s, some empirical studies, including those by Woo (2003), Watanabe (2007), and Gan (2007), demonstrated that the Japanese banking sector in this period experienced a capital crunch, in which many banks restrained their lending.[6] On the other hand, Peek and Rosengren (2005), Watanabe (2010), and Giannetti and Simonov (2013) found evidence of evergreening and the misallocation of bank loans to distressed firms in the late 1990s and the early 2000s.

Almost all prior studies on the lending behavior of impaired banks investigated bank loan changes in continuing bank-firm relationships (Peek and Rosengren (2005), Gan (2007), and Giannetti and Simonov (2013)), or investigated them without distinguishing between loan changes in continuing relationships and in relationship establishments and terminations (Woo (2003) and Watanabe (2007; 2010)).[7] However, as discussed above, we have the legitimate expectation that the intensive and extensive margins of bank loan adjustments are quite different. For example, even if impaired banks lent more to distressed borrowers because of the soft-budget problem (Dewatripont and Maskin (1995) and Bolton and

[4] It is difficult to construct a matched sample of banks because of numerous mergers and acquisitions (hereafter, M&As) and divestitures in Japan from the late 1990s to the early 2000s. To deal with this problem, we carefully constructed our dataset considering all M&As and divestitures of Japanese banks. See Section 2 and Appendix B for details.

[5] In Section 3, we define each hypothesis formally. For a theoretical study of impaired banks' lending behavior, see e.g. Besanko and Kanatas (1996), Thakor (1996), Holmström and Tirole (1997), Calomiris and Wilson (2004), and Diamond and Rajan (2000; 2011).

[6] For empirical studies of capital crunches in the US, see Bernanke and Lown (1991), Peek and Rosengren (1995), and Berrospide and Edge (2010).

[7] Peek and Rosengren (2005), Gan (2007), and Giannetti and Simonov (2013) used matched datasets of Japanese banks and borrowing firms; hence, their analysis of bank lending focused on the intensive margin of bank loans. On the other hand, Woo (2003) and Watanabe (2007; 2010) used a bank-level panel dataset; consequently, their analysis did not distinguish between the intensive and extensive margins of bank loans. On the other hand, Sekine et al. (2003) and Caballero et al. (2008) used a firm-level panel dataset to examine forbearance lending and its macroeconomic effect in Japan, respectively.

Scharfstein (1996)) or the impaired banks' window-dressing motives (Peek and Rosengren (2005) and Bruche and Llobet (2014)), once they decided to terminate such relationships, they could preferentially choose the relationships with their non-distressed firms in order to reduce the agency cost to control borrowers' projects through monitoring (Bernanke and Gertler (1989; 1990)). Indeed, through formal testing, we found evidence of a capital crunch as well as flight-to-quality behavior in distressed banks in relationship terminations, as theoretically predicted in Bernanke et al. (1996) and Holmström and Tirole (1997). That is, in the late 1990s and the early 2000s, when the Japanese banking system was in severe distress, impaired banks were more likely to terminate relationships than non-impaired ones; however, impaired banks' relationships with good-quality borrowers were more likely to be maintained than the non-impaired banks' ones, because of their motives to reduce agency costs. Our finding implies that impaired banks tended to keep more secured relationships, and hence "misallocation" by impaired banks in the bank loan market is not supported in relationship terminations.

Our interpretation of the empirical results from our termination analysis is based mainly on a "lender-driven termination view," which assumes that lender-side factors, such as banks' managerial decisions and capital conditions, lead to relationship terminations. Such a bank-side view is consistent with theoretical models emphasizing the role of agency costs in the bank loan market (Diamond (1984), Bernanke and Gertler (1989; 1990), Holmström and Tirole (1997), and Hellwig (2000)). On the other hand, it is possible that a firm could initiate terminations for various reasons. We empirically examine which factor is more dominant by employing the double fixed effect (hereafter, FE) approach developed by Jiménez et al. (2014), which allows us to ingeniously identify the total loan demand and supply factors using loan-level matched data. Thus, we find that not only during the financial crisis period, but also during the (normal) non-crisis period, the contribution of the bank factor is about 80 to 85 percent in explaining relationship terminations, while that of the firm factor is only about 5 to 10 percent. This finding supports the lender-side view of relationship terminations, thus providing an insight into the causes of terminations: the worsening of banks' capital conditions would boost such lender-driven terminations, while forcing impaired banks to sort out the good risks from the bad in the flight to quality because of the banks' motive of reducing agency costs. In other words, we show that banks' decisions become more important for terminations when their balance sheets are impaired.

This mechanism of relationship terminations can be explored in more depth in terms of the duration of bank-firm relationships. Ongena and Smith (2001) and Miyakawa (2010) empirically examined the termination of lender–borrower relationships by focusing on whether a longer duration decreased the likelihood of terminating relationships. Ongena and Smith (2001) found that more relationships would terminate as their durations increased using a matched sample from Norway. They attributed this result to firms' caution about the hold-up problem resulting from long-term relationships. Their inference is consistent with a "borrower-driven termination view" emphasizing that a firm could initiate relationship terminations, and also with Mankiw's (1988) critique: "why, if these long-term relationships are so valuable, firms do not develop them with lenders". However, in contrast to them, Miyakawa (2010) presented evidence against hold-ups: fewer longer relationships were terminated in a matched sample in Japan from 1999 onwards. Like Miyakawa (2010), we also use a matched sample for Japan, but our analysis covers a more recent sample period to 2010. Thus, our analysis of the duration effect produces the same result and implication for the non-crisis period as Miyakawa (2010), but not for the financial crisis period. Our results show that under normal economic conditions, a relationship-specific value existed in every Japanese bank-firm relationship and increased with duration, as the agency cost declined with duration (Sakai et al. (2010)) and the hold-up problem was not aggravated in long-term relationships, as argued by Miyakawa (2010); however during the financial crisis, this duration effect weakened, because many Japanese banks facing impaired capital were prompted to reduce agency costs and could not afford to maintain relationships with distressed borrowers irrespective of duration.

Our paper is organized as follows. Section 2 details the methodology for estimation of the termination function and describes our loan-level matched dataset. Section 3 formalizes the three hypotheses of banks' decisions on relationship terminations and the predicted effects of firm factors using microeconomic banking theory. Section 4 reports the estimation results for the termination function. In this section, we also examine which of the three scenarios is more plausible for explaining relationship terminations between impaired banks and borrowing firms by testing the capital crunch, evergreening, and flight-to-quality hypotheses. Section 5 examines the duration effect on the termination of bank-firm relationships. In Section 6, we extend our termination analysis by controlling for lender- and borrower-side factors more thoroughly. Furthermore, we identify the contribution of lender- and borrower-side factors and thereby examine whether relationship terminations are affected more by bank or firm factors. Section 7 provides concluding comments. Appendix A explains how we define a relationship termination in the cases of M&As, business transfers, and divestitures. Appendix B shows and discusses the estimation results of the termination model for the firm variables in more detail.

2. Estimation Model and Matched Data

We examine what factors contribute to the termination of relationships between Japanese banks and their borrowers by using not only lender-side but also borrower-side attributes with the loan-level matched data. To this end, we first define termination of a bank-firm relationship, and then introduce our estimation model and empirical methodology. We then describe the construction of our dataset, before defining a new relationship as well as firm and bank variables included in the estimation model.

2.1. Estimation Model and Method

We define a termination of a relationship in fiscal year t as a case where firm i borrows from bank j at the end of year $t-1$ but not at the end of year t. To examine what factors contributed to relationship terminations between Japanese banks and their borrowers, we employ a probit model. Specifically, we define a termination function of bank–borrower relationships as follows:

$$\mathrm{TERM}_{ijt} = 1\left[y_{ijt} \geq 0\right],$$

$$y_{ijt} = \mathrm{a} + \mathbf{FIRM}'_{\mathbf{it-1}}\mathbf{b} + \mathbf{BANK}'_{\mathbf{jt-1}}\mathbf{c} + \mathbf{RELATE}'_{\mathbf{ijt-1}}\mathbf{d} + \mathbf{DURATION'}_{\mathbf{ijt-1}}\mathbf{f} + \epsilon_{\mathrm{ijt}}, \quad (1)$$

$$\epsilon_{ijt} \sim N(0,1),$$

where TERM_{ijt} denotes a termination dummy variable that takes the value one if the relationship between firm i and lending bank j terminates in year t.

$\mathbf{FIRM_{it-1}}$ and $\mathbf{BANK_{jt-1}}$ are covariate vectors including observable characteristics of firm i and lending bank j at the end of year $t-1$, respectively. $\mathbf{RELATE_{ijt-1}}$ include the relationship factors that capture the characteristics of a relationship between lending bank j and its borrowing firm i at time $t-1$. To highlight the importance of a duration effect on the probability of termination in our study, the termination function (1) is explicitly written with a vector of duration dummy variables, $\mathbf{DURATION_{ijt-1}}$. The duration dummies indicate the number of years the relationship between lending bank j and its borrowing firm i has existed up to year $t-1$.

In addition to the probit model, we also employ a logit model. However, because the estimation results are qualitatively the same, we report only the estimation results based on the probit model. In Section 6, we also employ a linear probability model with bank and firm fixed effects, and thus attempt to show the robustness of the estimation results based on the probit model.

As discussed in the introduction, the purpose of our analysis is to examine what factors determine relationship terminations. However, we should not exclude the possibility that the effect of each factor on terminations is time varying, as the Japanese regulatory system as well as macroeconomic and financial conditions have changed drastically over time.[8] Accordingly, it would be best to incorporate the possible time-varying effects of each factor. To this end, we adopt the strategy of a period-by-period estimation of the termination function. Such a rolling estimation strategy allows us to control for period-by-period changes in the macroeconomic environment, thus avoiding misspecification of the termination mechanism. We employ this empirical strategy in the following analysis of relationship termination.[9]

[8] For example, in terms of a credit crunch study in Japan, Woo (2003) and Watanabe (2007) found that after 1998, the stipulated capital asset ratio was associated with the growth rate of bank loans, whereas this did not matter previously.

[9] Previous studies on relationship terminations, including those by Ongena and Smith (2001) and Miyakawa (2010), arbitrarily selected a sample period and then applied a non-rolling estimation approach to the entire sample period. Given that lending banks and their borrowing firms are expected to change their relationships according to changes in the macroeconomic environment, the non-rolling estimation approach based on an arbitrarily selected sample period can provide imprecise estimates of covariates, thus

2.2. **Construction of Loan-level Matched Sample** We use a loan-level dataset: a matched sample of Japanese banks and their listed borrowing firms. Our loan-level data are constructed using the Corporate Borrowings from Financial Institutions Database compiled by Nikkei Digital Media Inc. This Nikkei database collects information on corporate borrowings (long-term debt with a maturity of more than one year and short-term debt with a maturity of one year or less) classified by each Japanese bank. This Nikkei database, compiled through original Nikkei research, includes about 500,000 observations consisting of more than 100 Japanese banks, 2,000 listed borrowing firms, and 18,000 banking relationships for our sample period from 1990 to 2010 (see Table 1). The reason that we extended the sample to 2010 is that many relationships were found to be missing in the Nikkei database for the sample period after 2010, primarily because of changes in the data collection methods of Nikkei Digital Media Inc.

We combined the Nikkei database with financial statement data of Japanese banks and their listed borrowing firms, compiled by Nikkei Digital Media Inc. Japanese banks' fiscal year ends on March 31; however, the fiscal years of their borrowing firms do not necessarily end on the same date. When combining the Nikkei database with the financial statement data, we match bank-side information to borrower-side information in the same fiscal year.

Our loan-level dataset has two types of selection bias. One arises from the exit of some domestic listed companies from our loan-level data, for example, because of bankruptcy or a management buyout. We are not able to identify the reasons why listed companies exited from our dataset. To deal with such potential bias, we adopt the strategy of excluding firms from our sample in year t when the firm became unlisted between the end of year $t-1$ and t. In the estimation of the termination function, this strategy might lead to the underestimation of borrower-side effects on terminations.

A second bias is related to a bank's survivorship. The Japanese banking sector experienced a wave of M&As, business transfers, and divestitures from the late 1990s to the early 2000s. To construct our loan-level data set, we scrutinized whether continuing banks took over the credit claims of merged or failed banks against their borrowing firms before and after the relevant M&A, business transfer, or divestiture. Appendix A explains how we

resulting in a misunderstanding of a bank's and a firm's decisions on relationship terminations.

define the termination indicator and the duration of a bank-firm relationship in the cases of M&As, business transfers, and divestitures in more detail. s A failure to track a credit claim transfer appropriately will lead to excessive counting of terminations. To mitigate this problem and to control for banks' business restructuring effects on terminations, we include seven dummy variables in termination function (1) for M&A, nationalization, privatization, business transfer, change in corporate name, coming under a financial holding company, and divestiture. [10]

2.3. **Termination and New Relationships** In addition to a terminated relationship, we identify all "new relationships" and thereby examine whether a firm that established a new relationship in year $t-1$ is more likely to terminate other relationships in year t. Our measure of new relationships also includes one where a terminated relationship is revived. In this paper, however, we do not distinguish between these two. In other words, a new relationship in year t is simply defined as a case where firm i borrowed from bank j at the end of year t but had not borrowed from that bank at the end of year $t-1$. Figure 2 shows the historical paths of the various indicators.

3. Bank, Firm and Relationship Factors and Testing Hypotheses In this section, we define bank, firm, and relationship factors included in the covariate vectors, $\mathbf{FIRM_{it-1}}$, $\mathbf{BANK_{jt-1}}$ and $\mathbf{RELATE_{ijt-1}}$, thereby providing a more concrete specification of the termination function (1) as our baseline termination model. In addition, we formalize three hypotheses, namely capital crunch, evergreening, and flight to quality, and explain the predicted signs of the coefficients on the firm covariates.

3.1. **Bank Factors and Three Hypotheses: Capital Crunch, Evergreening, and Flight to Quality** The bank covariates, $\mathbf{BANK_{jt-1}}$, include a variable typically characterizing banks' financial fragility to investigate how banks' financial conditions affect the probability of termination. To this end, we include the one-period lag of the book leverage ratio (BLEV_{jt-1}), defined as $100 \times \left(\frac{\text{Book Value of Total Debt}}{\text{Book Value of Total Assets}}\right)$. In addition to this ratio, we also use the lowly capitalized bank dummy (LOWCAP_{jt-1}), the market lever-

[10] In this paper, we treat banks under the same financial holding company as different banks.

age ratio (BMLEV_{jt-1}), and the non-performing loan ratio (NPL_{jt-1}), thus conducting a robustness check on the estimation results for the leverage ratio. The lowly capitalized bank indicator, LOWCAP_{jt-1}, is a dummy variable indicating whether each bank's capitalization is low. More specifically, following Peek and Rosengren (2005) and Giannetti and Simonov (2013), if a bank's reported capital ratio based on the BIS banking regulation is less than 2% points above the target capital ratio (8% for international banks and 4% for domestic banks), we conjecture that the bank's capitalization is low; that is, $\text{LOWCAP}_{jt-1} = 1$, else $\text{LOWCAP}_{jt-1} = 0$. Note that after 2006, almost all banks have a zero value for the lowly capitalized bank indicator, and hence we conduct an estimation with this indicator to 2005. The market leverage ratio, BMLEV_{jt-1}, is defined as $100 \times \left(\frac{\text{Book Value of Total Debt}}{\text{Market Cap + Book Value of Total Debt}}\right)$. The non-performing loan ratio of bank j is defined as the ratio of outstanding non-performing loans over total loans. Using these three variables, instead of the bank book leverage ratio as a bank capital condition variable, we estimate the baseline termination model to address the capital crunch scenario.

The coefficient of the banks' financial health indicators, including the bank leverage ratio, can either be positive or negative. It would be positive when Japanese banks' financial health deteriorates and the Japanese banking system is subject to a capital crunch. According to Woo (2003) and Watanabe (2007), many Japanese banks were in a badly impaired capital state in the late 1990s and this severely constrained the supply of bank credit. However, in the literature, the capital crunch scenario is used to explain the lending behavior of lowly capitalized banks in continuing relationships (Gan (2007)), or to do so without distinguishing loan changes in continuing relationships from relationship establishments and terminations (Woo (2003) and Watanabe (2007)). In this paper, we extend the capital crunch hypothesis to relationship terminations: in this scenario, a lowly capitalized bank is likely to terminate the relationships with its borrowing firms, whether the firms are distressed or not. Thus, if the relationship termination can be ascribed to the capital crunch, the expected sign for the coefficient on the bank book leverage ratio is positive.[11] On the other hand, in some periods including a non-financial crisis or an economic boom,

[11] If we use the capital asset ratio as an indicator of banks' financial condition instead of the book leverage ratio, the expected sign of the capital-asset ratio is negative under the capital crunch hypothesis.

it is possible that banks with higher leverage could take more credit risks, as demonstrated by Adrian and Shin (2010). In this case, our expected sign is negative because highly leveraged banks or banks that take more risks will decide to preserve their existing relationships rather than to terminate them.

According to Peek and Rosengren (2005), a lowly capitalized Japanese bank whose reported capital ratio was close to the target capital ratio stipulated by the BIS regulation was more likely to evergreen loans to unprofitable firms in continuing relationships because of its window-dressing motives.[12] Evergreening of relationship termination assumes that banks with low capitalization are more likely to maintain relationships with their distressed borrowing firms than with non-distressed ones.

The flight-to-quality scenario makes opposite assumptions to the evergreening scenario. According to Bernanke et al. (1996) and Holmström and Tirole (1997), it assumes that lowly capitalized banks are more likely to maintain relationships with non-distressed firms than with distressed ones; thus, the lowly capitalized banks suppress agency costs by controlling borrowers' projects through monitoring. It is noteworthy that the flight-to-quality scenario is incompatible with the evergreening one in relationship terminations; however, it may coexist with the evergreening behavior of an impaired bank's lending in continuing relationships. Such an accommodation is based on our presumption that the reasoning behind a bank's decision in relationship terminations should be different from that in lending on the premise of the continuation of existing relationships, as discussed in the introduction.

To assess the two mutually exclusive hypotheses—evergreening and flight to quality—of relationship terminations, we include the interaction term ($\text{LOWCAP}\times\text{FROA}_{ijt-1}$) of the lowly capitalized bank indicator and the borrowing firm's return on assets (hereafter, ROA) or the highly leveraged bank indicator and the firm's ROA ($\text{HBLEV}\times\text{FROA}_{ijt-1}$) together with each bank's capital indicator into the baseline model (1). The highly leveraged bank indicator, HBLEV_{jt-1}, is a dummy variable that takes the value one if the book leverage ratio is in the highest tertile, and zero otherwise.

[12] Window-dressing behavior means that a lowly capitalized bank is reluctant to allow less profitable firms to go bankrupt because bankruptcy would force this bank to disclose the resulting impaired capital at an even lower level. In addition, see Watanabe (2010) and Giannetti and Simonov (2013) for empirical studies on the evergreening of bank credit in Japan.

We formalize the three hypotheses on the basis of average marginal effects (hereafter, AMEs) using the probit model described in equation (1). First, we denote the AME of a discrete variable z as follows:

$$\text{AME}(z) = E_x \left[\Pr(\text{TERM}_{ijt} = 1 | z = 1, X = x_{ijt}) - \Pr(\text{TERM}_{ijt} = 1 | z = 0, X = x_{ijt})\right], \quad (2)$$

where $E_x[s]$ denotes the expected value of random variable s over x. For a continuous variable z,

$$\text{AME}(z) = E_{xz} \left[\left. \frac{\partial \Pr(\text{TERM}_{ijt} = 1)}{\partial z} \right|_{z = z_{ijt}, X = x_{ijt}} \right], \quad (3)$$

where X denotes all covariates except for y. Then, we define the capital crunch hypothesis as a case where the following condition holds:[13]

$$\text{AME}(\text{LOWCAP}) > 0. \quad (4)$$

In other words, a change in the LOWCAP variable from zero to one should be associated with an increase in the termination probability on average to support the capital crunch hypothesis.

A flight to quality is demonstrated when we have:

$$\text{AME}(\text{FROA} | \text{LOWCAP} = 1) < 0, \quad (5)$$

and

$$\text{AME}(\text{FROA} | \text{LOWCAP} = 1) < \text{AME}(\text{FROA} | \text{LOWCAP} = 0), \quad (6)$$

where AME(FROA|LOWCAP = 1) denotes an AME of the firm ROA for relationships with lowly capitalized banks (LOWCAP = 1). Equation (5) means that an increase in firm ROA lowers the termination probability for lowly capitalized banks. Equation (6)

[13] When using the highly leveraged bank indicator, HBLEV_{jt-1}, as a proxy for bank financial health, we substitute HBLEV for LOWCAP.

means that the marginal effect of firm ROA is greater for such banks than for others; that is, lowly capitalized banks were more likely to maintain relationships with firms of high profitability than non-lowly capitalized banks. If these two conditions hold, the flight-to-quality hypothesis is supported.

In contrast, we define the evergreening behavior of lowly capitalized banks as follows:

$$\text{AME}(\text{FROA}|\text{LOWCAP} = 1) > 0, \tag{7}$$

and

$$\text{AME}(\text{FROA}|\text{LOWCAP} = 1) > \text{AME}(\text{FROA}|\text{LOWCAP} = 0). \tag{8}$$

Note that we do not distinguish between these two scenarios on the basis of the sign of the AMEs of the firm ROA for non-lowly capitalized banks, AME(FROA|LOWCAP = 0). Instead, we only ensure that non-lowly capitalized banks behave differently from lowly capitalized ones in these two hypotheses, as formalized in equations (6) and (8).[14]

In addition to the bank financial indicator, we include a major bank dummy variable (MAJOR_{jt-1}) and a size variable (BSIZE_{jt-1}). The major bank dummy variable equals one if bank j is a city bank or long-term bank, and zero otherwise. Bank size is calculated as the logarithm of the book value of total assets.

3.2. **Firm Covariates and Agency Costs** For firm factors $\mathbf{FIRM_{it-1}}$ to be controlled for, we consider 10 characteristics of firms: book leverage ratio (FLEV_{it-1}), liquid asset ratio (FLIQUID_{it-1}), volatility of assets ($\sigma_{A,it-1}$), return on assets (FROA_{it-1}), sales growth (FSALE_{it-1}), firm size (FSIZE_{it-1}), firm age (FAGE_{it-1}), the firm marry dummy (FMARRY_{it-1}), the firm termination dummy (FTERM_{it-1}), and the industry dummy variables (INDUSTRY_i).

The information monopoly model of Rajan (1992) predicts that as firm performance—

[14] Furthermore, note that a significant coefficient on the interaction term is not always associated with one of the two hypotheses in a nonlinear model. This is because equations (6) and (8) can hold even if the coefficient of the interaction term is not significant. This econometric problem involving an interaction term in a nonlinear model is well known in the literature (see Ai and Norton (2003)).

financial condition (FLEV_{it-1} and FLIQUID_{it-1}), business uncertainly ($\sigma_{A,it-1}$), and profitability (FROA_{it-1})—improves and firm size (FSIZE_{it-1}) increases, a bank's monopoly power decreases; hence, a well-performing large firm can take the initiative in terminating relationships. This view emphasizes a borrower's decision as the main determinant of relationships. In contrast, the agency cost model of Bernanke and Gertler (1989; 1990) and Bernanke et al. (1996) predicts that a good-quality firm with good solvency can lower agency costs or the cost of controlling the firm's project through monitoring; thus, banks will choose to maintain relationships with such a good-quality firm. Their agency cost model also predicts that as firm size (FSIZE_{it-1}) and firm age (FAGE_{it-1}) increase, the agency costs of the firm decrease; hence, it would induce banks to maintain relationships with larger and older firms (see also Cerasi and Daltung (2000) and Sakai et al. (2010) for the effect of size and age on agency costs).[15]

The book leverage ratio of borrowing firms is constructed in the same way as those of banks. The volatility of firm assets is defined as $\sigma_A = \sigma_E \times \frac{\text{Market Value of Equity}}{\text{Market Value of Firm}}$. The market value of a borrowing firm is defined as the sum of the market value of equity and the book value of total liabilities. The market value of equity is calculated by multiplying the stock price at the end of year $t-1$ by the number of shares. To estimate the volatility of the equity valuation σ_E, we calculate the standard deviation of the market value of equity for the last month of a firm's fiscal year, and then express the estimated volatility at annual rates.[16]

ROA is constructed by dividing a firm's net profits by the book value of its total assets, expressed in percentage terms. Firm size is defined as the logarithm of a firm's book value

[15] Cerasi and Daltung (2000) theoretically predicted that banks may prefer to focus their lending on larger firms, because such firms tend to have more diversified businesses and thus it allows banks to reduce agency (monitoring) costs without reducing the diversification in their lending. Sakai et al. (2010), using a data set of small Japanese firms, found that surviving firms' borrowing costs declined as they aged, because Japanese banks learned about the quality of the surviving firms during the long-term relationships.

[16] More specifically, we calculate the annualized estimated volatility of the market value of equity as in

$$\sigma_{E,it} = \sqrt{\frac{1}{20-1} \times \sum_{k=d(t)-19}^{d(t)} \left(ret_k - \overline{ret_{d(t)}}\right)^2} \times \sqrt{240},$$

where $d(t)$ denotes the last trading-day of firm i's fiscal year t. ret_k denotes the daily rate of change in equity valuation, and $\overline{ret_{d(t)}}$ is the average rate of change in equity valuation for the previous 20 days.

of assets. Firm age is defined as the number of years that have elapsed up to fiscal year t since borrowing firm i started business. Firm sales growth is calculated as the growth rate of gross sales. The firm liquid asset variable is defined as the ratio of liquid assets to total book value of assets.

FTERM_{it-1} denotes the one-period lagged value of a firm termination indicator, which takes the value one if any of firm i's relationships with its lending banks terminated in year $t-1$. The marry dummy variable (FMARRY_{it-1}) is an indicator variable that takes the value one if firm i established a new relationship or revived a terminated relationship in year $t-1$.[17]

INDUSTRY_i is the industry dummy variable indicating the industry to which borrowing firm i belongs. We use industry dummy variables for each of the 33 industries defined by Japan's Securities Identification Code Committee.

In addition to the 10 borrower-side factors, we include funding source variables to control for the dependence of a firm's funding on alternative funding sources such as equity and corporate bonds. This is because a firm's dependence on funding sources affects the significance of the relationship to the firm. According to the information monopoly theory of Rajan (1992), by issuing corporate bonds, firms are less dependent on bank loans, thereby terminating more relationships. In contrast, agency cost theory predicts that in Japan's arm's-length debt market, where Japanese firms cannot easily issue corporate bonds and commercial paper without higher solvency, Japanese banks will choose to continue relationships with such higher-solvency firms because of lower agency (monitoring) costs (see Nakashima and Saito (2009) for a survey on the corporate bond market in Japan).

[17] According to Lummer and McConnel (1989), a termination of firm i's relationships signals a negative change in its firm value from the perspective of financial markets, but a relationship establishment does not signal any change in the firm value. Given this finding, the agency cost view expects the sign of the coefficient for FTERM_{it-1} to be positive, and for FMARRY_{it-1} to be zero, because the continuing banks would terminate a relationship with a value-declining firm that experienced a termination in the previous year, and a firm's relationship establishment in the previous year would not affect the continuing banks' decisions about whether to terminate or continue the relationship with this firm. However, under the information monopoly view, the expected sign of the coefficient for FTERM_{it-1} is negative, and for FMARRY_{it-1} is positive; this is because a value-declining company that experienced a termination in the previous year is less likely to switch relationships, and a firm that diligently switched relationships is more likely to search for a loan rate from a new bank that is lower than the rates from the firm's current banks (see Ioannidou and Ongena (2010)).

We consider four funding sources in this paper: equity, bank loans, corporate bonds, and commercial paper. For a capital increase of borrowing firm i, we use the equity increase dummy variable (EQUITY_{it-1}) that takes the value one if the number of issued stocks increases in fiscal year $t-1$. For the remaining four funding sources, we normalize each of them by the firm's book value of total liabilities, and then calculate the one-period lags of the normalized funding variables, corporate bonds (CB_{it-1}), commercial paper (CP_{it-1}), and bank loans (LOAN_{it-1}).

3.3. **Relationship Factors and Duration Effects** We control for the relationship factors $\mathbf{RELATE_{ijt-1}}$ by including bank j's lending exposure to firm i (EXLEND_{ijt-1}) and firm i's borrowing exposure to bank j (EXBORROW_{ijt-1}). The lending exposure of bank j to firm i is calculated as a ratio of the loan to bank j's total loans in year $t-1$, while the borrowing exposure of firm i to bank j is calculated as a ratio of the loan to firm i's total loans.[18]

The theoretical model of Cerasi and Daltung (2000) focused on the possibility that the agency costs of monitoring additional loans would increase. According to their model, banks with a lending exposure (EXLEND_{ijt-1}) that already monitor a number of borrowers are reluctant to diversify their borrowers (see also Besanko and Thakor (1993) and Hellwig (1998)); hence, the bank would tend to maintain continuing relationships without more diversification of lending. Regarding the termination effects of the firm's borrowing exposure (EXBORROW_{ijt-1}), information monopoly theory (Sharpe (1990), Rajan (1992), and Von Thadden (1995)) predicts two opposite situations: lender-driven termination and borrower-driven termination. The former implies that as a firm depends more on a particular bank, the inside bank will lock the firm into the relationship, while the latter implies that the firm would switch to outside banks because of its caution about lock-in (see e.g. Farinha and Santos (2002) and Ongena et al. (2012) for empirical studies on borrowing concentration into a particular bank).

[18] Peek and Rosengren (2005) focused on the relative importance of a borrowing firm from the lender's viewpoint in estimating their loan supply equation, thus using the bank's lending exposure with a matched sample of Japanese banks and their borrowers. From the borrower's viewpoint, Dass and Massa (2011) focused on the relative importance of a firm's bank loans, using the firm's loan-to-asset ratio with US firm-level panel data but not using the firm's borrowing exposure.

In addition to the two exposure variables, the termination function (1) includes a third relationship factor, the duration dummy variables $\mathbf{DURATION_{ijt-1}}$ indicating the duration of the relationship between lending bank j and its borrowing firm i at time $t-1$. Following the previous studies of Ongena and Smith (2001) and Miyakawa (2010), we define the duration of a relationship as the number of years it remains in our dataset. This is because we cannot observe the true duration of a relationship if it started in a pre-sample period, before 1978. Hence, we use the duration of each relationship defined in our dataset as a first approximation of the true duration. However, considering the data limitation related to left censoring in the framework of the baseline model, we define our duration dummies as an indicator of a tertile of durations (that is, short-, medium- and long-duration dummies) in each fiscal year, instead of the duration itself. In Section 6, we discuss some advantages of our methodology in more detail.[19]

Now, we sum up the covariates included in our baseline termination model—bank factors consist of the book leverage ratio (BLEV_{jt-1}) or one of the other three bank balance sheet variables, the major bank indicator (MAJOR_{jt-1}) and the bank size variable (BSIZE_{jt-1}). Firm factors comprise the 10 characteristics of the book leverage ratio (FLEV_{it-1}), liquid assets ratio (FLIQUID_{it-1}), volatility of firm assets ($\sigma_{A,it-1}$), return on assets (FROA_{it-1}), sales growth (FSALE_{it-1}), firm size (FSIZE_{it-1}), firm age (FAGE_{it-1}), marry variable (FMARRY_{it-1}), firm termination variable (FTERM_{it-1}), industry dummy variable (INDUSTRY_i); and the four funding variables, equity increase (EQUITY_{it-1}), bank loan (LOAN_{it-1}), corporate bonds (CB_{it-1}), and commercial paper (CP_{it-1}). The relationship factors comprise the bank's lending exposure to each borrowing firm (EXLEND_{ijt-1}), the firm's borrowing exposure from each lending bank (EXBORROW_{ijt-1}), and the duration dummies ($\mathbf{DURATION_{ijt-1}}$). Table 2 details the descriptive statistics for each covariate.

Table 3 summarizes the theoretical predictions of the effects of the firm covariates on relationship terminations based on the agency cost view.

[19] In the baseline model, we used duration dummy variables based on the tertile of the duration. However, even if we use the duration dummy variables defined by the duration year directly, our conclusion does not change qualitatively.

4. Estimation Results

In this section, first, we report the estimation results of our baseline termination model for all variables apart from the duration dummy variables. Second, we report the estimation results of our other models to investigate which hypothesis is supported by the bank-firm relationship terminations in the banking crisis in the late 1990s and the early 2000s.

4.1. Baseline Model

In Figure 3-1, we report the estimation results of the AMEs for the bank factors. The positive and significant estimates for the banks' book leverage ratio (BLEV_{jt-1}) from the late 1990s to 2005 indicate that highly leveraged banks were more likely to terminate the relationships with their borrowing firms during these periods.[20] This result supports the existence of a capital crunch in relationship terminations at that time. To show the robustness of our estimation results, in the next subsection we will estimate the termination model using alternative indicators of a bank's capital condition.The AMEs of the major bank indicator (MAJOR_{jt-1}) are positive, indicating that city banks and long-term banks were more likely to terminate relationships than other banks such as local banks. The estimated AMEs of the bank size variable (BSIZE_{it-1}) are negative for almost all sample periods, which implies that large banks are less likely to terminate their relationships.

From the estimation results of the bank factors, we can infer that highly leveraged small banks were more likely to terminate relationships with their borrowers from the late 1990s to 2005.

Table 3 summarizes the estimation results for the firm covariates. This table demonstrates that the estimated AMEs—including those for firms' financial conditions (FLEV and FLIQUID), business uncertainty (Firm σ), profitability (ROA and Sales), age (FAGE), equity issuance (EQUITY), and arm's-length debt (CB and CP)—support the agency cost view, although the signs of AMEs for some variables fluctuate. That is, the estimation results overall support the agency cost theory emphasizing the monitoring costs for banks

[20] One can calculate the macroeconomic impact of the bank's book leverage ratio on relationship termination by multiplying the estimated marginal effect by the standard deviation of the book leverage ratio. The marginal effect of the book leverage ratio at its median value of 97% from 1996 to 2005 is estimated to be 0.5% and the standard deviation from 1996 to 2005 is 3.8%. Hence, the impact of the book leverage ratio on relationship termination is calculated as 1.9% ($= 0.5 \times 3.8$) and its magnitude is significant economically if we compare it to the termination rate (defined as the ratio of the number of terminations to the total number of relationships) of 11% in 1999, at which the number of terminations reached its highest level.

to control borrowers' projects, and are thus consistent with the lender-driven termination view. Information monopoly theory emphasizing borrowers' caution about information lock-in, which is based on the borrower-driven termination view, is not supported. In Appendix B, we discuss the time-varying developments of the effects in each year, which are reported in Figures B-1 to B-3.

Furthermore, note that in Table 3 (see Figures B-1 to B-3 for details), the agency cost effect increased especially during the Japanese banking crisis from the late 1990s to the early 2000s.

4.2. **Banks' Capital Condition and Relationship Termination** In this subsection, we investigate the effect of banks' capital condition and its interaction effect with firms' characteristics on relationship terminations.

4.2.1. **Banks' Capital Condition** In the previous subsection, we found that highly leveraged banks were more likely to terminate relationships with their borrowing firms from the late 1990s to the early 2000s. For the late 1990s, as pointed out by Woo (2003), Gan (2007), and Watanabe (2007), many Japanese banks suffered from badly impaired capital. Furthermore, the regulatory framework for Japanese banks changed drastically in the late 1990s and early 2000s, forcing banks to write off bad assets more aggressively.[21] Taking into account our estimation results for the bank book leverage ratio (BLEV_{jt-1}) and the findings of previous studies, we can infer that banks facing constraints imposed by statutory capital requirements were reluctant to maintain relationships with their borrowing firms in the late 1990s to the early 2000s. We fortify this inference using the lowly capitalized bank indicator (LOWCAP_{jt-1}), the market leverage ratio (BMLEV_{jt-1}), or the non-performing loan ratio (NPL_{jt-1}), instead of the bank book leverage ratio.

Figure 4 shows the estimated AMEs of the alternative bank capital variables, LOWCAP, BMLEV, and NPL. In fiscal years 1990, 1994, 1995, 1997, and 2003, the estimated AMEs of LOWCAP were positive. The AMEs of the market leverage ratio are estimated to have significantly positive from the late 1990s to the early 2000s. For the non-performing loan

[21] See, for example, Sakuragawa and Watanabe (2009) and Nakashima and Takahashi (2018) for detailed discussions about bank regulation changes in Japan.

ratio, its AMEs were estimated to be significantly positive from the late 1990s to 2001.

From the estimation results for the four bank capital variables (BLEV, LOWCAP, BMLEV, and NPL), we can conclude that banks' capital constraints significantly affected relationship terminations in the late 1990s and the early 2000s. Our results suggest the existence of a capital crunch in terms of relationship terminations in the financial turmoil period. In the next subsection, we further study which types of firms—significantly profitable or less profitable—were more likely to face terminations with these lowly capitalized banks.

4.2.2. **Lowly Capitalized Banks and Lowly Profitable Firms** In this subsection, we investigate which of the two scenarios—evergreening or flight to quality—were more plausible in explaining lowly capitalized banks' behavior in relationship terminations. To this end, we include—in addition to a bank capital variable, LOWCAP_{jt-1} or HBLEV_{jt-1}—an interaction term consisting of the bank capital variable and borrowing firms' ROA, $\text{LOWCAP}\times\text{FROA}_{ijt-1}$ or $\text{HBLEV}\times\text{FROA}_{ijt-1}$, into the baseline termination model.

Figure 5 shows the estimation results for the AMEs of FROA_{it} conditional on the value of LOWCAP_{jt}. When focusing on the sign of the AMEs of firm ROA, we see three distinct phases in our sample periods, in terms of the interaction effects on the probability of relationship terminations. The three periods are 1992, 1993–1998, and post-1999.

During the first period, by fiscal year 1992, the AMEs of firm ROA for lowly capitalized banks are positive; however, those for non-lowly capitalized ones are negative. These results indicate that lowly capitalized banks were more likely to maintain relationships with less profitable firms, whereas non-lowly capitalized banks did the opposite.

In contrast, in the second period from 1993 to 1998, the responses of lowly and non-lowly capitalized banks switched; that is, lowly capitalized banks were more likely to terminate relationships with less profitable firms, whereas non-lowly capitalized banks were more likely to maintain relationships with less profitable firms.

Finally, in the period after 1999, the estimated AMEs of firm ROA with both banks were negative. This implies that the less profitable the firms were, the more likely they were to terminate their relationships, whether or not the banks' capital condition was good.

To formally show the difference in the AMEs of firm ROA between lowly and non-lowly capitalized banks, we perform a Wald test for the null hypothesis that the two AMEs are the same. Namely, we test the following null hypothesis:

$$H_0 : \text{AME}(\text{FROA}|\text{LOWCAP} = 1) = \text{AME}(\text{FROA}|\text{LOWCAP} = 0). \tag{9}$$

Table 4 reports p-values for the χ^2 test statistics, indicating that the difference in the AMEs of the firm ROA between lowly and non-lowly capitalized banks was significant in 1995, 1996, 1998, 2000, and 2001.

In 1990–1992, the estimated AMEs seemed to support the evergreening behavior of banks. However, Table 4 indicates that the difference in the AMEs between lowly and non-lowly capitalized banks was not significant at the 10% significance level in this period. This implies that, according to our definition in Subsection 3.1, there is no evidence of the evergreening behavior that is particular to distressed banks in the early 1990s.

From 1993, the sign of the AMEs of FROA for lowly capitalized banks was negative and that for non-lowly capitalized banks was less negative or even positive until 2001. Therefore, the significant difference in the AMEs between lowly and non-lowly capitalized banks in Table 4 implies that in these periods, lowly capitalized banks were more likely to terminate relationships with less profitable firms than non-lowly capitalized banks. In other words, the relationships with lowly capitalized banks were more sensitive to a firm's profitability than those with non-lowly capitalized banks in 1995, 1998, 2000, and 2001. These results support the flight-to-quality scenario where lowly capitalized banks prefer maintaining relationships with more profitable firms.

Figure 6 illustrates the estimation results obtained by using the highly leveraged bank variable (HBLEV_{jt-1}) instead of the lowly capitalized bank indicator (LOWCAP_{jt-1}). From this figure, we see qualitatively similar results to those from the lowly capitalized bank indicator although not much difference is observed as in the results obtained by using the lowly-capitalized bank indicator.

Table 5 reports the Wald test statistics for the difference in the AMEs between highly and non-highly leveraged banks. Table 5 shows that in 1995 and 2003, highly leveraged banks were more likely to terminate relationships with lowly profitable firms than non-highly leveraged banks. We also find no evidence for the evergreening scenario for highly leveraged banks. For some periods such as 1999, even though the difference was significant, the AME of the firm ROA for highly leveraged banks was not significant, as shown in Figure 6. This implies that highly leveraged banks were not likely to maintain relationships with less profitable firms. Furthermore, in some periods such as fiscal year 2004, the difference between highly and non-highly leveraged banks was statistically significant; however, the AMEs for highly and non-highly leveraged banks were negative. This indicates that highly leveraged banks were less sensitive to firms' profitability; however, they still tended to terminate relationships with lowly profitable firms, which does not support evergreening behavior under our definition. This robustness check implies that the evergreening scenario is not supported, while the flight-to-quality scenario is plausible.

Our estimation results are more supportive of the flight-to-quality scenario, rather than the evergreening scenario, which Peek and Rosengren (2005) and Watanabe (2010) suggested to understand Japanese banks' lending decisions from the middle to the late 1990s. Unlike our study, however, they obtained their result on the basis of the continuation of the existing relationships between Japanese banks and their borrowing firms (Peek and Rosengren (2005)) or without considering the difference between the intensive and the extensive margins of bank loans (Watanabe (2010)).

Also note that our results supporting flight to quality in the financial turmoil period are consistent with the agency cost effects of firm factors on relationship terminations (see Subsections 3.2 and 4.1).[22] If we agreed with the findings of Peek and Rosengren (2005) and Watanabe (2010), the difference between our finding based on relationship terminations and their findings would suggest that during a financial crisis, lowly capitalized banks are more likely to increase loans to their unprofitable borrowing firms as long as relationships continue; however, once they decide to terminate such unviable relationships, they prefer to break up relationships with their unprofitable firms in order to reduce agency costs, as theoretically predicted by Bernanke et al. (1996) and Holmström and Tirole (1997).

[22] When using the firm leverage ratio (FLEV_{it-1}), volatility of firm assets ($\sigma_{A,it-1}$) or sales growth rate (FSALE_{it-1}) instead of firm ROA, we found evidence that lowly capitalized banks terminated more relationships with low-quality firms with greater leverage, higher business risks, or lower sales growth, than those with the high-quality ones.

5. Banking Crisis and Duration Effect In this section, we investigate duration effects on relationship terminations, particularly by focusing on banks' capital conditions.

Ongena and Smith (2001) empirically examined duration time until bank-firm relationships terminate using survival analysis. They used bank-firm matched samples from 1979 to 1995 in Norway. Then, they showed that relationships with a longer duration were more likely to terminate, thus suggesting that the value of the relationship declined over time. Ongena and Smith (2001) ascribed their finding to the possibility of a firm's apprehension about a hold-up.

Miyakawa (2010) applied survival analysis to a matched sample of Japanese banks and their borrowing firms, whose sample period ran from 1982 to 1999, thereby drawing conclusions that were opposite to the finding of Ongena and Smith (2001); that is, Miyakawa (2010) demonstrated that bank-firm relationships with a shorter duration were more likely to terminate than those with a longer duration. Miyakawa (2010) attributed this empirical result to the presence of relationship-specific assets; that is, the continuation of transactions in a particular bank-firm relationship would facilitate reusability of information and lowering of the agency costs to control borrowers' projects, so that it would enhance the value of that relationship as a relationship-specific asset.

These two opposing views about the longer duration were based on different mechanisms of a long-term relationship. The empirical results of Ongena and Smith (2001) emphasized the hold-up problem as the cost of the long-term relationship, while those of Miyakawa (2010) emphasized the presence of relationship-specific assets as a benefit of it. Here we reassess whether a longer duration of bank-firm relationships is associated with a higher probability of relationship termination.

The above two studies assumed time-invariant effects of a longer duration; however, our analysis of duration effects incorporates time-varying duration effects. This is because we expect duration effects to depend on the condition of credit markets, such as the accessibility of arm's-length markets and the competitiveness, tightness, and soundness of the bank loan market, as shown in existing studies (see Rajan (1992) for the theoretical predictions, and Degryse and Ongena (2008) for a review of duration effects). In Japan, over the 20 years of our sample period, drastic changes in the financial environment surrounding Japanese firms and banks have occurred. Therefore, we should be skeptical about time-invariant duration effects over our sample periods.

To conduct our duration analysis using the duration dummies, $\mathbf{DURATION_{ijt-1}}$, in the baseline probit model we classify all durations into a tertile group: short-, medium-, and long-duration dummies.[23] We have two reasons for not setting up dummy variables for each duration year directly. First, we cannot always exactly identify the starting year of each relationship in our dataset because most relationships commenced before the beginning of our dataset, or fiscal year 1978. Therefore, we are not able to estimate the duration effects by exactly measuring the duration year of a relationship in terms of the "absolute" time that elapsed from its start. Hence, we focus on its "relative" duration among all relationships in our dataset in each fiscal year.

The second reason, which is closely related to the first, is that our strategy of classifying duration years into a tertile group allows us to study time-varying duration effects. If we employed duration-year dummies instead of duration-quantile dummies, we would not be able to compare duration effects in the 1990s with those in the 2000s. This is because the use of a raw duration year variable causes the maximum possible duration and the distribution of the duration variables to change over time because of our data limitation related to left censoring, which distorts our estimation results.[24] In this analysis, the first-quantile duration dummy variable indicates the shortest duration group, while the third-quantile one is the longest duration group.

5.1. **Baseline Model Estimation** In this subsection, we report estimates of the duration effects in the baseline probit model. In Section 6, we will use the linear probability

[23] Frederiksen et al. (2007) showed that a proportional hazard model reduces to a discrete choice model with duration dummy variables. To construct the short-, medium-, and long-duration dummy variables, we define a quantile on the basis of the maximum duration year instead of the number of observations. For instance, if the maximum duration is nine years, the first quantile group consists of ones with 1–3 year durations, the second with 4–6 years, and the third with 7–9 years.

[24] If we use duration dummies based on a raw duration year in 1990, the longest duration, 12 years, has the highest density because our original data start in 1978. By construction, relationships for which the 12-year duration dummy variable equals one include all relationships with a duration of more than 12 years. However, in 2000 for instance, the raw duration dummy variable for a 12-year duration equals one only if the relationship duration is truly 12 years. Therefore, we cannot deal with a 12-year duration dummy in 1990 in the same way as for one in 2000.

model with fixed effects to conduct a robustness check of the duration analysis. Figure 7 shows the estimation results for the AMEs of the second-quantile and the third-quantile duration dummy variables in which the first quantile is set as the reference group. The left and right figures plot the estimates of the second- and third-quantile duration dummy variables, respectively. We can make the following four inferences based on our estimation results.

First, Figure 7 shows that in the early 1990s, the duration effects of tightening relationships were stable and significant; a longer duration of a relationship was associated with a lower probability of its termination. To see this point more clearly, Figure 8 illustrates the term structure of duration effects for selected periods. For example, in 1995, longer duration variables have a significantly larger negative value, which implies that longer durations are associated with a lower probability of relationship terminations. This result is suggestive of the existence of a relationship-specific value. Furthermore, the result of the increasing effects of a longer duration coincides with the findings of Miyakawa (2010). We should note that the AMEs of the duration dummies are estimated by controlling for other relationship variables such as the borrowing exposure of a firm to its lending bank.

Second, the second quantile duration dummy becomes insignificant in the late 1990s and the early 2000s, indicating that the duration effect starts to diminish in this period. From this result, we can infer that the effect of the tight bank-firm relationship becomes irrelevant to a small difference in their duration. As discussed in Subsection 4.1, this period corresponds to the occurrence of a financial crisis and a capital crunch. The deterioration of banks' financial conditions causes a change in the duration effects. In the next subsection, we will discuss this point in more detail. The decreasing duration effect is observed more clearly in Figure 8; for example, in fiscal year 2000, the term structure of the duration effect flattened with the insignificant second quantile duration variable.

Third, Figure 8 indicates that the term structure of duration effects steepened again for the period 2004–2007. As in the early 1990s, a longer duration of a relationship implied a lower probability of its termination. This result means the duration effect was restored after the financial turmoil in the late 1990s and the early 2000s, although the duration effect substantially weakened at one point. In this period, the Japanese economy and financial system remained relatively stable and sound. From these results, it is clear that a stable financial system is an important condition for the duration effect to lower the probability of termination.

Lastly, in 2008 and 2009, the estimates of duration effects increased substantially. During the 2008 financial crisis, the banking function remained relatively sound, which allowed the effect of longer duration to materialize by mitigating the asymmetric information problem, as pointed out by Uchino (2013).

5.2. **Duration Effect and Bank's Financial Health** The above duration analysis has the following implications. When a banking system is relatively stable, such as the period before 1996 and in the mid-2000s in Japan, the duration effect is apparent in the sense that a longer duration would decrease the likelihood of termination of the relationship between banks and their borrowers. However, when a banking system is relatively fragile, such as the period from 1997 to 2003, the duration effect was weakened. Hence, we can deduce that a relatively stable banking system is an important condition for a longer duration to decrease the likelihood of the relationship terminating.

To show the robustness of this finding, we use the lowly capitalized bank indicator, LOWCAP_{jt-1}, instead of the bank's book leverage ratio and additionally include its interaction terms with the two duration dummies, the second-quantile and the third-quantile duration dummy variables. If the AMEs of the duration dummy variables for lowly capitalized banks (banks of $\text{LOWCAP}_{jt-1} = 1$) do not have negative estimates only in the banking crisis period of the late 1990s and the early 2000s, and the duration dummies for non-lowly capitalized banks (banks of $\text{LOWCAP}_{jt-1} = 0$) have negative ones in the whole sample period including the banking crisis period, we can infer that the bank's financial health is an important condition for the duration effect to lower the probability of termination.[25]

Figure 9 shows the estimation results for the AMEs of the duration dummies for lowly and non-lowly capitalized banks. It is observed that the AMEs for non-lowly capitalized banks have significantly negative estimates in the banking crisis periods of the late 1990s

[25] We also used the highly leveraged bank indicator, HBLEV_{jt-1}, as a proxy for bank financial health. We found that estimation results obtained using the highly leveraged bank indicator did not differ qualitatively from those obtained using the lowly capitalized bank indicator.

and the early 2000s, whereas the AMEs for lowly capitalized banks do not.[26] This implies that the duration effects were preserved during the financial system turmoil for relationships with non-lowly capitalized banks.

Our analysis in this subsection supports the suggestion that a relatively stable banking system, in particular, based on a bank's financial health, is a prerequisite for the existence of the duration effect, and a longer duration decreases the likelihood of terminating the bank-firm relationship. Our duration analysis in this section leads to the inference that Japan's banking system took time to cultivate a relationship-specific asset in every bank-firm relationship to lower the agency cost gradually; at the same time, the "partial malfunction" of this system caused a flight to quality, where many Japanese banks with impaired capital were prompted to reduce agency costs, and then could not afford to maintain relationships with distressed borrowers irrespective of duration.

6. Robustness and Extension of Termination Analysis In this section, we extend the termination analysis in two dimensions. First, we control for lender- and borrower-side factors more thoroughly to show the robustness of our empirical results thus far. To this end, instead of the probit model, we use a linear probability model with fixed effects, in which we control for the total loan supply and demand factors through time*bank and time*firm fixed effects. Second, we examine to what degree the termination of a bank-firm relationship is driven by the bank or the firm. For this purpose, we compare the contribution of estimated lender- and borrower-side factors to terminations using the linear probability model with fixed effects.

6.1. **Linear Probability Model with Fixed Effects** A distinctive analytical advantage of using loan-level matched data is that one can simultaneously control for the demand and supply factors in an equation specified at the loan-level unit. To exploit this analytical advantage, we included various types of bank and firm observable covariates in the probit equation (1) (see Subsection 2.1). However, in this termination equation, we may not have adequately controlled for lender- and borrower-side factors because of omitted variables.

[26] We conducted the Wald test for equality among the AMEs of the duration dummies and the AMEs of their interaction terms with the lowly capitalized indicator. We found that the equality hypothesis is rejected at the 10% level of significance in 1998, 1999, and 2002.

To address this potential problem of omitted variable bias, we use the linear probability model with fixed effects. Thus, we attempt to show the robustness of our estimation results obtained using the probit model.

As discussed in the Introduction, the FE approach was developed in some important previous studies that used loan-level matched data in order to control for loan demand and supply factors (see Khwaja and Mian (2008) and Jiménez et al. (2014)). Under this approach, the total loan demand and supply factors are embodied in firm i's and bank j's time-variant unobservables, each denoted as FirmFE_{it} and BankFE_{jt}. If the FEs can fully capture the total loan demand and supply factors, the FE approach would allow us to identify the effects of bank and firm observable covariates.

More concretely, we introduce the following two equations to identify the effects of bank and firm observable covariates on relationship terminations:

$$\begin{aligned}\text{TERM}_{ijt} &= \text{a} + \text{FirmFE}_{it} + \mathbf{BANK'_{jt-1}c} + \mathbf{RELATE'_{ijt-1}d} + \mathbf{DURATION'_{ijt-1}f} \\ &\quad + \text{BankFE}_{j} + \epsilon_{ijt}, \end{aligned} \tag{10}$$

$$\begin{aligned}\text{TERM}_{ijt} &= \text{a} + \mathbf{FIRM'_{it-1}b} + \text{BankFE}_{jt} + \mathbf{RELATE'_{ijt-1}d} + \mathbf{DURATION'_{ijt-1}f} \\ &\quad + \text{FirmFE}_{i} + \epsilon_{ijt}, \end{aligned} \tag{11}$$

where TERM_{ijt} is a dummy variable that takes a value of one if firm i borrowed from bank j at the end of year $t-1$ but not at the end of year t.

Equation (10) is the termination equation that disentangles the effects of bank observable covariates ($\mathbf{BANK_{jt-1}}$) from those of the total firm-side factors specified as the firms' fixed effects (FirmFE_{it}). However, equation (11) is the termination equation that disentangles the effects of firm observable covariates ($\mathbf{FIRM_{it-1}}$) from those of the total bank-side factors specified as the banks' fixed effects (BankFE_{jt}).

The bank observable covariates ($\mathbf{BANK_{jt-1}}$) are composed of the three bank variables including the bank leverage ratio (BLEV_{jt-1}), while the firm observable covariates ($\mathbf{FIRM_{it-1}}$) are composed of the nine firm variables including the firm ROA (FROA_{it-1}) and the volatility of firm assets ($\sigma_{A,it-1}$) and the four firm funding variables (see Subsections 3.1 and 3.2 for definitions of all of the bank and firm variables). In equations (10) and (11), we also include bank and firm time-invariant unobservables (BankFE_j and FirmFE_i) as well as the bank and firm observables.

Note that the two termination equations should be specified in the linear probability model, and not in the probit model. This is because we cannot employ the FE approach in the probit model because it cannot exclude the FEs through the within transformation. The linear probability model with FEs and the probit model are not competing but rather complementary, partly because the probit model gives a consistent and unbiased estimator but the linear probability model does not, and partly because the linear probability model can control for unobserved loan demand and supply factors elaborately, but the probit model cannot. In the following, given the pros and cons of the two models, we use the FE approach to show the robustness of the estimation results based on the probit model.

6.2. **Robustness of Capital Crunch and Flight to Quality** Of the estimated coefficients on the bank and firm covariates in equations (10) and (11), we focus particular attention on those of the bank leverage ratio (BLEV_{jt-1}) and the firm ROA (FROA_{it-1}) in the banking crisis period of the late 1990s and the early 2000s, because the estimated coefficients on the two variables in this period are very important in our termination analysis developed in Section 4. Furthermore, instead of the bank leverage ratio, we also use the lowly capitalized bank indicator (LOWCAP_{jt-1}) as an alternative bank leverage variable in equation (10) (see Subsection 3.1 for the definition of the lowly capitalized bank indicator). If the estimated coefficients on the two types of bank leverage variables are positive and significant in equation (10), this implies that banks with greater leverage are more likely to terminate existing relationships with all types of borrowing firms. However, if the estimated coefficients on firm ROA are significantly negative in equation (11), then a lower level of firms' unprofitability leads to more relationship terminations regardless of bank characteristics.

Figure 10 reports the estimated coefficients on the two types of bank leverage variables in equation (10) (upper panels) and the firm ROA in equation (11) (lower panel). When estimating equations (10) and (11), we conducted a rolling linear regression with a five-year window. This figure appears to complement the results obtained in Subsections 4.1 and 4.2:

the two bank leverage variables have significantly positive coefficients in the banking crisis period from the late 1990s to the early 2000s, though this tendency is more pronounced for the lowly capitalized bank indicator than for the bank leverage ratio. This confirms the presence of a capital crunch in relationship terminations. The firm ROA has significantly negative estimates after the late 1990s, confirming that after the capital crunch, banks evaluated firm performance more stringently. [27]

Next, in order to conduct a robustness check on the termination analysis of unviable relationships between lowly capitalized banks and unprofitable firms during the financial turmoil, which was developed in Subsection 4.2, we additionally introduce the following termination equation:

$$\begin{aligned}\text{TERM}_{ijt} &= \text{a} + \text{FirmFE}_{it} + \text{BankFE}_{jt} + \mathbf{RELATE'_{ijt-1}d} + \mathbf{DURATION'_{ijt-1}f} \\ &\quad + \text{gFROA}_{it-1} \times \text{LOWCAP}_{jt-1} + \epsilon_{ijt}, \qquad (12)\end{aligned}$$

where the variable $\text{FROA}_{it-1} \times \text{LOWCAP}_{jt-1}$ denotes the interaction term of the firm ROA and the lowly capitalized bank indicator. Note that in contrast to equations (10) and (11), this specification controls for both total bank- and firm-side factors using the double FEs. An estimated coefficient $\hat{g}$ on the interaction term measures the difference of the effects of firm profitability on relationship termination between the two cases of $\text{LOWCAP}_{jt-1} = 1$ and $\text{LOWCAP}_{jt-1} = 0$.

Figure 11 reports the estimated coefficients on the interaction terms obtained using a rolling liner regression with a five-year window for equation (12). This figure clearly shows that the interaction term has significantly negative coefficients for the period from 1995 to 1998, and does not have significantly estimated coefficients for the other sample periods. It suggests that as long as lowly capitalized banks led relationship terminations in the late 1990s, in order to reduce agency costs, those banks were more likely to terminate their relationships with unprofitable firms than those with profitable firms; that is, the flight-to-quality behavior of lowly capitalized banks occurred in relationship terminations during

[27] When including the volatility of firm assets ($\sigma_{A,it-1}$) in equation (11), we found that it had positively estimated coefficients after the late 1990s, as reported in Table 3 and Figure B-1. This indicates that after the capital crunch, banks evaluated borrowers' business uncertainty more stringently.

the banking crisis period.[28]

6.3. **Duration Effect and Agency Costs** In this subsection, we briefly report the robustness results for the duration analysis developed in Section 5, and then examine the relationship between duration and borrowing rates.

To conduct a robustness check for the duration analysis, we include the interaction term of the duration dummies and the lowly capitalized bank indicator ($\mathbf{DURATION'_{ijt-1}} \times \text{LOWCAP}_{jt-1}$), instead of including the interaction term of the firm ROA and the lowly capitalized bank indicator ($\text{FROA}_{it-1} \times \text{LOWCAP}_{jt-1}$) in equation (12) specified in the previous subsection. Thus, Figure 12 shows that the duration effects for non-lowly capitalized banks (the case of $\text{LOWCAP}_{jt-1} = 0$) are significant even in the banking crisis periods of the late 1990s and the early 2000s, whereas those for lowly capitalized banks (the cases of $\text{LOWCAP}_{jt-1} = 1$) are not for duration dummy 2 (i.e. the dummy variable for the second tertile of duration) and those for duration dummy 3 (for the longest tertile of duration) because they become weaker in that period. This confirms that the duration effects are preserved in the financial turmoil period for relationships with non-lowly capitalized banks and banks' financial health would be a prerequisite for Japan's banking system to cultivate bank-firm relationships over a long period of time, as discussed in Subsection 5.2.

Another important concern for the length of bank-firm relationships is whether Japanese banks require an agency premium for a longer duration. If this is the case, firms have a strong incentive to initiate terminations in order to avoid a hold-up (see e.g. Degryse and Ongena (2005) and Ioannidou and Ongena (2010)); otherwise, a longer duration could help increase the value of a relationship-specific asset and lower the agency cost without causing a hold-up (see e.g. Berger and Udell (1995), Brau (2002), and Sakai et al. (2010)).

Table 6 reports the estimation results obtained by regressing firms' borrowing rates on the duration of the relationships with their main banks. We identify a firm's main bank as a lending bank that has the highest borrowing exposure for the firm.[29] As shown in this table,

[28] When including the interaction term of the volatility of firm assets and the lowly capitalized bank indicator in equation (12), we found that it had positively estimated coefficients during the banking crisis period, indicating that lowly capitalized banks were more likely to terminate relationships with firms facing higher business risks than those with firms facing lower business risks.

[29] We estimated a pooled regression model for each year separately in order to allow covariates to have

firms' borrowing rates have a negative association with relationship duration, although the estimates are not significant for some periods, implying that a longer duration contributes to lowering agency costs (firm's borrowing) in Japanese bank–borrower relationships. In other words, the hold-up problem was not the main driving force of relationship terminations in Japan's banking system.

6.4. **Bank- and Firm-Driven Terminations** One critical assumption behind our explanation of all the estimation results is that the effects of the bank leverage ratio and lowly capitalized bank dummy on relationship terminations in the late 1990s and the early 2000s reflect banks' managerial decisions after we control for firms' other characteristics. More precisely, our findings that the capital crunch and the flight to quality of banks prevailed in those periods is based on the premise that firms did not take initiative in terminations depending on these banks' measures. Here, we show the plausibility of our interpretation that firms did not terminate relationships based on those banks' health, but banks did, by using termination equations with double FEs.

$$\mathrm{TERM}_{ijt} = \mathrm{a} + \mathrm{FirmFE}_{it} + \mathrm{BankFE}_{jt} + \mathbf{RELATE}'_{\mathbf{ijt-1}}\mathbf{d} + \mathbf{DURATION'}_{\mathbf{ijt-1}}\mathbf{f} + \epsilon_{\mathrm{ijt}}. \quad (13)$$

In this specification with double FEs, we have the advantage that the loan demand and supply factors (FirmFE_{it} and BankFE_{jt}) can be identified through a linear regression (see Jiménez et al. (2014)); hence, we can decompose and compare the contribution of the two factors as well as the relationship factors ($\mathbf{RELATE}_{\mathbf{ijt-1}}$ and $\mathbf{DURATION'}_{\mathbf{ijt-1}}$) to relationship terminations. We exploit such an advantage to examine whether the termination of a bank-firm relationship is driven by bank factors or firm factors, such as their managerial decisions, financial conditions, and profitability.

Table 7 shows the decomposition of the contribution of the bank, firm, and relationship factors for subsample periods. When calculating the contribution of the three factors, we standardize each of the contributions so that the three covariances between the termination variable and each of the three factors sum to one. Hence, this table shows to what degree

a time-varying impact on the borrowing rate. To control other firm covariates and industry attributes, we also included all the firm covariates introduced in Subsection 3.2 and industry dummies.

the bank, firm, and relationship factors contribute to the R-squared of the termination regression (13). Surprisingly, as shown in this table, for all subsample periods the contribution of the bank factors is calculated to be about 80 to 85 percent, while those of the firm and the relationship factors are calculated to be about 5 to 10 percent. This indicates that relationship terminations are mainly driven by lender-side factors, not only in the financial crisis period, but also in the non-financial crisis period.[30]

6.5. **Insight into Relationship Terminations** Our analysis in the previous subsection demonstrated that relationship terminations are always primarily attributable to lender-side factors including banks' managerial decisions and financial conditions, and not to borrower-side ones. Given that relationship terminations substantially increased during the financial crisis period of the late 1990s and early 2000s, as observed in Figure 1, we can infer that the worsening of banks' capital conditions would boost such lender-driven terminations and lead to flight to quality. Under flight to quality, lowly capitalized banks terminate relationships with low-quality borrowers in order to reduce agency costs, thus destroying a relationship-specific asset in a bank-firm relationship.

This lender-driven termination view also highlights the fact that the information monopoly of inside banks and the resultant hold-up problem, which emphasizes the negative aspect of a tight relationship, cannot fully explain actual terminations, at least in the context of Japan's bank loan market. This theory predicts that a borrower may initiate terminations as well as a lender. More concretely, under the information monopoly, a borrower with low credit risk and high future profitability can initiate a relationship termination to surmount the hold-up problem, as predicted in Rajan (1992). However, our results for Japan's bank-firm relationships do not support this prediction well: Japanese banks have a tendency to maintain relationships with borrowers with low credit risks, particularly in periods of financial turmoil. To support the information monopoly theory, low-risk firms are more likely to terminate relationships. However, the results show the opposite. These results implying flight-to-quality behavior in periods of financial turmoil cannot be explained with-

[30] In a similar way, Amiti and Weinstein (2018) extracted loan demand and supply factors from the same Japanese matched bank-firm lending data, albeit unlike ours, their analysis did not pay particular attention to relationship terminations, or the extensive margin of bank loans. They showed that the loan supply factors explain 30–40 percent of aggregate loan and investment fluctuations in Japan.

out introducing the agency cost view, in which lowly capitalized banks are more likely to display flight-to-quality behavior to reduce agency costs in terminating relationships, as theoretically predicted in Bernanke and Gertler (1989; 1990), Bernanke et al. (1996), and Holmström and Tirole (1997). Our empirical results for Japan's bank loan market are consistent with this theoretical prediction.

7. Conclusion Using a large matched sample of Japanese lending banks and their borrowing firms over 20 years, we examined what factors caused relationships between lending banks and their borrowers to terminate. This paper draws three main substantive conclusions about this question.

First, firm factors have only minor effects on relationship terminations, whereas bank factors, such as banks' managerial decisions and financial conditions, have major effects. Such lender-driven terminations are boosted when banks' capital conditions worsen substantially, such as during Japan's banking crisis period. Concretely, the constraints on bank capital in the banking crisis period increased relationship terminations in the capital crunch, and also caused flight-to-quality behavior, in which lowly capitalized banks have the tendency to maintain relationships with good-quality firms (such as firms with lower business uncertainty and higher performance). The flight to quality in relationship terminations is consistent with the agency cost effects; that is, it results from lowly capitalized banks' motives to reduce agency costs in the capital crunch.

Second, Japanese banks are more likely to select relationships with older firms that use arm's-length debts (corporate bonds and commercial paper) and have better financial conditions (lower leverage and higher liquidity ratios), lower business uncertainty (lower asset risks), and higher performance (higher profitability and sales growth). Their effects are based on banks' motives to lower agency costs and strengthen performance, especially during the Japanese banking crisis from the late 1990s to the early 2000s.

Last, when Japan's banking system is relatively stable, a longer relationship duration decreases the likelihood of every bank-firm relationship being terminated. Conversely, when the system is fragile, the duration effect is diminished. This result is counter to the hold-up problem and implies that Japan's banking system took a long time to cultivate a relationship-specific asset in all bank-firm relationships to lower agency costs gradually;

however, the "partial malfunction" of this system resulted in flight to quality, where many Japanese banks facing impaired capital were forced to reduce agency costs, and then could not afford to maintain relationships with distressed borrowers irrespective of duration.

The frequency of relationship terminations is influenced by the characteristics of a banking system. Hence, the above conclusions highlight the necessity of a comparative view of banking systems (Aoki and Patrick (1994) and Allen and Gale (1995; 2001)), because empirical studies on the Japanese banking system, including Miyakawa (2010), Sakai et al. (2010), and the present paper, provide evidence against the hold-up problem in long-term relationships, which is emphasized by, for example, Ongena and Smith (2001), Degryse and Ongena (2005), and Ioannidou and Ongena (2010). Our analysis of relationship banking should be extended along this line.

Appendix A: Construction of a Loan-Level Matched Sample with M&A, Business Transfer, and Divestiture Activity The Japanese banking sector saw significant M&A, business transfer, and divestiture activity over the late 1990s and early 2000s. To construct our loan-level dataset, we checked whether successor banks took over the merged or eliminated bank's credit claims on its borrowing firms before and after the relevant M&A, business transfer, or divestiture. This appendix explains how we define the termination of a bank-borrower relationship in the case of M&As, business transfers, and divestitures.

The Case of M&As Here, we consider the case of an absorption-type merger. If a surviving bank takes over a merged bank's loan lent to a borrowing firm after the absorption merger, we assume that the pre-M&A relationship between the merging bank and the borrowing firm continues in the post-M&A relationship between the surviving bank and the firm. That is, the pre-M&A relationship does not terminate at the time of the absorption merger. In contrast, if no bank takes over the loan of the merging bank, we assume that the pre-M&A relationship terminates at the time of the absorption merger.

The Case of Business Transfers Next, we consider the case in which a bank transfers its business to other banks. In this case, we define a relationship termination as the case of an M&A. If we find that the transferee bank takes over the loans of the transferor bank, we assume that the transferor bank also transfers pre-transfer relationships between the transferor bank and its borrowing firms, and that the pre-transfer relationships do not terminate. As long as we find that the transferee banks did not take over the loans of the transferor bank, we assume that the pre-transfer relationships between the transferor bank and its borrowing firms are terminated. We adopt the above way of defining a relationship termination, whether the accepting banks enjoyed relationships with those borrowing firms before the business transfer or not.

The Case of Mergers and Divestitures We consider the case in which banks merge and then divest. In this case, we should identify which banks formed after the merger and divestiture, and whether they took over the loans of the merging banks. If a firm enjoyed relationships with one of the merging banks before the merger and divestiture, and the firm had a relationship with at least one of the surviving banks after the merger and divestiture, we assume that the relationships between the merging banks and the firm were preserved. That is, the relationships did not terminate. If the firm does not have any relationships with the surviving banks after the merger and divestiture, we assume that the relationships between the merged banks and the firm terminated at that time.

Appendix B: Estimation Results for the Firm and Relationship Factors in the Termination Model In Subsection 4.1, we briefly reported estimation results for firm covariates and pointed out that the results support the agency cost view in terminating relationships. In this appendix, we report the estimation results in more detail.

Firm Factors Table 3 summarizes the predicted signs of the coefficients based on the agency cost view and the estimation results. Figures B-1 and B-2 show the estimation results of the AMEs for the firm and its funding factors. As shown in Figure B-1, the AMEs for firms' book leverage ratio (FLEV_{it-1}) are estimated to be negative before 1998 and after the mid-2000s, indicating that highly leveraged firms are less likely to face relationship terminations than lowly leveraged ones. In contrast, the AMEs have significantly positive values for some periods in the late 1990s and the early 2000s. Given that these periods correspond to the time when the Japanese financial system was in turmoil, this result suggests that Japanese banks evaluated firms' financial conditions more stringently for these periods in order to reduce agency costs. However, in the non-turmoil periods, financially fragile firms with greater leverage were more likely to be locked in.

The estimated AMEs for firm liquid assets (FLIQUID_{it-1}) indicate that firms with more liquid assets were more likely to experience relationship terminations, except for in 1999. This result underscores the fact that fiscal year 1999 was the peak of the banking crisis; in a normal period, a higher liquid assets ratio would imply more terminations, because of the weaker lock-in effect, as predicted by information monopoly theory, while in 1999, firms with a high liquid assets ratio were able to maintain their relationships with banks because of the lower agency costs, as predicted by agency cost theory. This finding for the firm liquidity assets is compatible with that for the firm leverage ratio.

The AMEs of volatility of firm assets ($\sigma_{A,it-1}$) is estimated to have significantly positive values from 1998, while the sign of the AMEs was unstable in the early 1990s. This means that highly volatile firms were more likely to face relationship terminations after the late 1990s. From these results for the firm leverage and volatility variables, in the late 1990s and the early 2000s, firms with higher risks were more likely to face relationship terminations than less risky firms because of Japanese banks' motives to reduce agency costs, whereas this was not always the case before.

The estimated AMEs for the firm ROA (FROA_{it-1}) and the sales growth rate (FSALE_{it-1}) support the agency cost view; that is, banks selected relationships with highly performing firms in order to reduce agency costs. The AMEs for the firm ROA (FROA_{it-1}) are significantly positive in the early 1990s, while they are significantly negative after the mid-1990s. In this latter period, the bank relationships of highly profitable firms were more likely to last. With respect to the sales growth rate (FSALE_{it-1}), the estimated AMEs are negative through all periods except for a few years such as 1994. These negative estimates show that a firm's strong growth was associated with a higher probability of continuing relationships.

The firm size (FSIZE_{it-1}) has significantly positive estimates after 1997, which is not consistent with the agency cost theory, but rather with the information monopoly theory; that is, it is more difficult for larger firms to be locked in.

The firm age (FAGE_{it-1}) coefficient is negative for almost all sample periods, although the negative estimates are not necessarily significant. These results indicate that a relationship with an older firm was more likely to continue than one with a younger one, because maintaining a relationship with such a long-standing firm keeps the agency costs down, as empirically demonstrated in Sakai et al. (2010).

The AMEs of the marry indicator (MARRY_{jt-1}) is significantly positive only during the late 2000s; however, for the overall sample period, the estimates are insignificant, indicating that the establishment of a new relationship in the previous year does not affect the continuing bank's decision about whether to terminate or continue the relationship with the firm that experienced the relationship establishment. The positive AMEs for the one-period lag of the borrowing firm's termination indicator (FTERM_{it-1}) indicate that borrowing firms that had experienced a relationship termination in the previous year were more likely to face the termination of other relationships in the next year. The results for the marry and the termination indicators support the agency cost view for the overall sample period.

Figure B-2 presents the estimation results for the firm funding factors. For the equity increase dummy variable (EQUITY_{it-1}), the estimates have either positive or negative values, varying over time. Specifically, they have significantly positive estimates in 1995, 1999, and 2008–2009, indicating that firms with increasing equity faced relationship terminations. In other words, the bank relationships of firms that did not increase their equity were more likely to last. This result implies that bank loans were substitutes for equity in these periods. The years 1999 and 2008–2009 were times when the financial markets were in turmoil. Therefore, we can infer that firms that had difficulty in issuing equity were more able to maintain relationships.

Regarding the arm's length debt, the estimated AMEs for corporate bonds (CB_{it-1}) and commercial paper (CP_{it-1}) are significantly negative in the early 2000s when Japan's banking system was fragile, whereas they are positive in the other periods when the system was stable, albeit not always significant. As discussed in Subsection 3.2, only high-solvency firms can issue corporate bonds and commercial paper in Japan. The negative estimates for the financial turmoil period support the agency cost view, implying that Japanese banks selected secured relationships with high-solvency firms that were able to use the two debt-funding tools. However, the positive estimates in the pre- and post-financial turmoil period support the information monopoly view, implying that the high-solvency firms issuing corporate bonds and commercial paper were less likely to be locked in during normal times.

The estimated AMEs for the dependence on bank loans (LOAN_{it-1}) indicate that the more a firm depended on bank loans, the fewer relationship terminations it faced. The magnitude of the AMEs is greater for 1999 and 2009–2010. This result suggests that during a period of financial turmoil, the dependence on bank loans accelerated because of the stronger lock-in effect.

To sum up, in order to reduce agency costs, Japanese banks selected relationships with longer-established firms that used arm's-length debt (corporate bonds and commercial paper) and have lower business uncertainty (lower asset volatility), and higher performance (higher profitability and sales growth), while terminating relationships with the other types of firms. Also note that such agency cost effects strengthened in the financial turmoil period such as in the late 1990s as the signs of the coefficients on firm book leverage and liquidity-asset ratio changed to ones that support the agency cost view.

Relationship Factors For the two relationship factors (see Figure B-3), the coefficients on firms' borrowing exposure (EXBORROW_{ijt-1}) are significantly negative for the overall sample period, with the impact being the biggest in 1999. Moreover, banks' lending exposure (EXLEND_{ijt-1}) has significantly negative AMEs for the overall period, with the impact being the biggest in 2004. This implies that an increase in a firm's and a bank's dependence on a particular relationship is associated with a higher probability of maintaining the relationship, especially during a period of financial turmoil.

However, the mechanism of strengthening bank-firm relationships is different between a bank's lending exposure and a firm's borrowing exposure: the negative AMEs for a bank's lending exposure support the agency cost view in which each bank is reluctant to bear the additional agency costs to diversify lending portfolios, whereas those for a firm's borrowing exposure support the information monopoly view or relationship-specific asset hypothesis in which a borrower that depends more on a particular bank is more locked in or benefits from the relationship.

We report estimation results for the duration dummy variables ($\mathbf{DURATION_{ijt-1}}$) in Section 5.

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Table 1: Number of Observations: Average per Year

Number of observations	Full sample	1990–1999	2000–2010
Firms	1,992	1,792	2,174
Banks	138	150	127
Relations	16,528	19,760	13,411

Notes: This table shows sample averages of the numbers of observations for borrowing firms, lending banks, and relationships, each calculated per year. "Full sample" indicates the sample period from fiscal year 1990 to 2010.

Table 2: Summary Statistics

	Full Sample				1990–1994		1995–1999		2000–2004		2005–2010	
Variable	**Mean**	**Std. dev.**	**Min.**	**Max.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
Termination												
TERM	0.067	0.25	0	1	0.031	0.18	0.066	0.25	0.082	0.27	0.095	0.29
Bank factors												
BLEV	96.17	2.83	87.3	149.11	96.57	0.83	96.65	1.97	96.15	5.06	95.30	1.62
LOWCAP	0.40	0.49	0	1	0.88	0.33	0.64	0.48	0.054	0.23	0.007	0.081
NPL	3.93	3.25	0.13	53.73	4.21	1.19	3.07	3.22	5.31	4.06	3.38	1.75
MAJOR	0.42	0.49	0	1	0.51	0.5	0.41	0.49	0.38	0.49	0.38	0.49
BSIZE	14.64	1.34	11.68	18.85	14.57	1.41	14.63	1.35	14.64	1.31	14.73	1.28
Firm factors												
FLEV	61.07	19.65	0.91	835.43	65.11	17.74	62.36	19.97	61.03	20.99	57.66	18.64
FLIQUID	0.523	0.204	0.006	0.999	0.591	0.183	0.547	0.192	0.504	0.202	0.481	0.215
Firm σ	19.17	15.09	0.081	520.13	20.58	9.74	17.80	10.33	18.63	15.86	19.91	19.56
FROA	0.62	7.76	-372.92	157.16	1.44	4.17	0.65	5.12	0.15	8.73	0.55	9.96
FSALE	0.011	0.254	-4.681	7.299	0.034	0.199	0.005	0.159	0.013	0.244	0.001	0.341
FSIZE	10.535	1.488	4.522	16.46	11.01	1.43	10.65	1.45	10.38	1.45	10.3	1.51
FAGE	3.768	0.578	-0.693	4.859	3.866	0.347	3.809	0.441	3.754	0.585	3.689	0.746
FMARRY	0.251	0.434	0	1	0.227	0.419	0.203	0.402	0.268	0.443	0.292	0.455
FTERM	0.267	0.442	0	1	0.209	0.407	0.273	0.446	0.306	0.461	0.263	0.44
Firm funding factors												
EQUITY	0.318	0.466	0	1	0.451	0.498	0.292	0.455	0.182	0.386	0.235	0.424
CB	-0.137	6.331	-75.407	78.431	0.779	8.517	-0.634	7.628	-0.453	5.764	-0.191	5.64
CP	0.041	1.379	-32.025	33.919	0.048	0.837	0.052	1.254	-0.023	1.176	0.009	1.212
LOAN	-0.08	8.595	-80.89	87.22	0.069	6.907	0.893	7.363	-0.955	8.478	-0.184	10.284
Relationship factors												
EXPBORROW	11.53	14.43	0	100	8.159	11.035	9.785	12.655	13.224	15.392	15.982	17.395
EXPLEND	0.712	3.033	0	100	0.78	3.411	0.612	2.734	0.703	2.918	0.78	3.082
Duration years	11.6	8.468	1	33	11.148	5.284	11.689	7.907	12.023	9.452	11.544	10.732
Duration dummy 1	0.422	0.494	0	1	0.214	0.41	0.388	0.487	0.532	0.499	0.587	0.492
Duration dummy 2	0.137	0.344	0	1	0.128	0.334	0.132	0.338	0.117	0.321	0.177	0.381
Duration dummy 3	0.441	0.497	0	1	0.658	0.474	0.48	0.5	0.35	0.477	0.236	0.425

Notes: Duration dummy 1 indicates the shortest duration tertile and 3 indicates the longest. The mean and standard variations (Std. dev.) of relationship factors are calculated on the basis of relationships.

Table 3: Predicted and Estimated Effects of Firm Covariates on Relationship Terminations in Terms of the Agency Cost Theory

	Predicted effects	Estimated effects	Periods of largest agency cost effects
Firm factors			
Book leverage ratio (FLEV)	+	+ in 1999, 2000 and 2003-2005	1999
Liquidity-to-asset ratio (FLIQUID)	−	− in 1997 and 1999	1999
Asset volatility (Firm σ)	+	+ in the overall period	2003
ROA (FROA)	−	− in the overall period	2003
Sales (FSALE)	−	− in the overall period	2000
Size (FSIZE)	−	− through 1996	1993
Age (FAGE)	−	− in the overall period	2004
New relationship (FMARRY)	0	0 in the overall period	-
Lagged termination (FTERM)	+	+ in the overall period	2007
Firm funding factors			
Equity Issue (EQUITY)	−	− except in 1999, 2008 and 2009	2004
Corporate bond-to-debt ratio (CB)	−	− except in 1995-1997 and 2005	2003
Commercial paper-to-debt ratio (CP)	−	− except in 2004-2006	2001
Bank loan-to-debt ratio (LOAN)	0	− in the overall period	-

Notes: +, −, and 0 in the predicted effects indicate that the agency cost theory predicts that each firm covariate has positive, negative, and no simple associations with relationship terminations, respectively. See Subsection 3.2 for the predicted effects of the agency cost theory. The estimated effects summarize estimated AMEs of each firm covariate on relationship terminations, which is reported in Figures B-1 and B-2, obtained by running the rolling estimations of the baseline probit model (1). The periods of largest agency cost effects indicate a period when an estimated AME of each firm covariate becomes the largest in terms of the agency cost effect. See Appendix B for more details on the estimation results.

Table 4: Wald Test for the Difference of AMEs of the Firm Return on Assets between Lowly and Non-Lowly Capitalized Banks

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
p-value	0.76	0.28	0.11	0.20	0.16	0.08*	0.06*	0.86	0.02**	0.96
Year	2000	2001	2002	2003	2004	2005				
p-value	0.10*	0.03**	0.49	0.13	0.23	0.50				

Notes: Using the estimated AMEs of FROA, we conducted a Wald test for the null hypothesis that the AME for lowly capitalized banks is equal to that for non-lowly capitalized ones. ***, **, * indicate 1%, 5%, and 10% levels of significance, respectively.

Table 5: Wald Test for the Difference of AMEs between Highly and Non-Highly Leveraged Banks

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
p-value	0.42	0.21	0.35	0.72	0.16	0.01**	0.54	0.98	0.67	0.07*	
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
p-value	0.27	0.61	0.73	0.03**	0.02**	0.13	0.95	0.29	0.74	0.21	0.24

Notes: Using the estimated AMEs of FROA, we conducted a Wald test for the null hypothesis that the AME for highly leveraged banks is equal to that for non-highly leveraged ones. ***, **, * indicate 1%, 5%, and 10% levels of significance, respectively.

Table 6: The Effects of Duration on the Borrowing Rate

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Duration	-0.217**	-0.227*	-0.220**	-0.134	-0.0295*	-0.0189	-0.0183	-0.00861**	-0.0100	-0.00548	-0.00559*
	(0.106)	(0.118)	(0.106)	(0.0823)	(0.0165)	(0.0143)	(0.0131)	(0.00417)	(0.00670)	(0.00607)	(0.00340)
Number of obs.	1424	1455	1504	1553	1568	1584	1613	1973	2185	2115	2112

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Duration	-0.00297	-0.00868**	-0.000777	-0.00212	-0.00682**	-0.00684*	-0.00196	-0.00153	-0.000318*	0.000382
	(0.00467)	(0.00414)	(0.00288)	(0.00349)	(0.00344)	(0.00367)	(0.00346)	(0.00384)	(0.00200)	(0.00278)
Number of obs.	2047	2022	2018	2029	2012	1998	1978	1950	1944	1877

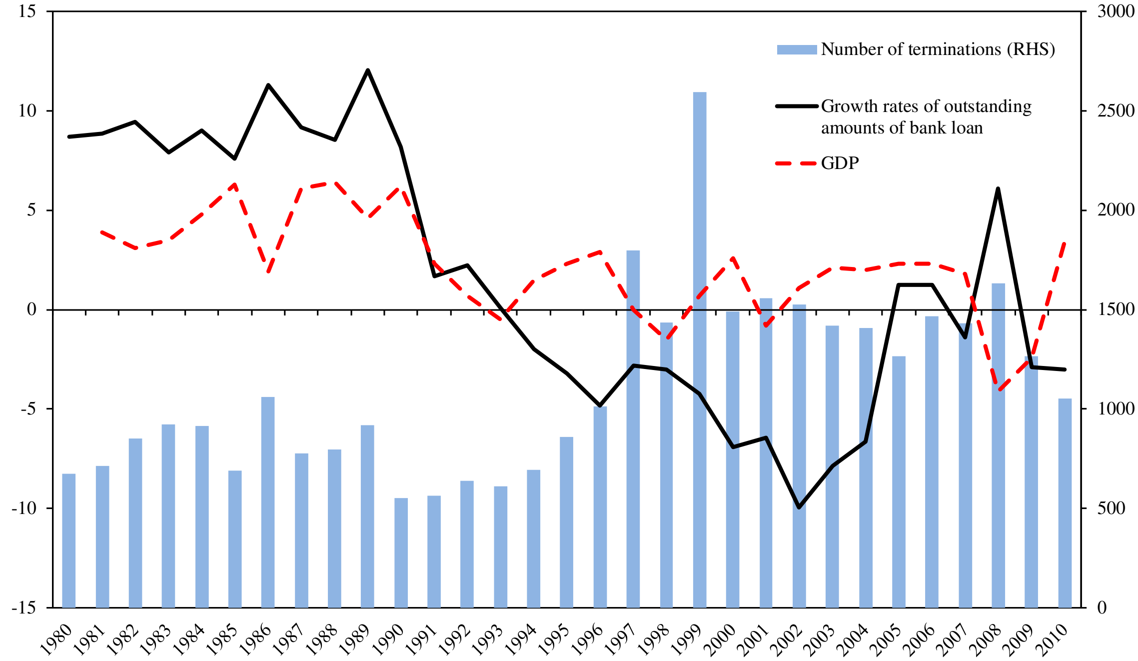
Notes: Estimation results are obtained by regressing firms' borrowing rates on the duration of the relationships with their main banks. We identify a firm's main bank as the lending bank that has the highest borrowing exposure for the firm. To control other firm covariates and industry attributes, we also include all the firm covariates introduced in Subsection 3.2, and industry dummies. ***, **, * indicate 1%, 5%, and 10% levels of significance, respectively.

Table 7: The Contribution of the Firm, Bank and Relationship Factors to Terminations

Sample Period	1990-1994	1995–1999	2000–2004	2005–2010
Firm factors	0.107	0.107	0.050	0.048
Bank factors	0.815	0.806	0.866	0.853
Relationship factors	0.078	0.086	0.083	0.098
R-squared	0.438	0.440	0.476	0.428

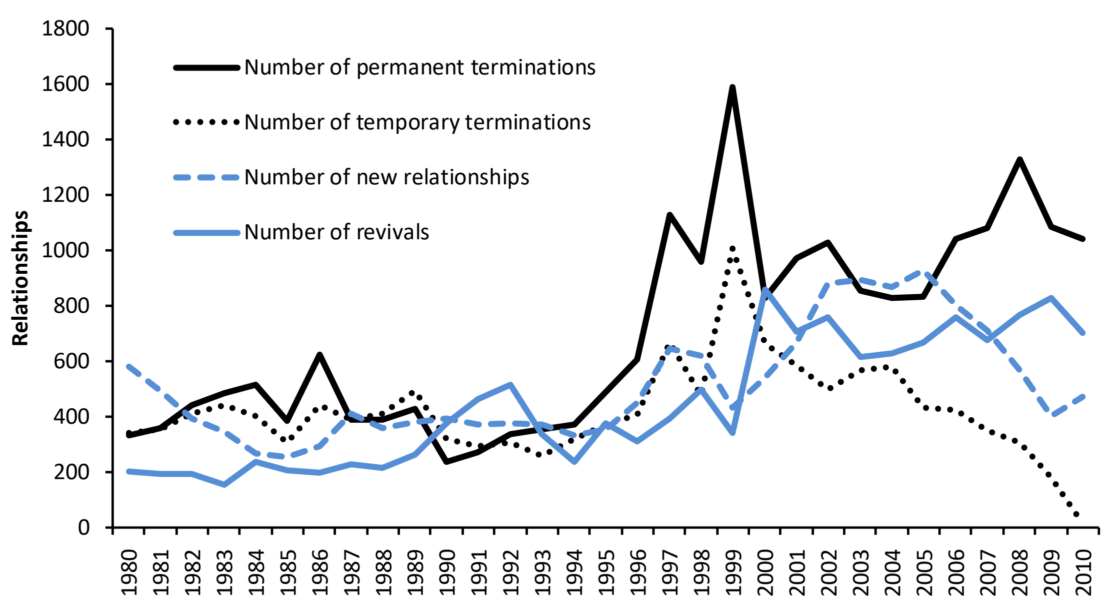
Notes: We calculate the contribution of the firm, bank, and relationship factors using the linear probability model with fixed effects (14). Each contribution is standardized so that the three covariances between the termination variable and each of the three factors sum to one.

Figure 1. Number of Relationship Terminations, Bank Loans, and GDP



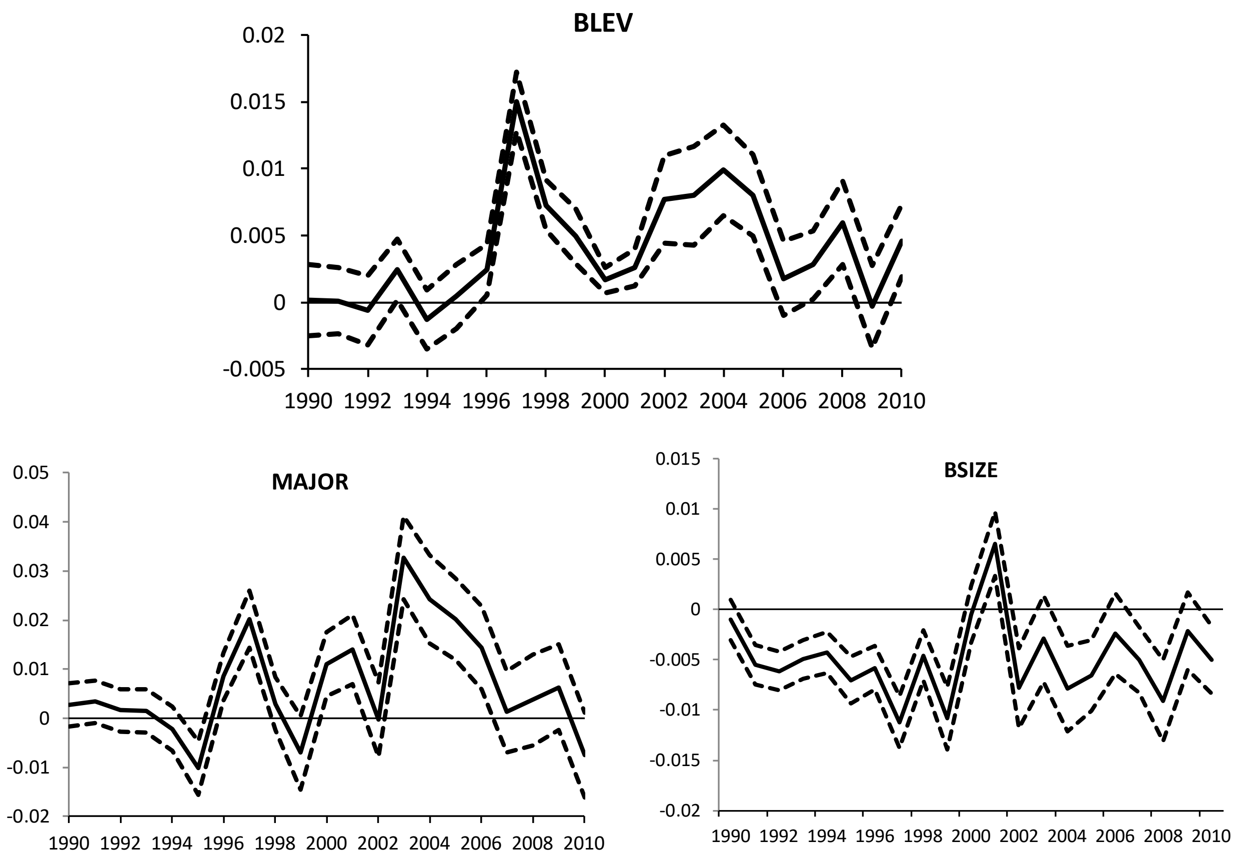
Notes: The number of terminations is calculated by summing all terminations over Japanese listed firms for each fiscal year. The growth rate of outstanding amounts of bank loans is calculated as the first log difference of outstanding amounts of loans by private financial institutions to private nonfinancial corporations.

Figure 2. Terminations, New Relations, and Revivals



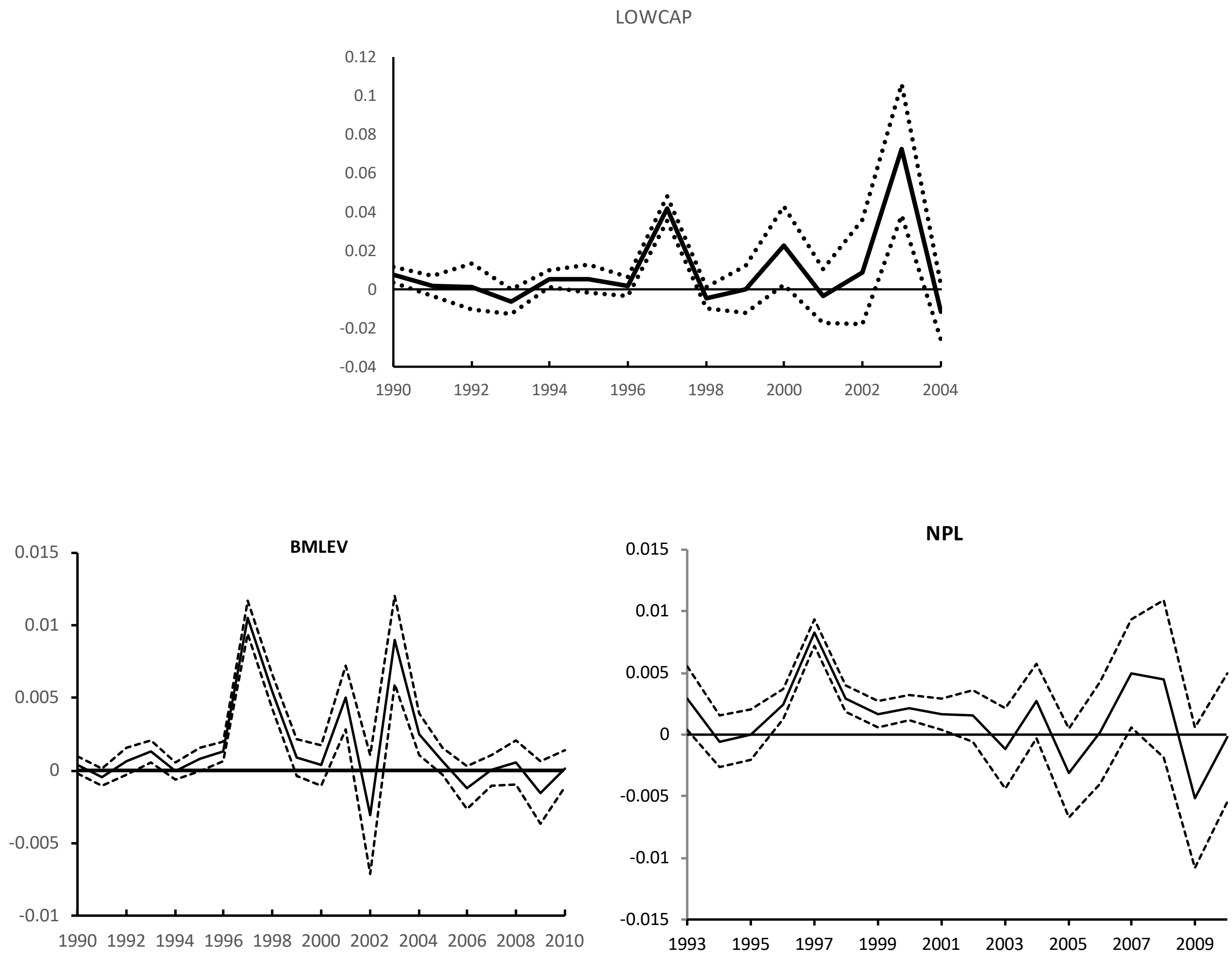
Notes: The number of terminations and new relationships is calculated by summing all terminations and new relationships over Japanese listed firms.

Figure 3. Effects of the Bank Factors in the Baseline Termination Model



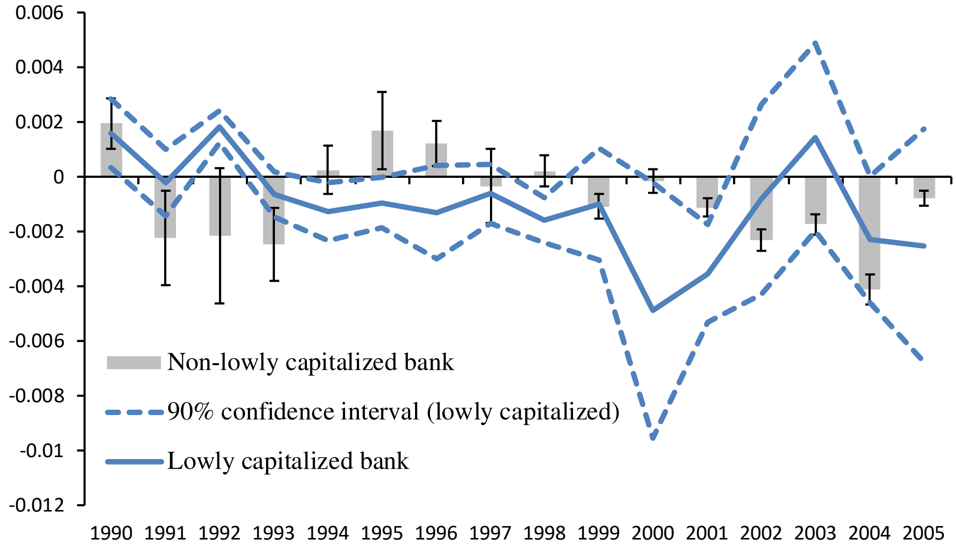
Notes: BLEV, MAJOR and BSIZE indicate the bank book leverage ratio, the dummy variable of a major bank, and the bank size variable, respectively. The solid line indicates a point estimate of the AMEs for each covariate and the shaded area shows the 90% confidence interval of the estimate based on the rolling estimations of the baseline probit model.

Figure 4. Estimated AMEs of the Lowly Capitalized Bank Dummy, the Market Capital Ratio, and the Nonperforming Loan Ratio



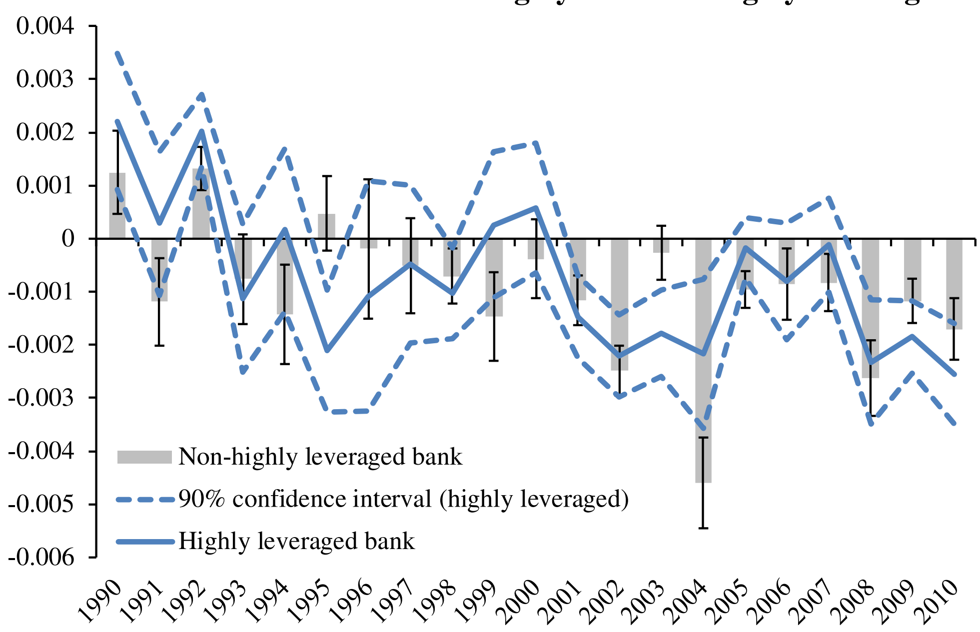
Notes: LOWCAP, BMLEV, and NPL indicate the lowly capitalized bank indicator, the market capital ratio, and the nonperforming loan ratio, respectively. AME indicates the average marginal effect calculated by using the estimation results. The solid line indicates point estimates of the AMEs for each bank variable and the dotted line indicates the 90% confidence interval of the estimates based on the rolling estimations of alternative models where the bank book leverage ratio is replaced with the lowly capitalized bank indicator (LOWCAP), the market capital ratio (BMLEV), or the nonperforming loan ratio (NPL). Because after 2006, almost all banks have zero values for the lowly capitalized bank variable, the estimation results after 2006 are not shown in this figure.

Figure 5. Estimated AMEs of FROA for Lowly and Non-Lowly Capitalized Banks



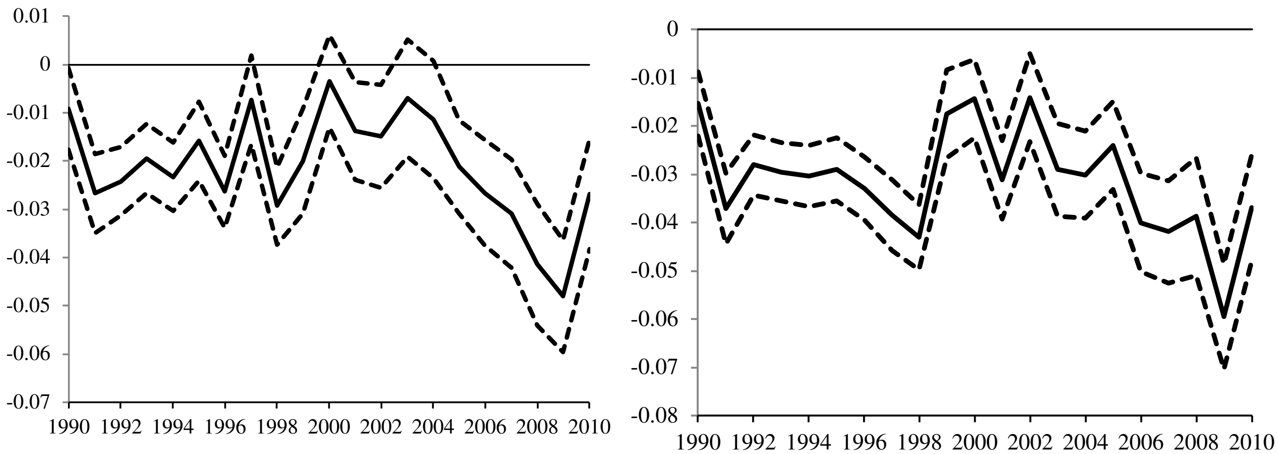
Notes: The solid line indicates point estimates of the AMEs of the firm return on assets (FROA) for lowly capitalized banks and the dotted line indicates the 90% confidence intervals of the estimates. The gray bar indicates point estimates of the AMEs of the firm ROA for non-lowly capitalized banks with error bars for the 90% confidence intervals. Because after 2006 almost all banks have zero values for the lowly capitalized bank variable, the estimation results after 2006 are not shown in this figure. The results are obtained by the rolling estimations of alternative models where the bank book leverage ratio is replaced with the lowly capitalized bank indicator and the interaction variable between the lowly capitalized dummy, and the firm ROA is included.

Figure 6. Estimated AME of FROA for Highly and Non-Highly Leveraged Banks



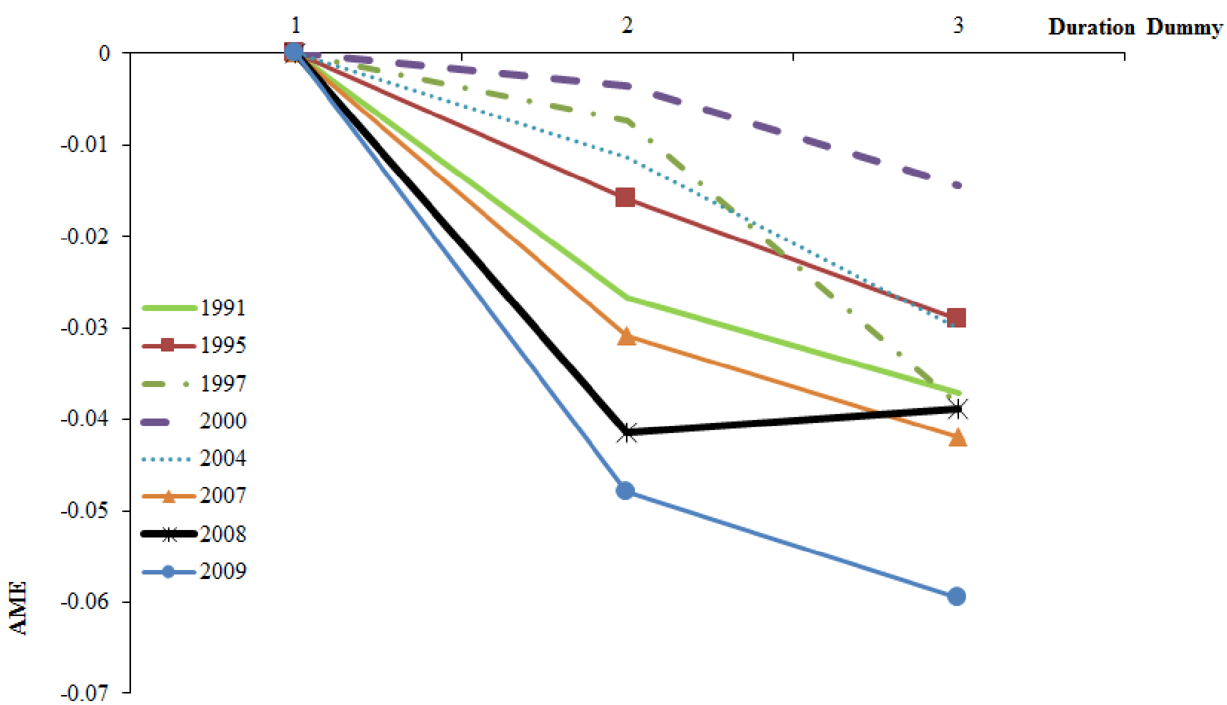
Notes: The solid line indicates point estimates of the AMEs of the firm return on assets (FROA) for highly leveraged banks and the dotted line indicates the 90% confidence intervals of the estimates. The gray bar indicates point estimates of the AMEs for non-highly leveraged banks with error bars for the 90% confidence intervals.

Figure 7. Estimated Duration Effects



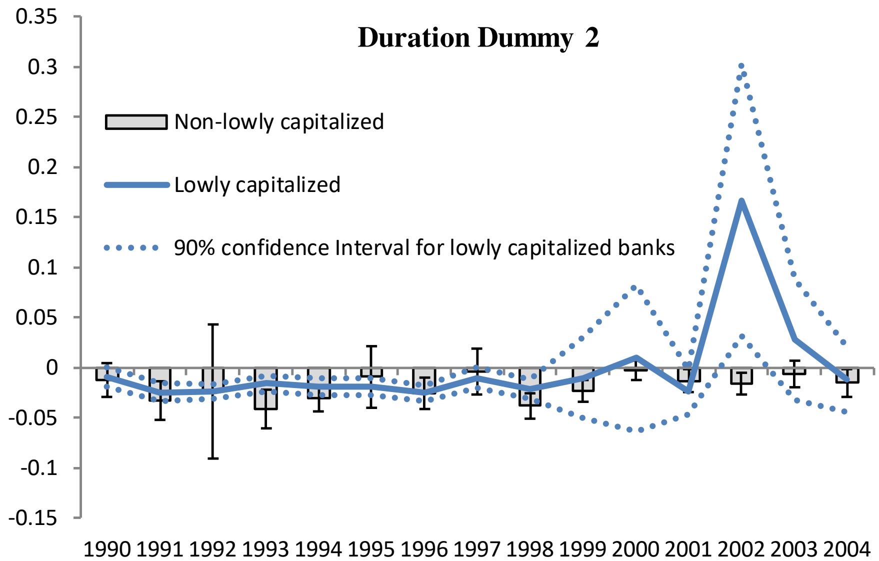
Notes: The solid line indicates point estimates of the AMEs for the duration dummy variables from the rolling estimations based on the baseline probit model and the dotted line indicates the 90% confidence intervals of the estimates. To calculate the AMEs, we used the shortest duration group as the reference.

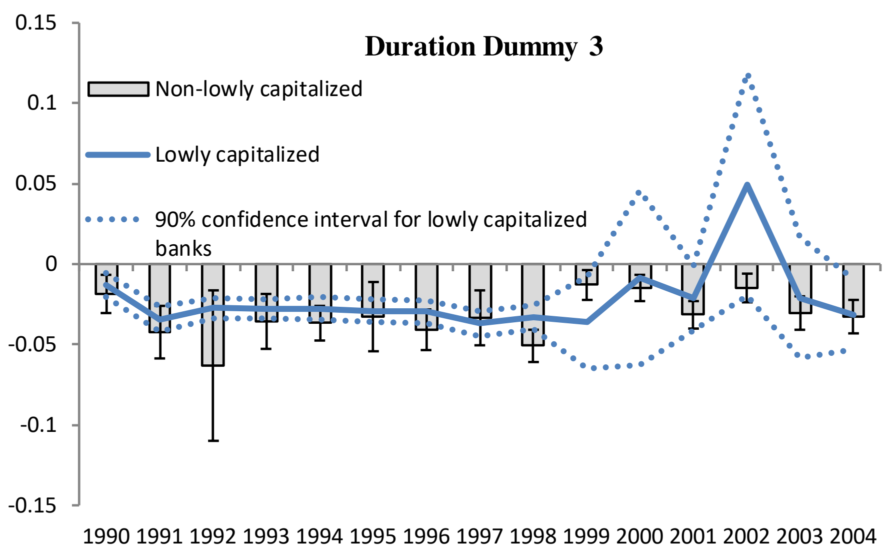
Figure 8. Term Structure of Duration Effects for Selected Period



Notes: Each line indicates the point estimates of the AMEs of the duration dummy variable for a specific fiscal year from the rolling estimations based on the baseline probit model.

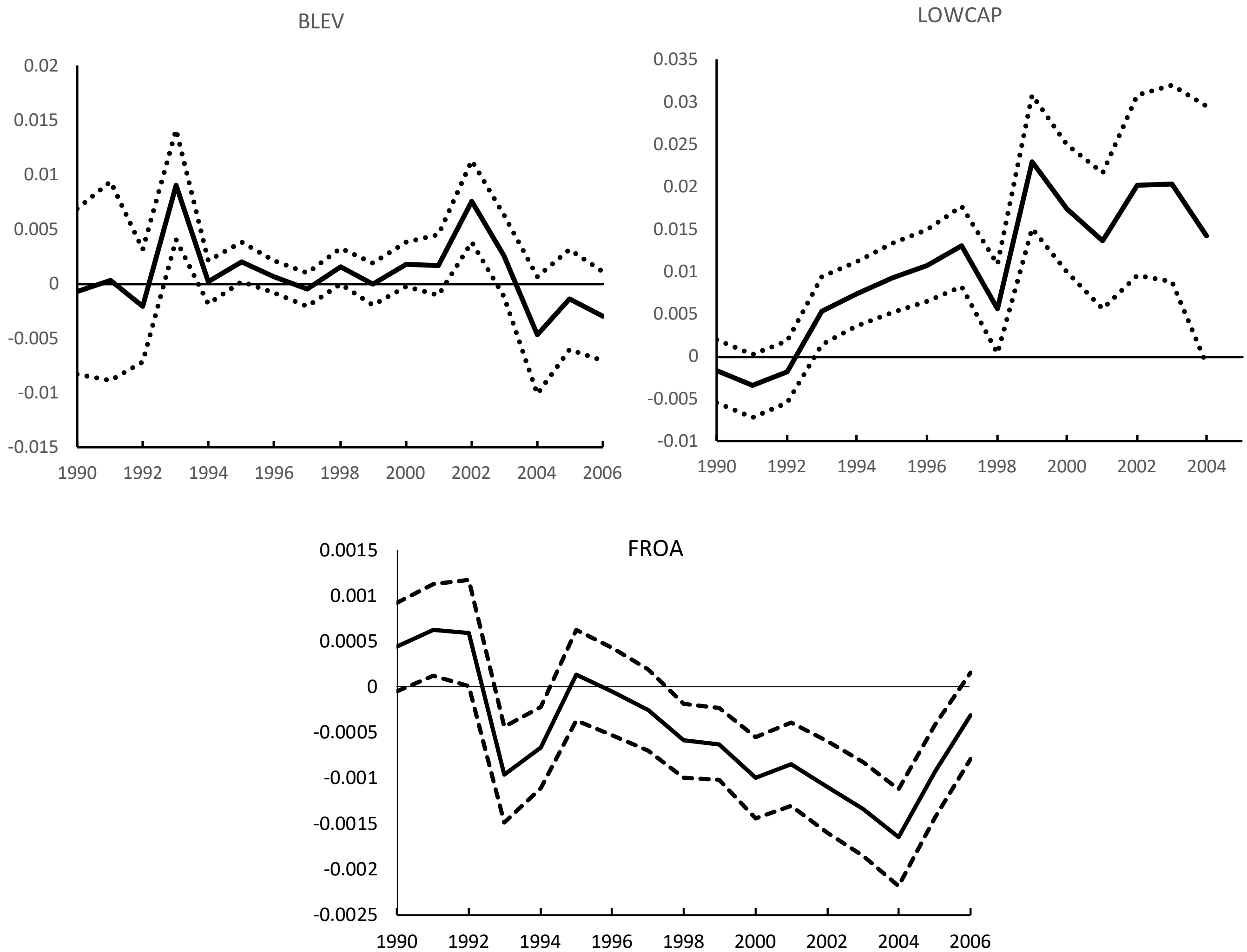
Figure 9. Estimated Duration Effects by Bank Capitalization





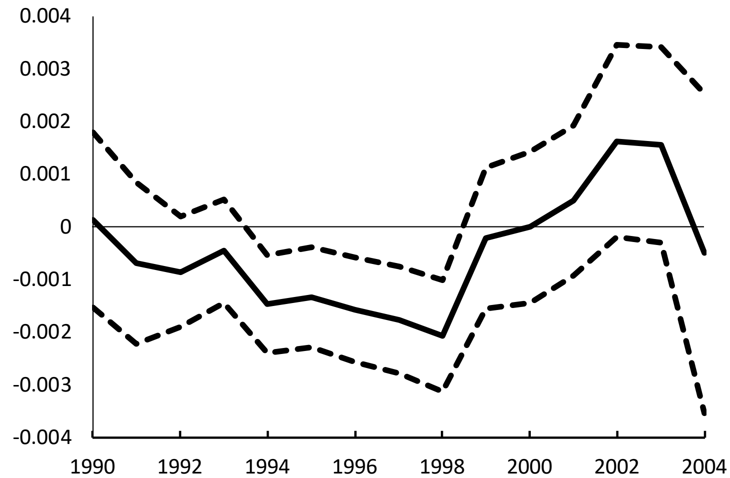
Notes: The solid line indicates point estimates of the AMEs of the duration dummy variables for lowly capitalized banks and the dotted line indicates the 90% confidence intervals of the estimates. The gray bar indicates point estimates of the AMEs for non-lowly capitalized banks with error bars for the 90% confidence intervals. The results are obtained by rolling estimations of alternative models where the lowly capitalized bank dummy and the interaction variables between it and the duration dummy variables are included.

Figure 10. Estimated Effects of the Bank Leverage Ratio and the Lowly Capitalized Bank Indicator in the Linear Probability Model with Fixed Effects



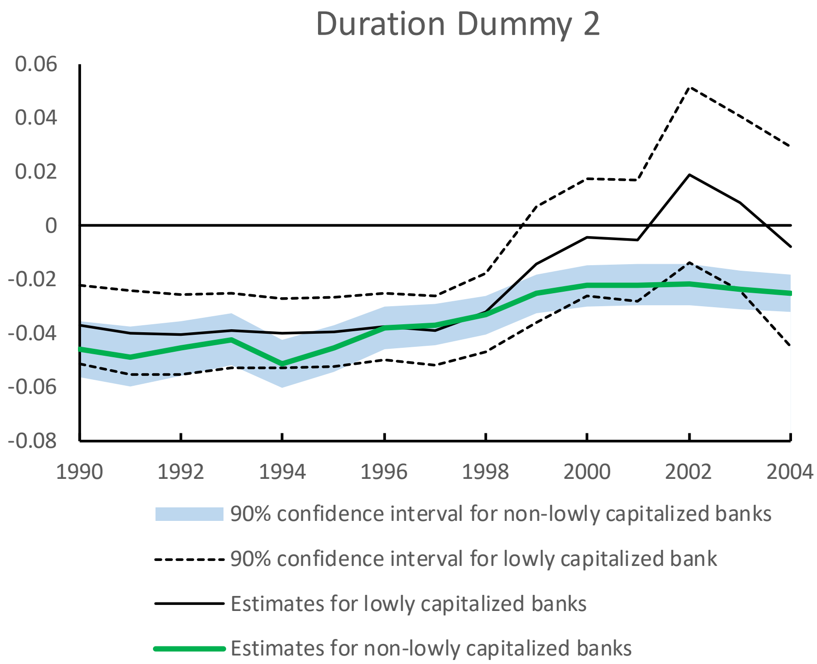
Notes: The solid line indicates the point estimates of the coefficients for the bank leverage ratio (BLEV), the lowly capitalized bank indicator (LOWCAP), and the firm return on assets (FROA), while the dashed line shows the 90% confidence intervals of the estimates based on the rolling estimations of the linear probability models (10) and (11). The X-axis indicates the starting year of each subsample period. The plot in year t shows the estimate based on the subsample period from years t through t+4. As the lowly capitalized indicator (LOWCAP) equals zero almost always after 2005, the estimates after 2005 (i.e. those in 2005--2009 and 2006--2010) are not shown in the figure.

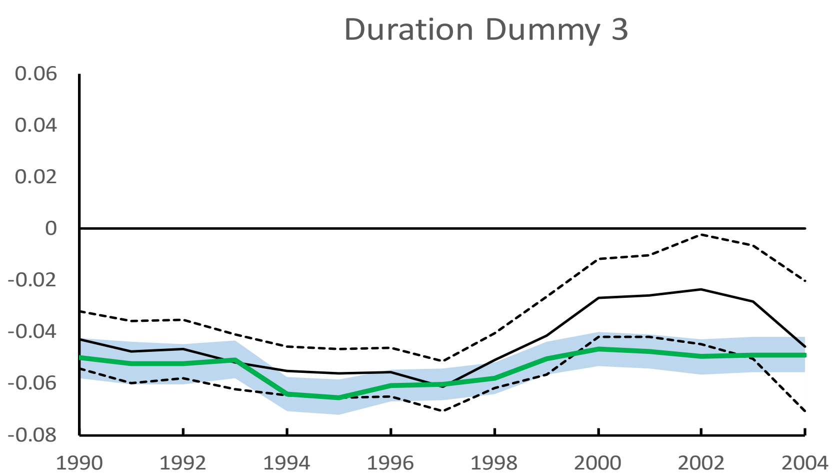
Figure 11. Estimated Interaction Effects of the firm ROA and the Lowly Capitalized Bank Indicator in the Linear Probability Model with FEs



Notes: The solid line indicates the point estimates of the coefficients for the interaction term of the firm return on assets (FROA) and the lowly capitalized bank indicator (LOWCAP), and the dashed line shows the 90% confidence intervals of the estimates based on the rolling estimations of the linear probability model (12). The X-axis indicates the starting year of each subsample period. The plot in year t shows the estimate based on the subsample period from years t through t+4.

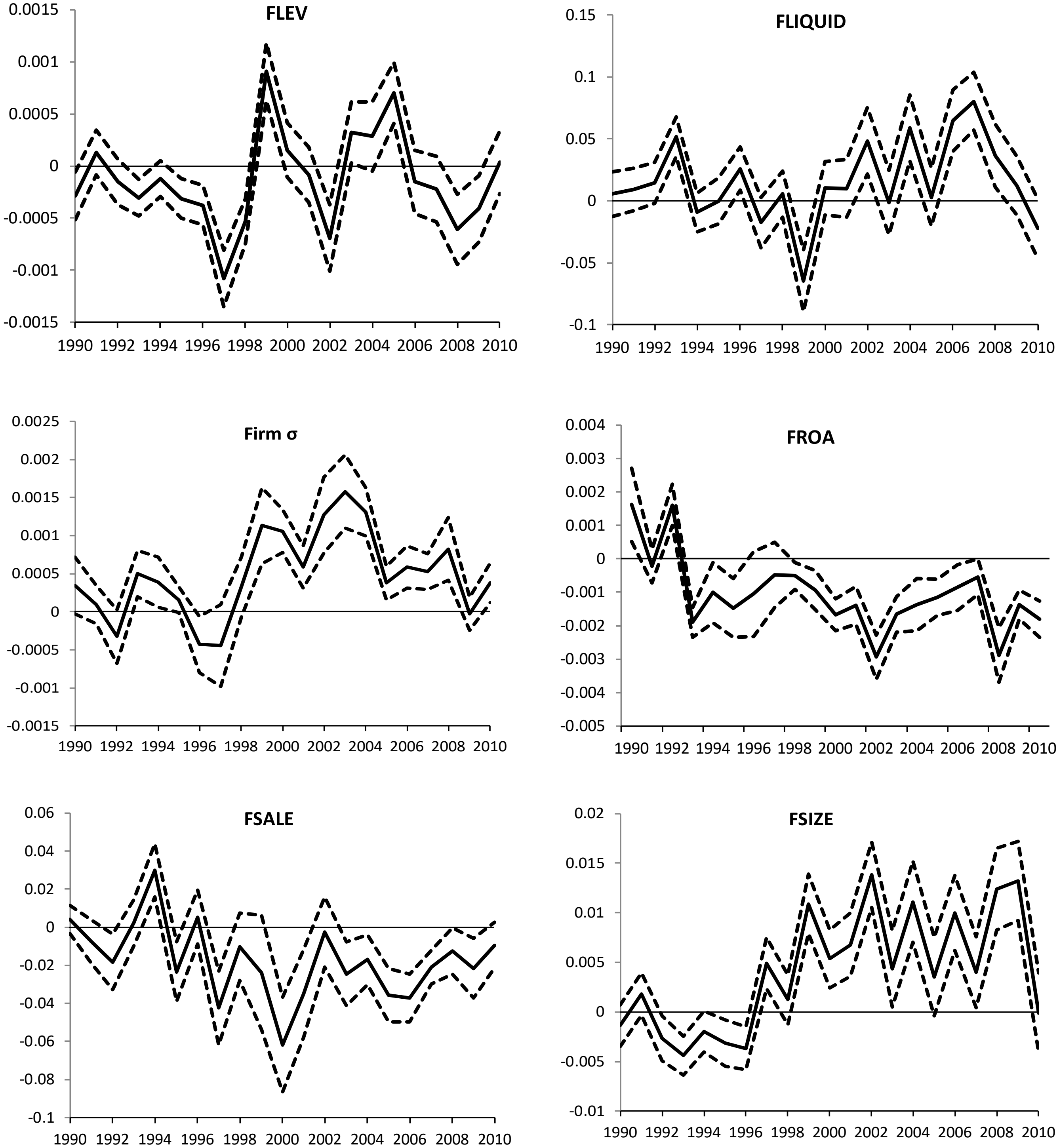
Figure 12: Estimated Duration Effects by Bank Capitalization in Linear Probability Model with FEs





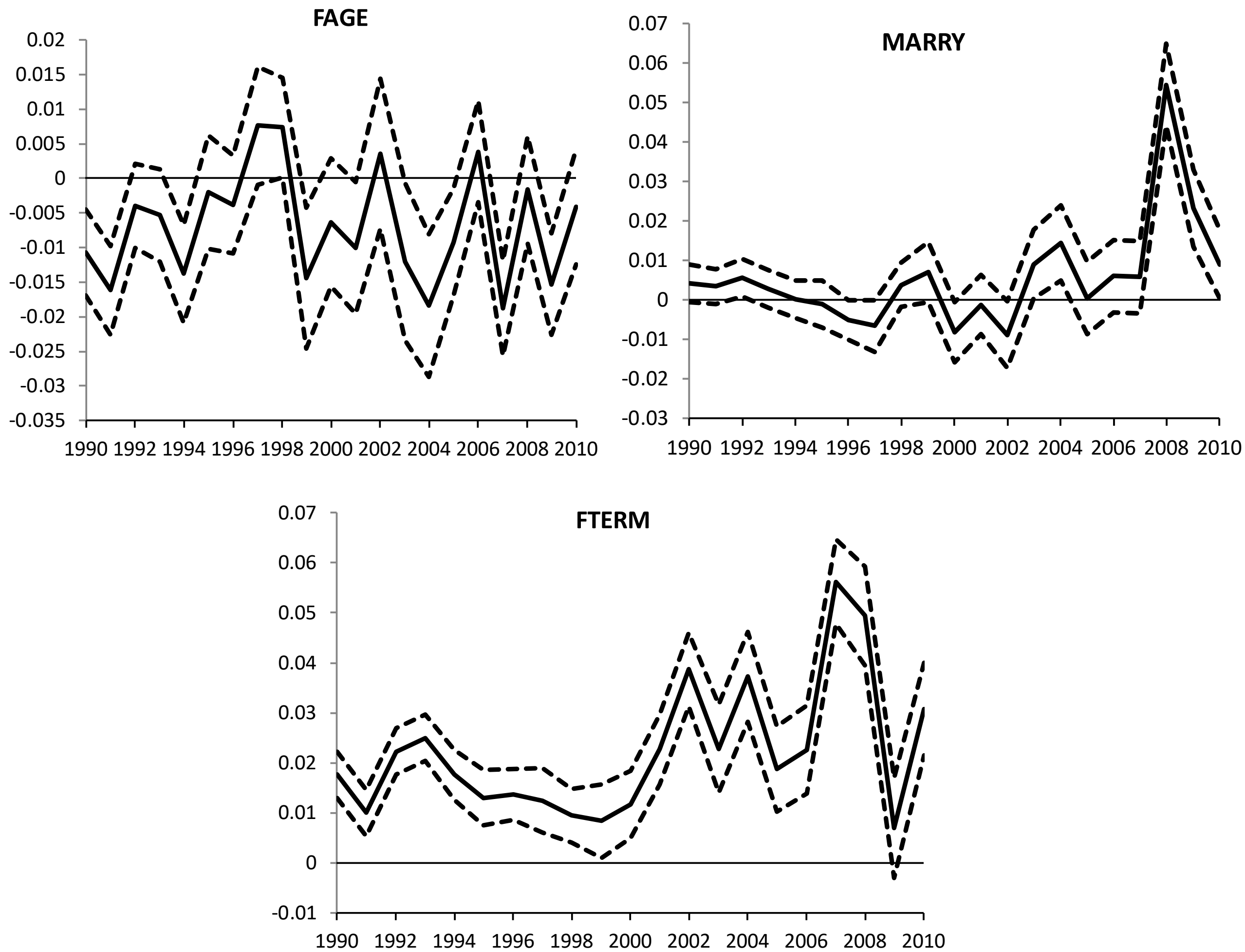
Notes: The solid black line indicates the point estimates of the marginal effect of the duration dummy variables for lowly capitalized banks and the dotted line indicates the 90% confidence intervals of the estimates. The bold green line indicates point estimates of the marginal effect for non-lowly capitalized banks with the blue shaded area for the 90% confidence intervals. The results are obtained by rolling estimation of the linear probability model with the time-varying bank and firm fixed effects, where the interaction variable between the lowly capitalized bank dummy and the duration dummy variables are included. The plot in year t shows the estimate based on the subsample period from years t through t+4.

Figure B-1. Effects of Firm Factors on Relationship Terminations



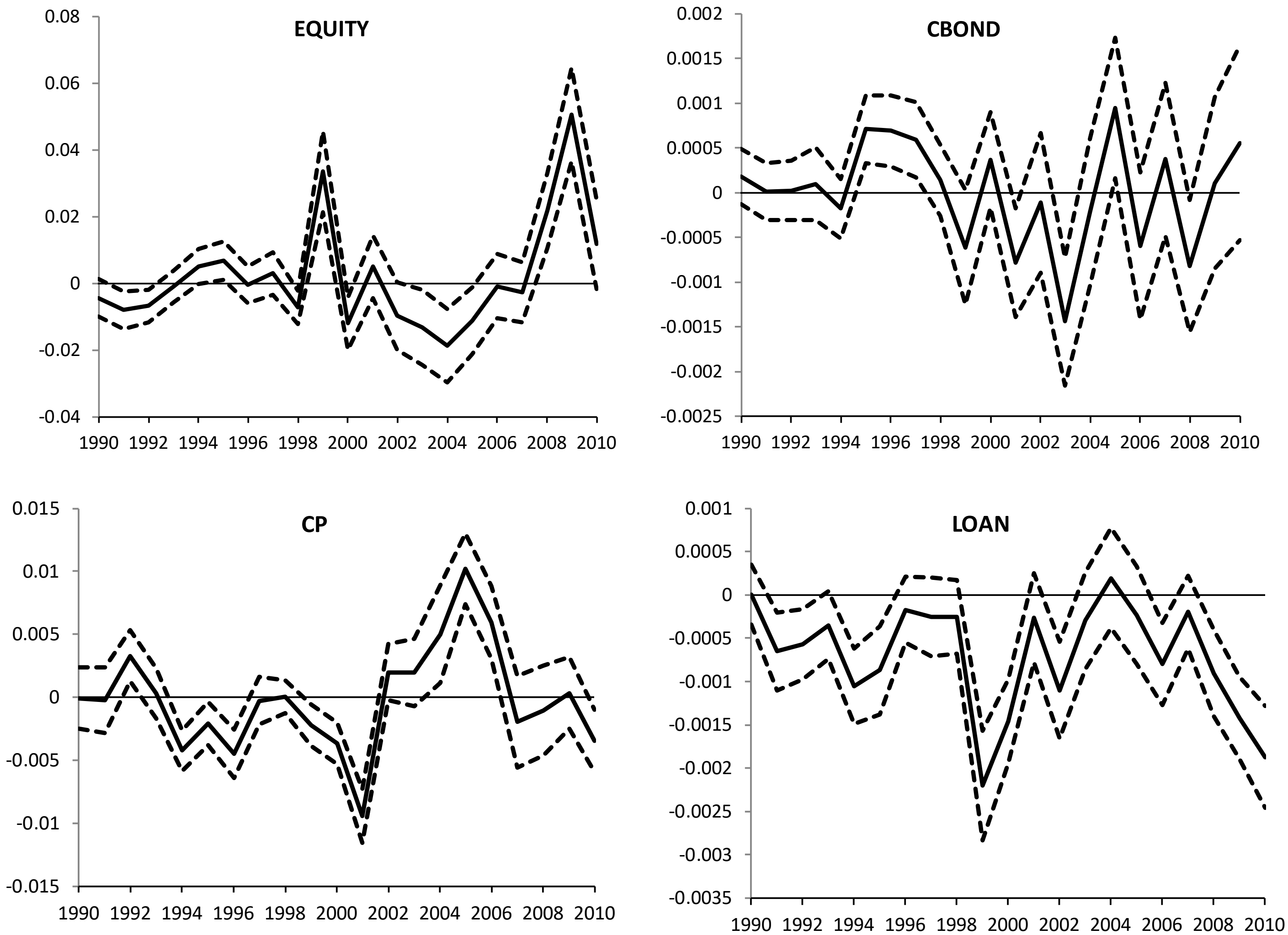
Notes: FLEV, Firm σ, FROA, FSIZE, FSALE, and FAGE indicate the variables for firm book leverage ratio, firm volatility, firm return on assets, firm size, sales growth, and firm age, respectively. The solid line indicates the point estimates of the AMEs for each covariate and the shaded area shows the 90% confidence intervals of the estimates based on the rolling estimations of the baseline probit model.

Figure B-1. Effects of Firm Factors on Relationship Terminations (continued)



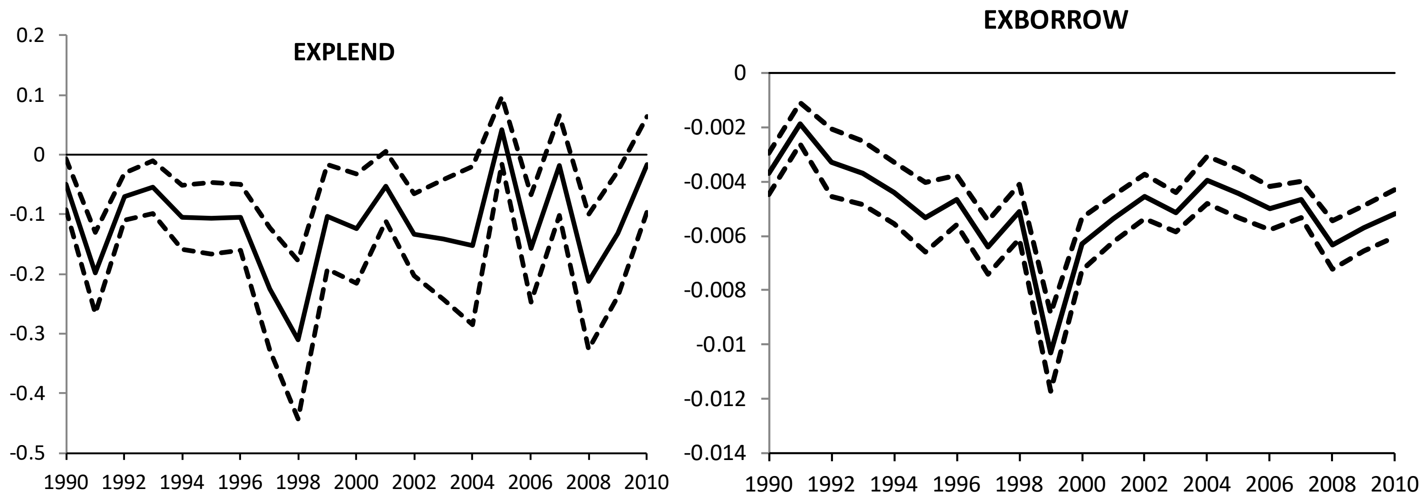
Notes: FLIQUID, MARRY, and FTERM indicate the firm liquid asset ratio, firm marry indicator, and firm termination indicator, respectively. The solid line indicates the point estimates of the AMEs for each covariate and the shaded area shows the 90% confidence intervals of the estimate based on the rolling estimations of the baseline probit model.

Figure B-2. Effects of Firm Funding Factors on Relationship Terminations



Notes: EQUITY, CBOND, CP, and LOAN indicate the equity increase indicator, corporate bonds, commercial paper, and bank loan dependence variables, respectively. The solid line indicates the point estimate of the AMEs for each covariate and the shaded area shows the 90% confidence intervals of the estimate based on the rolling estimations of the baseline probit model.

Figure B-3. Effects of Relationship Factors on Relationship Terminations



Notes: EXBORROW and EXLEND indicate the borrowing exposure of firms, and the lending exposure of banks, respectively. The solid line indicates the point estimates of the AMEs for each covariate and the shaded area shows the 90% confidence intervals of the estimates based on the rolling estimations of the baseline probit model.