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Hirofumi Uchida
Iichiro Uesugi
Hiromichi Iwaki

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Hitotsubashi Project on Real Estate, Financial Crisis, and Economic Dynamics
Institute of Economic Research, Hitotsubashi University
Naka 2-1, Kunitachi-city, Tokyo 186-8603, JAPAN
Tel: +81-42-580-9145
Email: hit-refined-sec@ier.hit-u.ac.jp
http://www.ier.hit-u.ac.jp/hit-refined/

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Tests taking advantage of the introduction of non-collateralized loans[*]

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Hirofumi Uchida[†], Iichiro Uesugi[‡], and Hiromichi Iwaki[§]

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[†] Graduate School of Business Administration, Kobe University, uchida@b.kobe-u.ac.jp.

[‡] Corresponding author. Institute of Economic Research, Hitotsubashi University, iuesugi@ier.hit-u.ac.jp.

[§] Faculty of Economics, Daito Bunka University, hiromichi.iwaki@ic.daito.ac.jp.

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Abstract

Taking advantage of a quasi-natural experiment of an introduction of non-collateralized loans by a large public bank, we test the existence of adverse selection and moral hazard in financial contracting. Based on theoretical predictions, we design one test for moral hazard and two tests for adverse selection that compare ex post performance of borrowers of collateralized and/or non-collateralized loans. Applying the tests to the data of all loans underwritten by the bank by using OLS, DID (difference-in-differences) and RDD (regression discontinuity design) approaches, we find an increase in credit risk for firms that switch to non-collateralized loans after the introduction, which is consistent with moral hazard. In contrast, we do not find that borrowers are sort themselves out depending on their types as an adverse selection model predicts.

JEL Classification Codes: G21; G28; H81

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1. Introduction

In the field of finance, information asymmetry between lenders and borrowers plays an integral role as one of the most fundamental causes of financial frictions. Lenders do not know the creditworthiness of borrowers (hidden information) and/or cannot detect inefficient behavior of borrowers after lending (hidden action). For fear of lending to borrowers with poor creditworthiness or those that take inefficient behavior, lenders are unwilling to provide their own funds, which creates severe financial frictions. This is the problem of adverse selection (in the case of hidden information), or of moral hazard (in the case of hidden action).

Among the many strands of the literature on financial frictions in the loan market, the studies on the role of collateral provide a solid theoretical basis for the relationship between different types of information asymmetry and lending outcomes. On the one hand, the so-called ex ante theory focuses on an ex ante information gap between borrowers and lenders (hidden information or adverse selection), and demonstrates that collateral serves as a device to sort out good and bad borrowers that are observationally equivalent (e.g., Bester 1985 and Chan and Kanatas 1985). On the other hand, the so-called ex post theory focuses on ex post incentive frictions (hidden action or moral hazard), and demonstrates that lenders use collateral to provide borrowers with incentives for more efficient behavior (e.g., Boot, Thakor, and Udell 1991).[1]

Despite a clear-cut theoretical distinction between adverse selection and moral hazard, identifying each one is empirically difficult, because both predict the same relationship between the use of collateral and borrowers' ex post performance. On the one hand, the ex ante theory predicts better performance by collateralized borrowers because firms with high creditworthiness self-select loans with collateral. On the

[1] See Section 3 for the versions of these theories under specific environments that we consider in this paper.

other hand, the ex post theory predicts the same relationship because the provision of collateral by borrowers provides them with an incentive to behave more efficiently. There are many empirical studies that report a positive correlation between the use of collateral and borrowers' performance (see Degryse, Kim, and Ongena 2009 and Steijvers and Voordeckers 2009 for a survey), but an empirical identification of adverse selection and moral hazard remains an open issue. This identification is important not only from an academic but also from a practical viewpoints. This is because the identification can provide an important insight into to what extent banks should focus on ex ante screening and/or ex post monitoring of borrowers to mitigate different types of asymmetric information.

Against this background, this paper directly addresses this issue of identifying adverse selection and moral hazard by taking advantage of a quasi-natural experiment. We focus on an institutional change in a public (government-affiliated) bank in Japan, the Small and Medium Enterprise Unit of the Japan Finance Corporation (hereafter the JFC-SME) in August 2008. To respond to a policy initiative, this bank introduced non-collateralized loans to small- and medium-sized enterprises (hereafter SMEs) at the time when most of the other financial institutions in the country, either private or public, provided collateralized loans only. Due to this introduction, SME borrowers obtain a choice between non-collateralized and collateralized loans. In Section 2, we provide more account for this introduction, together with institutional background and the description of actual lending process by this bank.

The focus on this public bank around the time of the relevant institutional change provides us with an ideal setting to test theoretical predictions on the behavior of borrowers based on the ex ante and ex post theories. First, we can focus on borrowers' choice, because the JFC-SME, as it is a public bank, designs and offers a menu of loan contracts that make itself break even. This means that we can focus on the situation where the lender's participation constraint binds and borrowers make the decision to choose.

Second, the introduction of non-collateralized loans provides borrowers with a choice from two (break-even) contracts. Given factors such as a firm's credit rating and the loan's maturity, this bank offers a borrower two options, a collateralized loan with a low interest rate and a non-collateralized loan with a high interest rate, where the margin in their interest rates (ranging between 30 and 90 basis points) is set as risk premium.[2] Third, the institutional change enables us to compare borrowers with different options to choose. Evidently, the number of options increased due to the fact that (1) no borrowers could have obtained non-collateralized loans before August 2008. However, the difference in the number of options also stems from the fact that even after August 2008, (2) some borrowers without sufficient amount of assets to pledge as collateral cannot choose collateralized loans.

Based on these considerations, we first set up simple theoretical models of borrower behavior under moral hazard and adverse selection in Section 3. Based on these models, we establish three testable hypotheses that predict differences in ex post performance of borrowers depending on their choices and their characteristics: one for moral hazard and two hypotheses for adverse selection. We then explain in Section 4 our empirical approach that enable us to test each of these hypotheses independently.

Specifically, we first test the ex post theory or moral hazard, which we call Test MH. Theory predicts that due to the incentives provided by collateralized loans, ex post performance for borrowers is better for borrowers of collateralized loans than those of non-collateralized loans (Hypothesis MH).[3] To test this

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[2] Also, as an internal rule this bank does not change the intensity of ex post monitoring depending on whether or not borrowers pledge collateral. We can thus neglect the influence of incentives or disincentives that collateral could provide with lenders in their monitoring of borrowers (Rajan and Winton 1995 and Manove and Padilla 2001).

[3] Another version of moral hazard model, the so called lender selection model (Berger, Frame, and Ioannidou 2016), predicts that lenders require risky borrowers to pledge collateral as an incentive devise (Boot, Thakor,

hypothesis, we isolate the effect of adverse selection by taking into account the borrowers' time-invariant fixed effects. Because the fixed effects control for the ex ante creditworthiness of the borrowers (hidden information) that is privately known to the borrowers and is unobservable to the lenders, we can isolate the effect of the use or non-use of collateral on the ex post performance of borrowers through hidden actions. In other words, Test MH examines a difference-in-differences of ex post performance for borrowers of collateralized and non-collateralized loans.[4]

The other two tests are the tests of ex ante theory or adverse selection, which we call Tests AS1 and AS2. Both of these tests compare ex post performance of borrowers between (i) those that choose one type of loans (either collateralized or non-collateralized) despite that they could have chosen the other type, and (ii) those that choose the same type of loans because it is the only type of loans available to them. The idea behind this comparison is that, because incentives provided by a contract are the same among the borrowers that choose the same type of loans, any difference in the ex post performance between (i) and (ii) stems from the difference in unobservable ex ante characteristics of the borrowers as the ex ante theory predicts, and not from the effect of moral hazard.

In the first version of this test (Test AS1), we compare collateralized borrowers before and after the introduction of the non-collateralized loans. Theory predicts that ex post performance increases after the introduction, because borrowers with higher probability of failure prefer non-collateralized loans (Hypothesis AS1). In the second version (Test AS2), we compare non-collateralized borrowers that have

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and Udell 1991). However, this mechanism works only when lenders can discern the riskiness of borrowers, or works only pertaining to observable riskiness. In our paper, we control for observable riskiness by using different covariates, and focus on effects of unobservable riskiness.

[4] This method is similar to the one adopted in Aarbu (2015) in his analysis on home insurance and to the one in labor economics that examines the causes of long-term unemployment (see Abbring et al. 2003).

a sufficient amount of assets and could have chosen collateralized loans, and those that do not have such assets. Theory predicts that ex post performance is worse for borrowers with assets, because among such borrowers, creditworthy borrowers choose collateralized loans with low interest rates (Hypothesis AS2). In both Tests AS1 and AS2, we make the relevant comparisons using regression methods as well as regression discontinuity designs (RDDs).[5]

After explaining our data in Section 5, we report the test results in Section 6. First, we find from Test MH that after controlling for the time-invariant heterogeneity in firms (hidden information), an increase in credit risk is more sizable and sales growth is marginally larger for non-collateralized borrowers than for collateralized borrowers. These findings support the existence of moral hazard.

Second, from Test AS1, we find little support for the existence of adverse selection. On balance, borrowers that self-select collateralized loans after August 2008 (when non-collateralized loans are also available) do not perform better than those that choose collateralized loans before August 2008 that is the only option available for them. Third, we find no evidence to support, and some evidence against, Hypothesis AS2 from Test AS2. The credit risk is lower, and sales growth is higher, for firms that self-select non-collateralized loans despite that they have a sufficient amount of assets to pledge as collateral, than those that choose non-collateralized loans because they do not have sufficient amount of assets to pledge. Our findings suggest that actual borrower behavior is different from what a typical adverse selection model predicts.

Our study is closely related to a strand of the literature of empirical contracts that test different

[5] Our RDD analysis is similar to that in Keys, Mukherjee, Seru and Vig (2010) which examine moral hazard on the part of lenders by taking advantage of the discontinuity around a threshold that determines a possibility to securitize subprime mortgage.

hypotheses based on contract theory (see Chiappori and Salanié 2001 for a survey). Many studies empirically find evidence for the presence of information asymmetry in markets for automobile insurance (Chiappori and Salanié 2000; Abbring, Pinquet, and Chiappori 2003; Saito 2006), health insurance (Chiappori, Durand, and Geoffard 1998; Cardon and Hendel 2001), home insurance (Aarbu 2015), and annuities (Finkelstein and Poterba 2004). However, earlier approach could not identify adverse selection and moral hazard.[6] Later studies test adverse selection and moral hazard in demand for medical care by taking advantage of a natural experiment (Chiappori, Durand, and Geoffard 1998) and in claims for car insurance by focusing on a state-dependent contract (Abbring, Pinquet, and Chiappori 2003).

There are also some studies that identify moral hazard and adverse selection in the consumer loan market. Adams, Einav, and Levin (2009) do so in the auto loan market by taking advantage of a unique instrument. Dobbie and Skiba (2013) use the regression continuity design, but they focus on a discontinuity in the amount of loans due to specific contract features for payday lending. De Giorgi, Drenik, and Seira (2017) also use the regression discontinuity design to examine moral hazard for consumers that multiple loans in sequence, but they focus on a discontinuity in the probability of obtaining credit card loans due to credit score.

To the best of our knowledge, there is scarcity of researches that identify adverse selection and moral hazard in corporate loan markets. There are many empirical studies on borrower risk and collateral (see Degryse, Kim, and Ongena 2009 and Steijvers and Voordeckers 2009 for a survey), and among these studies, Jiménez and Saurina (2004) is the closest to ours because they examine ex post performance of

[6] Following these studies, we applied the method proposed by Chiappori and Salanié (2000) to our data and found evidence for the existence of asymmetric information. However, because the main focus of this paper is the identification between adverse selection and moral hazard, we report this analysis in Appendix A.

borrowers depending on the use or non-use of collateral. However, no further identification is made in this paper, and so their results allow various interpretations.[7]

A rare exception is Berger, Frame, and Ioannidou (2011) who use detailed loan-level data in the credit registry in Bolivia. These authors focus on information that is recorded in the registry but not disclosed to lenders as private and unobservable information to the lenders, and examine the effect of this information on the use of collateral as a test of adverse selection.[8] In the present paper, we also test adverse selection, but by taking advantage of a quasi-natural experiment of the introduction of non-collateralized loans. Jiménez et al. (2006) also examine predictions from adverse selection models by examining the choice of collateral depending on past record of default and the observability of credit quality. However, they focus on the choice of collateralized and non-collateralized loans, and do not focus on ex post performance as we do in this paper.[9] Also, these studies do not directly test moral hazard models.

2. Institutional Background

In this section, we provide institutional background behind our analysis. We first provide information on public banks in Japan and the public bank that we specifically focus in this paper. We then explain the non-collateralized loans that this bank introduced. We finally explain how the public bank makes lending decisions and thereby how our data provide with an ideal setting for testing adverse selection and moral

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[7] There are many empirical studies that examine the relation between collateral and *ex ante* risk (measured by loan risk premiums). For these studies, see references in Berger, Frame, and Ioannidou (2016, p.29), for example.

[8] Using a similar data set and taking advantage of information on types of assets pledged as collateral, Berger, Frame, and Ioannidou (2016) examine the relative dominance of the lender selection model and the ex ante theory.

[9] Jimenez et al. (2006) do use information on ex post default, but they use this information as a proxy for borrowers' private information on their future default probability.

hazard.

2.1. Small and Medium Enterprises Unit of the Japan Finance Corporation

Public banks, or banks that are affiliated with the government, play important roles in many countries to meet policy objectives such as financing for economic development, for the poor, or for SMEs, because private banks cannot provide sufficient funds for these purposes. In Japan, there are some public banks that provide business loans and loan guarantees, and/or securitize loans underwritten by private banks, for policy purposes. Almost all of these institutions are 100% owned by the central government and specialize in areas such as financing foreign infrastructure projects, financing regional development, and loans to SMEs.[10] These banks do not take deposits, and raise funds through bonds with and without explicit government guarantees.

Providing loans to SMEs is one of the most important areas that the public banks in Japan are involved. There are two banks in this area: the Japan Finance Corporation (hereafter JFC) and the Shoko Chukin Bank. The former has two business units that specialize in financing SMEs: the Small and Medium Enterprises Unit (hereafter JFC-SME) and the Micro Business and Individual Unit (hereafter JFC-MBI). These units extend loans to SMEs of different sizes: the JFC-SME to relatively larger SMEs, and the JFC-MBI to smaller SMEs and sole proprietorships.[11]

The JFC-SME and the JFC-MBI used to be independent banks, the Japan Finance Corporation for Small and Medium Enterprise (hereafter JASME) and the National Life Finance Corporation (hereafter

[10] See Uchida and Udell (2014) for more information on the government-affiliated financial institutions in Japan.

[11] The other (third) unit of the JFC is the Agriculture, Forestry, Fisheries and Food Business Unit.

NLFC), respectively. The two banks merged in October 2008 to form the JFC, but their business operations and missions remained separated in respective units with mutual independence. The data from the JFC-SME and its predecessor JASME are available to us. For brevity, below we use the term JFC-SME to indicate both the JFC-SME and the JASME.

The JFC-SME operates nationwide, and has 63 branches in 47 prefectures in Japan. Although this number is significantly smaller than that of private banks, the JFC-SME provides a sizable amount of loans to SMEs. The amount of its loans outstanding is JPY 6.0 trillion at the end of year 2015, which correspond to about 2.3 percent of the total JPY 258.4 trillion of SME loans outstanding in Japan.[12]

The loans by the JFC-SME are provided on "program-base," where borrowers apply for different loan programs that target specific types of SMEs for different policy-purposes. Safety-net Loans, Loans for Enhancing Corporate Vitality, and New Business Development Loans are examples of such programs that the JFC-SME actually provides. Each program has its own eligibility requirements depending on, for example, industry that borrowers belong to, firm age, and purposes for the borrowed funds.

2.2. Introduction of Non-Collateralized Loans

Our analysis below takes advantage of an institutional change in the JFC-SME to introduce non-collateralized loans. Although the JFC-SME has provided only collateralized loans, it introduces two new types of loans in 2005 to provide non-collateralized loans in response to political pressure to provide more funds to SMEs.[13] These loans are either non-collateralized or partially collateralized, but with upper limits

[12] See Table 13 in the 2016 White Paper on Small and Medium Enterprises in Japan, the Small and Medium Enterprise Agency of the Government of Japan.

[13] To promote easier access to bank loans, the Financial Services Agency (FSA) of the Government of Japan,

of JPY 50 or 80 million.[14] A far more substantial institutional change occurs in August 2008, when the JFC-SME lifts the upper limits of the non-collateralized loans. This lift enables borrowers to borrow sufficient amounts of funds either through non-collateralized and through collateralized loans. Within our sample period, there are no further essential changes, even after the JASME becomes the JFC-SME in October 2008

Figure 1 shows the numbers (Panel (1)) and the amounts (Panel (2)) of loans of different types extended by the JFC-SME. We find that few borrowers use the two new types of loans introduced in 2005, i.e., non-collateralized and partially collateralized loans with upper limits. This is presumably because the limits are too restrictive. Even in fiscal year 2007, the amounts of these loans (respectively JPY 61.7 billion and JPY 132.3 billion) are substantially smaller than the total amount of collateralized loans (JPY 754.6 billion).

The black bars in the figure show the use of non-collateralized loans with no upper limits introduced in 2008. We find a sizable increase in their amount. Although this increase is partially attributable to the surge in loan demand driven by the financial crisis after the fall of 2008, the new loans are used extensively even within 2008 when the crisis has not yet had a significant impact on the Japanese economy. Further, the share and the amount of non-collateralized loans keep increasing even several years after the crisis. Compared with collateralized loans, the total amount of non-collateralized loans increase from less than

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the regulatory agency that supervises financial institutions in Japan, announced "the Action Program that Enhances the Functions of Relationship Banking" in March 2003. Based on this program, the FSA encouraged banks to increase the amount of loans that rely less on collateral or personal guarantees.

[14] The non-collateralized loans do not require collateral, have an upper-limit of JPY 50 million and are provided to financially healthy firms that agree to include covenants in their borrowing contract. The partially collateralized loans are covered by collateral of no less than 25 percent of the total loan amount, and have an upper limit of JPY 80 million.

half in 2009 to almost comparable in 2011. This substantial increase also implies that the upper limits for the two previous types of loans are too restrictive for many firms. Thus, in the analysis below, we focus on the lifting of the upper limits for non-collateralized loans in August 2008 as an effective exogenous policy shock.

2.3. Lending Decisions and Borrowers' Choice

The focus on the JFC-SME and the use of its data provide us with an ideal setting to test the theories of moral hazard and adverse selection. To explain this, this subsection describes how the JFC-SME underwrites these collateralized and non-collateralized loans and determines their terms of lending.[15] The description here serves as a basis for the theoretical models to be formulated in the next section.

When receiving loan applications from firms that satisfy the eligibility requirements for a loan program, the JFC-SME first screens the applicants based on information from different sources such as financial statements, on-site monitoring, and interviews with borrowers, and assigns an internal credit rating. It rejects loan applications by firms with very low credit ratings, e.g., firms that do not earn profits for many years and are considered by the JFC-SME to go bankrupt in the near future. For firms with better credit ratings, the JFC-SME offers loans with details of their terms. The borrower decides whether or not to accept them.

The terms of lending by the JFC-SME are predetermined based on its internal rule. The terms differ by program, and depend solely on the credit rating of the borrower. The JFC-SME strictly applies the rule, and does not change the terms depending on other factors. Ceteris paribus, the interest rates that the JFC-

[15] This description is based on publicly available information as well as on several interviews with loan officers from the JFC-SME.

SME sets differ between collateralized and non-collateralized loans by a margin added to the latter as risk premiums (or higher interest rates). The margins are calculated to compensate possible additional losses due to the absence of collateral, based on information such as past default rates and collection rates.

Judging from these and other considerations, our focus on the JFC-SME and its data provide us with a unique ground on which we can test theoretical predictions on the behavior of borrowers. First, we can focus on borrowers' choice. Because it is a public bank that does not seek profits, the contracts that the JFC-SME offers are designed for the bank to break even. Thus, the lender's participation constraint binds, and it is the borrower that chooses the contracts to maximize its expected profits.[16]

Second, we can focus on a simple choice by borrowers facing two options: a non-collateralized loan with a high interest rate and a collateralized loan with a low interest rate. The complete information we obtain from the JFS-SME allows us to control for factors such as a firm's credit rating, the loan's amount and maturity. Under this control, we can focus on the choice between a high-interest rate loan without collateral and a low-interest rate loan with collateral, which is a typical set up in the baseline theoretical model of adverse selection or moral hazard. As formulated in theoretical models in the next section, and the focus on this dichotomous choice enable us to directly test predictions from moral hazard and adverse selection models.

Finally, in our analysis, we can take advantage of the existence of some borrowers in our data set that have only one option to choose. Obviously, non-collateralized loans are not an option for any borrowers before their introduction in 2008. Requiring collateral is a common practice in Japan, as often called as

[16] Some bankers from the JFC-SME tell us that they sometimes advise borrowers perceived as less creditworthy to choose a collateralized loan, but do not force them to do so if the borrowers insist on receiving a non-collateralized one.

the collateral principle (*yuu-tanpo gensoku* in Japanese) (see IMES 1995, p.21), especially for loans to small- and medium-sized firms. The JFC-SME introduced non-collateralized loans because it is a public bank and needed to respond to political pressure. However, there were only a very limited number of banks, either private or public, that provide non-collateralized loans at such a large scale.[17]

In addition to the absence of non-collateralized loans before their introduction, there is another factor that limits the number of options to choose for some borrowers. Even after the introduction, borrowers that do not have sufficient amount of assets to pledge as collateral, e.g., real estate properties, do not have an access to collateralized loans. In contrast, firms with sufficient amount of asset can also choose collateralized loans.

The presence of these differences in the choice set is advantageous for our analysis. Due to these differences, our data set include not only borrowers that are forced to choose collateralized or non-collateralized loans as their only option, but also borrowers that choose the same type of loans despite that they could have chosen the other type. As theoretically demonstrated in the next section, comparisons within these borrowers enable us to take unique approaches to identify adverse selection and moral hazard.

3. Theoretical Models

[17] The NLFC (the predecessor of the JFC-MBI) has provided non-collateralized loans for many years but these loans are for smaller firms or sole proprietorships, mostly startups and microbusinesses. A relatively large number of private banks introduced small business credit scoring (SBCS) without collateral in response to a government's policy initiative to promote loans that do not depend on collateral ("the Action Program that Enhances the Functions of Relationship Banking" in March 2003). However, SBCSs are for working capital of small amount and are not alternatives to ordinary business loans like the ones that the JASME provides. Also these banks decreased the volume of SBCS in the late 2000s due to huge loan losses (see Uchida and Udell 2014, Sec. 36.3.2.2).

In this section, we set up theoretical models to capture the borrower behavior around the time of the introduction of non-collateralized loans by the JFC-SME in August 2008, and produce testable hypotheses. Based on a common baseline setting explained in Section 3.1, we set up two models. Section 3.2 formulates the model for moral hazard and produces one testable hypotheses. Section 3.3 formulates the model for adverse selection and produce two testable hypotheses.

3.1. Baseline Setting

Suppose that there are many firms, and each of them has an investment project. By investing funds of a unit size, all firms' projects succeed with probability p and produce a return of R, while they fail with probability $(1-\mathrm{p})$ and produce zero return. The firms do not have funds to invest on their own, and need to borrow them from outside lenders.

Denote generically a loan contract by (r, C), where r is the amount of repayment when the project succeed and C is the amount of collateral that the borrower pledges to lenders. We consider two types of lending contracts that abstract the actual contracts that the JFC-SME offers to its borrowers: collateralized and non-collateralized. A collateralized loan is $(r, C) = (\mathrm{s}, \mathrm{C})$ where $\mathrm{s} > 0$ and $\mathrm{C} > 0$, and a non-collateralized loan is $(r, C) = (\mathrm{t}, 0)$ where $\mathrm{t} > \mathrm{s} > 0$. The values of $\mathrm{s}, \mathrm{t}, \mathrm{C}$ are determined by the JFC-SME to make itself break even. The cases where only (s, C) is available and where both (s, C) and $(\mathrm{t}, 0)$ are available respectively correspond to the environments before and after the JFC-SME introduced non-collateralized loans. For our testable hypotheses that pertain to the behavior of borrowers, no additional assumption on the value of the contract terms is needed, so we abstract their determination and take them

as given in the analysis below.[18]

We assume that both lenders and the borrowers are risk neutral and maximize their expected profits. The expected profits for a borrower in the cases of collateralized and non-collateralized loans are respectively $p(R-s)-(1-p)C$ and $p(R-t)$, and the lender's expected profits from the corresponding loans are respectively $ps+(1-p)C-1$ and $pt-1$.

3.2. Model for Moral Hazard (Ex Post Theory): Hypothesis MH

In the moral hazard version of our model, we further assume that after a borrower signs a lending contract and before the project return realizes, the borrower can choose the risk-return profile of the project (p, R). Suppose that there are two profiles to choose: a safe profile with low risk and low return ($\overline{p}$, $\underline{R}$) and a risky profile with high risk and high return ($\underline{p}$, $\overline{R}$), where $\underline{p}<\overline{p}$ and $\underline{R}<\overline{R}$. Without loss of generality, we assume that $\overline{p}=1$. To focus on relevant cases where the analysis is meaningful, we assume that $\underline{R}-1>0$ and $\underline{p}\overline{R}-1>0$, i.e., the net present value of the investment project is positive. For the moment, we also assume that $\underline{R}-1>\underline{p}\overline{R}-1$, so that the choice of the safe profile is socially efficient. We introduce informational asymmetry by assuming that the choice of the risk-return profile is not observable to lenders. We also assume that the realization of return (whether $R=\underline{R}$ or $\overline{R}$) is not verifiable. Because no contract can be contingent on the choice of the profile due to these assumptions, we can focus on the collateralized and non-collateralized loan contracts explained above.

Let us examine the choice of the risk-return profile by a borrower. A borrower of non-collateralized

[18] Also, for simplicity, we do not explicitly consider other characteristics of borrowers that are observable to lenders. We can easily incorporate them into the model by denoting them by a vector X, and considering the case where the terms of loans depends on X, e.g., $s=s(X)$. In the case of the actual term-setting by the JFC-SME, all the information of X is summarized into credit score.

loan chooses a safe profile if $\underline{R} - t \geq \underline{p}(\overline{R} - t)$, or $t \leq (\underline{R} - \underline{p}\overline{R})/(1 - \underline{p})$. However, to satisfy the lender's participation constraint, t must be large enough. If we denote by $\underline{t}$ the minimum value of t that satisfies the participation constraint, no equilibrium with the choice of the safe profile exists if $(\underline{R} - \underline{p}\overline{R})/(1 - \underline{p}) < \underline{t}$. This is the case where the so-called asset substitution takes place, one of the typical moral hazard problems.

In contrast, for a borrower of collateralized loan, the incentive compatibility condition for the choice of the safe profile is $\underline{R} - s \geq \underline{p}(\overline{R} - s) - (1 - \underline{p})C$, or $s \leq (\underline{R} - \underline{p}\overline{R})/(1 - \underline{p}) + (1 - \underline{p})C/(1 - \underline{p})$. Thus, even if there is no equilibrium with the choice of the safe profile in the case of a non-collateralized loan (i.e., $(\underline{R} - \underline{p}\overline{R})/(1 - \underline{p}) < \underline{t}$), such an equilibrium exits if C is set to satisfy $\underline{t} \leq (\underline{R} - \underline{p}\overline{R})/(1 - \underline{p}) + (1 - \underline{p})C)/(1 - \underline{p})$.[19] Thus, under some parameter constellation, collateralized loans can provide greater incentives for borrowers to avoid inefficient asset substitution. We can thus establish the following testable hypothesis.

Hypothesis MH: The probability of failure for firms borrowing collateralized loans is lower than that for firms borrowing non-collateralized loans.

Note that when it comes the profitability of borrowers, we cannot establish a clear prediction. Under the specific setting above, we can indeed predict that the average profitability of firms borrowing collateralized loans is higher than that for firms borrowing non-collateralized loans. However, this result is an artifact of the assumption $\underline{R} - 1 > \underline{p}\overline{R} - 1$. In general, this inequality might not hold, or the risky

[19] The borrower's participation constraint also needs to be satisfied, although we abstract it for expositional simplicity.

profile might be more socially efficient. In that case, the average profitability of firms borrowing collateralized loans is rather lower than that for firms borrowing non-collateralized loans.

When we empirically test this hypothesis, we should keep in mind that there is an implicit assumption of ceteris paribus behind the above model. Ideally we can test Hypothesis MH only by comparing the ex post performance of a borrower when the borrower chooses a collateralized loan and when the same borrower chooses a non-collateralized loan. However, we can only observe one of the two cases. In the empirical analysis below, we try to make our test as close as possible to the ideal one by controlling for observable and unobservable characteristics of borrowers.

3.3. Models for Adverse Selection (Ex Ante Theory)

In an adverse selection version of the model, or the ex ante theory, we assume, building on the baseline model, that there are continuum types of borrowers that differ in their success probability. Specifically, we assume that p is a random variable distributed within the region $[\underline{p}, \bar{p}]$ with a density function $f(p)$. We further assume that the type of borrowers, or the realization of p for a specific borrower, is not observable to lenders. In this setting, the inability to select and lend to borrowers with positive net present value is the problem of adverse selection.

Using this model, we can establish two hypotheses for adverse selection that we can test by taking advantage of the unique quasi-natural experiment of the introduction of non-collateralized loans by the JFC-SME. The first hypothesis compares the ex post performance of borrowers of collateralized loans before and after the introduction of non-collateralized loans. The second hypothesis compares the performance between two types of borrowers of non-collateralized loans after the introduction of non-collateralized loans.

3.3.1. Ex post performance for borrowers of collateralized loans before and after the introduction of non-collateralized loans

First, we focus on a change in borrower behavior that the introduction of the non-collateralized loans by the JFC-SME could have brought about. Before the introduction, the JFC-SME offers only a collateralized loan (s, C). Types of borrowers (or p) that apply for this loan satisfy $p(R-s) - (1-p)C \geq 0$. Thus, for a given (s, C), $p \geq p^*$ is the range of borrowers that borrow the collateralized loan, where the cutoff p^* is determined by $p^*(R-s)-(1-p^*)C=0$, or

$$p^* \equiv \frac{C}{R-S+C}.$$

In this case, the expected probability of success for a borrower of a collateralized loan before the introduction is:

$$\int_{p^*}^{\bar{p}} pf(p)dp, \quad (1)$$

Then, suppose that the non-collateralized loan (t, 0) is introduced. In this case, borrowers choose the collateralized loan if $p(R-s)-(1-p)C \geq p(R-t)$, and the non-collateralized loan if otherwise. Thus, given t, $p \geq p^{**}$ is the range of borrowers that borrow the collateralized loan, where the cutoff p^{**} is determined by $p^{**}(R-s)-(1-p^{**})C = p^{**}(R-t)$, or

$$p^{**} \equiv \frac{C}{t-S+C}.$$

In this case, the expected probability of success for a borrower of a collateralized loan after the introduction of non-collateralized loans is:

$$\int_{p^{**}}^{\bar{p}} pf(p)dp, \quad (2)$$

For a given (s, t, C), $p^* \leq p^{**}$ because $t \leq R$ for the borrower's participation constraint to be satisfied and

$s<t$ due to the risk premium charged on the non-collateralized loan. Thus, by comparing equations (1) and (2), we can establish the following testable hypothesis:

Hypothesis AS1: The probability of failure for firms that borrow collateralized loans decrease after the introduction of non-collateralized loans.

This hypothesis claims that among firms that borrowed collateralized loans before the introduction of non-collateralized loans, riskier borrowers change to non-collateralized loans after their introduction. This change is due to riskier borrowers' preference for non-collateralized loans. As their projects have higher likelihood of failure, a contract that force them to make payment in the case of failure is less preferable to a contract without such a payment. As a corollary to AS1, we can also predict that the average profitability (return) of firms that borrow collateralized loans increase after the introduction of non-collateralized loans.

When we empirically test this hypothesis, we should keep in mind some important assumptions of ceteris paribus that are implicit in the above model. First, we implicitly assume that the distribution of the type of borrowers (or the success probability) does not change after the introduction of non-collateralized loans. This assumption is important because soon after the introduction in August 2008, firms in Japan suffered from adverse effects due to the Global Financial Crisis. Thus, to test Hypothesis AS1, we need to focus on the period before the shock from the crisis hits the Japan's economy. Second, we implicitly assume in the above model that the terms of the collateralized loan (the levels of s and C) do not change after the introduction of non-collateralized loans. Fortunately, this assumption is satisfied, because at least in the short run, the JFC-SME introduced non-collateralized loans as an additional choice, without changing the terms of the conventional collateralized loans.

3.3.2. Ex post performance for borrowers of non-collateralized loans with and without sufficient amount of asset

To establish another hypothesis for adverse selection, we take advantage of a difference in the choice sets among borrowers of non-collateralized loans. Although the introduction of non-collateralized loans expanded the choice set for borrowers, the number of options that borrowers can actually choose differ depending on the availability of assets to pledge as collateral. For borrowers with sufficient amount of asset to pledge as collateral, the number of options is two (collateralized and non-collateralized). However, for those without sufficient amount of asset, the number is one (non-collateralized only). This means that even among the borrowers of non-collateralized loans, there are two types of borrowers: those that choose the non-collateralized loans notwithstanding that they have sufficient amount of asset, and those that choose them because they are the only choices for them.

Let us examine the choice of a loan. Firms with sufficient amount of asset chooses a non-collateralized loan if $\mathrm{p}(\mathrm{R}-\mathrm{t}) \geq \mathrm{p}(\mathrm{R}-\mathrm{s})-(1-\mathrm{p})\mathrm{C}$, or

$$\mathrm{p} \leq \mathrm{p}^{**} \equiv \frac{\mathrm{C}}{\mathrm{t}-\mathrm{S}+\mathrm{C}}.$$

In contrast, firms without asset choose non-collateralized loans as long as $\mathrm{p}(\mathrm{R}-\mathrm{t}) \geq 0$. That is, as far as $\mathrm{R} \geq \mathrm{t}$, all borrowers without asset choose the non-collateralized loan. Thus, the expected probability of success for borrowers of a non-collateralized loan with sufficient amount of asset is:

$$\int_{\underline{\mathrm{p}}}^{\mathrm{p}^{**}} pf(p)dp, \tag{3}$$

whereas the probability for those with only one choice is:

$$\int_{\underline{\mathrm{p}}}^{\bar{p}} pf(p)dp, \tag{4}$$

By comparing (3) and (4), we can establish the following testable hypothesis:

Hypothesis AS2: The average probability of failure for firms that borrow non-collateralized loans is worse when they have sufficient amount of asset to pledge as collateral than when they do not.

As a corollary to this hypothesis, we can also predict that the average profitability (return) of firms that borrow non-collateralized loans is better when they have sufficient amount of asset to pledge as collateral than when they do not.

Note, however, that as in the case of AS1, we implicitly assume in the above model that the distribution of p is indifferent between borrowers with and without sufficient amount of asset. Without this assumption, the model becomes too complex to produce a clear prediction. In the empirical analysis below, we will try to assure this assumption by using many different controls to capture differences between borrowers with and without sufficient amount of asset.

4. Empirical Approach

In this section, we proceed to explain our empirical approach to test the three hypotheses that we established in the previous section, i.e., MH, AS1, and AS2. The quasi-natural experiment of the introduction of non-collateralized loans provides us with a unique ground for testing these hypotheses, because we can compare ex post performance of borrowers among different types of borrowers: among borrowers of collateralized and non-collateralized loans (for Hypothesis MH); among borrowers of collateralized loans before and after the introduction (for AS1); and among borrowers of non-collateralized loans with and without sufficient amount of asset to pledge as collateral (for AS2). As mentioned above,

however, we also need to deal with the challenges in testing these hypotheses by assuring the implicit *ceteris paribus* assumptions.

4.1. Test for the Moral Hazard Hypothesis (MH)

To test Hypothesis MH, we compare the ex post performance of borrowers of non-collateralized and collateralized loans. The main idea here is to control for the effect of adverse selection or the difference in the ex ante characteristics of borrowers by taking into account of the differences in observable and unobservable borrower characteristics. With such controls, the remaining differences in ex post performance due to the use/non-use of collateral stem solely from moral hazard. Most importantly, we eliminate the effect of adverse selection by controlling for firm fixed effects. To the extent that the firms' unobservable characteristics are time-invariant, this is a reasonable approach. This approach is similar to the one adopted in Aarbu (2015) that examines moral hazard in the home insurance market, and to the one in labor economics that examines the causes of long-term unemployment.[20]

To test hypothesis MH, we examine a difference-in-differences (DID) in ex post performance of borrowers. Let us first denote the ex post performance of firm i that borrows before as well as after the introduction of non-collateralized loans in August 2008 as follows:

[20] The issue of distinguishing moral hazard and adverse selection is in parallel with the issue in labor economics of distinguishing state dependence and heterogeneity as a cause for long-term unemployment (see Abbring et al. 2003). One explanation for long-term unemployment based on state dependence is that the past unemployment experience of workers has a direct negative impact on the probability of their future employment. The other explanation based on heterogeneity is that workers are different because of unobserved characteristics that affect their future probability of employment. The literature on unemployment has tried to distinguish between the two by assuming that the unobservable heterogeneity is not affected by labor market conditions and controlling for it with panel data estimations. Their approach is similar to ours in that both control for time-invariant unobservable characteristics to examine moral hazard, which is one form of state-dependent behavior.

$$z_{it+k} = \alpha_i + X_{it}\beta + \xi y_{it} + \epsilon_{it+k},$$

$$z_{it'+k} = \alpha_i + X_{it'}\beta + \xi y_{it'} + \epsilon_{it+k'},$$

where *t* and *t'* indicate before and after the introduction, and z is the ex post performance that depends on the borrower's time-variant (X) and invariant attributes (α), and the type of loan (y) that indicates whether the relevant loan is collateralized or non-collateralized. Taking the difference between the two equations, we obtain the following equation to estimate:

$$\Delta z_{it+k} = \Delta X_{it}\beta + \xi \Delta y_{it} + \Delta \epsilon_{it+k} \quad (5)$$

In this equation, we focus on ξ, the coefficient for the change in the type of loan contract Δy_{it}. We define Δy_{it} as taking the value of one if the relevant borrower changed the type to a non-collateralized loan after August 2008, and zero if the borrower does not change the type and keep borrowing a collateralized loan. To the extent that we can eliminate the effect of adverse selection by controlling for the firm fixed effect (α_i), the remaining difference in ex post performance (Δz_{it+k}) due to the use of a non-collateralized loan as opposed to a collateralized one (Δy_{it}) captures the effect of moral hazard. Hypothesis MH predicts that ξ should capture a lower default probability for borrowers that changed types of loans.

4.2. Tests for the Adverse Selection Hypotheses (AS)

Hypotheses AS1 and AS2 predict that even among borrowers that choose the same type of loans, the average quality of borrowers may differ depending on whether or not there is another option to choose. In testing these hypotheses, we need to extract the effect of adverse selection by eliminating the confounding effect caused by moral hazard, or the effect of the differences in ex post incentives that collateralized and non-collateralized loans provide with borrowers. Also, behind this prediction, there is an important implicit

assumption of *ceteris paribus*, i.e., the underlying distribution of the quality of potential borrowers does not differ depending on whether there is another option or not.

To test hypothesis AS1, we estimate the following equation:

$$z_{it+k} = X_{it}\beta + \delta I(ELAPSED\_DAYS_{it} \geq 0) + \epsilon_{it+k}, \quad (6)$$

where $I(ELAPSED\_DAYS_{it} \geq 0)$ is an indicator to capture the difference in the choice set, which takes the value of unity if a firm receives a collateralized loan after August 2008, and zero if before.. The vector of firm attributes X_{it} is added on the right hand side to control for any differences in ex ante firm characteristics and the difference in the distribution of good and bad borrowers before and after August 2008.[21] The coefficient of our interest is δ. We expect that it represents a positive effect on firm performance, because after the expansion of the choice set, borrowers with higher creditworthiness should choose collateralized loans.

In addition to the usual regression analysis, we also test AS1 by the regression discontinuity design (RDD) in order to carefully control for the time-varying factors. We compare the ex post performance of borrowers that signed collateralized loan contracts just before and after August 2008 when non-collateralized loans were introduced. In this vein, we adopt the following specification:

$$z_{it+k} = X_{it}\beta + \mu I(ELAPSED\_DAYS_{it} \geq 0) + \gamma(ELAPSED\_DAYS_{it})$$
$$+\delta I(ELAPSED\_DAYS_{it} \geq 0) \cdot (ELAPSED\_DAYS_{it}) + \varepsilon_{it+k}, \quad (7)$$

for the window defined by $-\mathrm{h} \leq ELAPSED\_DAYS_{it} \leq h$, where h is the size of the bandwidth that are determined to balance the tradeoff between bias and variance of the parameters. Hypothesis AS1 predicts that there is a jump in the performance in August 2008, so we expect μ to be non-zero and to represent

[21] Because we are interested in the differences in ex post performance due to ex ante characteristics of borrowers, we do not control for firm fixed effects in the tests for AS1 and AS2.

a positive effect on firm performance.

To test hypothesis AS2, we make a comparison among borrowers of non-collateralized loans after August 2008. Among such borrowers, there are two groups of borrowers: those with and without another option to choose. We distinguish them based on information on borrowers' collateral margin, which is defined as the ratio of the amount of collateralizable assets (net of the amount already pledged as collateral to other debtors) to the amount of total loans outstanding. Borrowers whose margins are equal to or larger than unity are those that could have chosen a collateralized loan, or those that had two options to choose. Hypothesis AS2 suggests that these borrowers have chosen non-collateralized loans because they are risky. In contrast, borrowers whose collateral margins are less than unity are those that had no other choice but the non-collateralized loan. Hypothesis AS2 suggests that these borrowers include creditworthy borrowers.

To test AS2, we estimate the following equation:

$$z_{it+k} = X_{it}\beta + \mu I(MARGIN_{it} \geq 1) + \epsilon_{it+k}, \quad (8)$$

where $I(MARGIN_{it} \geq 1)$ is an indicator that the collateral margin is equal to, or greater than the unity. We expect that the coefficient μ captures worse performance for borrowers with sufficient amount of asset. To control for any differences in ex post performance stemming from ex ante difference in firm characteristics, we include a vector of firm attributes X_{it} as a set of control variables.

Similar to the case of AS1, we test AS2 not only by an ordinary OLS regression analysis but by the regression discontinuity design (RDD). In the RDD, we focus on firms that borrowed non-collateralized loans and whose margin is within a calculated bandwidth around the value of unity. The specification we adopt is as follows:

$$z_{it+k} = X_{it}\beta + \mu I(MARGIN_{it} \geq 1) + \gamma MARGIN_{it} + \delta I(MARGIN_{it} \geq 1) \cdot MARGIN_{it} + \varepsilon_{it+k}, \quad (9)$$

for the window defined by $-\mathrm{h} \leq MARGIN_{it} - 1 \leq \mathrm{h}$, where h represents the bandwidth. Hypothesis

AS2 predicts a jump in the ex post performance at $MARGIN=1$, so we expect μ to be non-zero and to represent a negative effect on firm performance.

5. Data

5.1. Data and Sample Selection

The data set used for our analysis is compiled from several firm-level and loan-level sources provided by the JFC-SME. The information that we can use include balance sheets and firm characteristics such as the number of employees, location, and industry; borrowers' internal credit rating; and the terms of loan contracts such as the amount of loans, interest rates, and maturities.

We implement estimations at the firm level rather than at the loan level, since we measure ex post performance at the firm level. In case a firm obtains both collateralized and non-collateralized loans in the same year, we need to determine if this firm is a borrower of collateralized or non-collateralized loan. In our Tests MH and AS2, we define non-collateralized firms (obtaining non-collateralized loans) as those that receive at least one non-collateralized loan during the year. In Tests AS1, we define collateralized firms (obtaining collateralized loans) as those that receive at least one collateralized loan during the year.

Firms in our sample are relatively large-sized SMEs in Japan, because they are the targets of the JFC-SME (see Section 2). Compared with the universe of firms in Japan, the industry composition of JFC-SME borrowers skews toward manufacturing firms, because the original purpose of the JFC-SME is to provide loans for fixed capital investment.[22]

To implement the three tests that we proposed in Section 4, we need different data sets. For Test MH where we control for the impact of adverse selection by using firm fixed effects, we construct the data set

[22] However, the JFC-SME underwrites many loans for working capital.

in the following manner. First, we concentrate on borrowers that receive collateralized loans at least two different time periods: one before and one after the introduction in August 2008. Second, we limit length of the intervals for these two time periods in order to prevent firms' unobservable characteristic to vary. Thus, our sample before the introduction covers only one year (From April 2007 to March 2008) and that after the introduction covers one year and eight months (From August 2008 to March 2010).

For the two versions of Test AS, we also use different data sets. The data set for Test AS1 consists of borrowers that receive collateralized loans before and after the introduction. In the case of the ordinary OLS specification, the data set includes firms that receive collateralized loans in the fiscal year of 2008 (April 2008 to March 2009), and divide them into pre (April 2008 and July 2008) and post (August 2008 and March 2009).In the case of the RDD specification, the data set consists of borrowers that receive collateralized loans during seven fiscal years from 2005 to 2011. Note, however, that most of the observations are solely used for determining the bandwidth in the actual estimation, which ranges between 123 and 408 days.

Finally, the data set for Test AS2 consists of borrowers that receive non-collateralized loans after their introduction. Due to the availability of data for the collateral margin, however, the window for this data set is from fiscal year 2010 to 2012. In the ordinary OLS specification, we use all observations for the analysis, In the case of the RDD specification, we use a substantial number of observations with extreme values of MARGIN only to determine the bandwidth in the actual estimation.

5.2. Variables

In this subsection, we explain the variables that we use in our tests. The definitions of these variables are summarized in Table 1. Because we use different samples depending on the tests we perform, the

summary statistics for each sample are reported in the next subsection.

One of the most important variables in our analysis is an indicator for non-collateralized loans that we employ for the MH and AS2 Tests, NONCOLL, which takes the value of one if a firm obtains at least one non-collateralized loan during the sample period and zero if otherwise. There are two other important variables in our analysis. First, the variable ELAPSED_DAYS is the main variable for Test AS1, which indicates the number of days between the date of the introduction of non-collateralized loans (August 1, 2008) and the contract date of the relevant collateralized loan. If the contract is made before the introduction, this variable takes a negative value. Second, the variable MARGIN is a main variable for Test AS2, which measures the collateral margin defined as the ratio of the amount of collateralizable assets (net of the value already pledged as collateral to other debtors) to the amount of loans. The collateralizable assets are mostly real estate properties (land and buildings) but occasionally machinery.

We use four variables to measure ex post performance of the borrowers. Two of them are measures of credit risk, used as proxies for p in the model in Section 3. First, we use CREDIT, the JFC-SME's internal credit rating. The rating is based on hard and soft information that the JFC-SME collects, and ranges from 1 (most creditworthy) to 12 (least creditworthy and bankrupt). A rating that is equal to or larger than 9 indicates that the JFC-SME regards the firm as being in financial distress and the loans are non-performing. Our second variable Possible BANKRUPTCY takes the value of one if the relevant rating is 9 or larger.[23]

In addition to these variables to measure ex post credit risk, we use two variables for firms' financial

[23] We also construct dummies for virtual bankruptcy (rating of 11 or 12) and actual bankruptcy (rating of 12). However, mainly because the numbers of observations that takes a value of one for these variables are small, they do not produce reliable results.

performance as proxies for *R* in the model in Section 3. The variable d_lnSALES is the difference in the natural logarithm of firms' sales, or sales growth. The variable ROA is the return on asset, defined as the ratio of business profits to total assets.

Using these four variables, we measure ex post performance at three different time points, year t+1, t+2, and t+3, with year t as the year that the borrowers obtain loans. In sum, we use 12 (= 4 times 3) different variables for z_{it+k}.

For the variables in the vector of control variables X_{it}, we use the following variables: LEVERAGE (firms' leverage), TANGIBILITY (the ratio of tangible asset to total asset), lnAGE (the natural logarithm of firm age), LENDERS (the number of lenders), LENGTH (the duration (years) of lending relationship with the JFC-SME), INDj (industry dummies: j=1, …, 8), REGIONj (regional dummies: j=1, …, 8), and YEARj (year dummies: j=2003 to 2014). We also include in the vector X_{it} ROA and CREDIT at time *t*. See Table 1 for more details on the definitions.

5.3. Summary statistics

5.3.1. Sample for Test MH

Table 2 shows the summary statistics for the sample for Test MH. Firms in this sample are those that receive loans both before and after the introduction of non-collateralized loans in August 2008. Panel (a) reports the statistics for about 3,600 firms that obtain collateralized loans both before and after August 2008. Panel (b) reports the statistics for about 2,300 firms that obtain a collateralized loan before August 2008 and a non-collateralized loan after August 2008. Columns (1) and (2) in each panel respectively shows the statistics before and after August 2008, and the third column shows those for the entire period. In the right-most column in each panel, we report the difference in means between Column (2) and (1).

The difference in the differences between the upper and the lower right-most columns (between Panels (a) and (b)) corresponds to ξ the difference-in-differences (DID) represented by in equation (5) in Section 4.1.

From this table, we can see similar patterns of changes in the firm characteristics between periods before and after August 2008 in the two panels. In both panels, the frequency of Possible BANKRUPTCY to take the value of unity is higher after August 2008 than before. The magnitude of the differences is more sizable in Panel (b) than in Panel (a), indicating that firms that switch to non-collateralized loans perform worse than non-switcher firms.

5.3.2. Sample for Tests AS1 and AS2

Tables 3 and 4 respectively report the summary statistics for the characteristics of sample firms used for Tests AS1 and AS2. In each table, we report the statistics for the two comparison groups in columns (1) and (2). We also report the statistics for the entire sample, together with the between-group differences.

In Table 3, we find that among the entire 10,500 borrowers that obtain collateralized loans in the fiscal year of 2008, 3,300 borrow before July 2008 and 7,200 borrow after August 2008. Comparing the ex ante firm characteristics between firms in these two different periods of loan provision, LEVERAGE and TANGIBILITY are higher, and ROA and lnSALES are lower for the firms that borrow before August 2008 than for those that borrow after. As for ex ante credit risk, CREDIT is higher, i.e., the rating is lower, for the firms that borrow before August 2008 than after. We also find that firms that borrow before August 2008 are riskier in terms of the ex post distress measure (Possible BANKRUPTCY). In this sample, collateralized borrowers prior to August 2008 are riskier than those after August 2008.

In Table 4, we find that among 51,100 borrowers of non-collateralized loans, about 47,300 firms do

not have sufficient assets to pledge as collateral (Column (a)), while about 3,800 firms do (Column (b)). At the time of loan origination, the firms in the former group have lower ROA, lnSALES, and TANGIBILITY than those in the latter group. Not only is the ex ante credit risk (CREDIT) higher among firms in the former group than those in the latter, but also the ex post distress frequency measured by Possible BANKRUPTCY is higher among the firms in the former.

6. Results

6.1. Results for Test MH: Test for Moral Hazard

The results for Test MH are shown in Table 5. In order to report the results using the four variables for ex post performance, the table has four panels from (a) to (d). The most important explanatory variable in this difference-in-differences (DID) analysis is ΔNONCOLL, which takes the value of unity if a firm that used to borrow a collateralized loan obtains a non-collateralized loan after August 2008, and zero if such a firm again obtains a collateralized loan. Because the sample firms in this analysis are only firms that used to borrow collateralized loans before August 2008, ΔNONCOLL is an indicator for a change in loan types.

In this table, we first find that as to credit risk measured by possible bankruptcy (Panel (a)) and credit rating (Panel (b), first column only), ΔNONCOLL has statistically significant and positive coefficients. These findings respectively indicate that firms that switch from collateralized to non-collateralized loans are more likely to fall into the category of possible bankruptcy, or to be downgraded in their credit ratings. Since we control for time-invariant fixed effects, these findings are not likely to be driven by ex ante borrower characteristics, including the effect of adverse selection. Thus the results are consistent with Hypothesis MH that predicts higher default probability for switchers.

Turning to the results for financial performance (Panels (c) and (d)), we find that the coefficients for ΔNONCOLL are only marginally or occasionally significant. We find a positive coefficient in Column (2) of Panel (c) and marginally positive coefficient in Column (2) of Panel (d), which indicates that firms that switch to non-collateralized loans tend to have higher ROA and sales growth than those without a switch. However, we also find a marginally negative effect on sales growth in the short run as seen in Column (1) of Panel (d), and the effect is insignificant in the other cases. These mixed results indicate that the effect of the switch on financial performance is unclear. However, as we confirmed in Section 3.2, the predicted effect of the switch on financial performance is theoretically unclear as well.

On balance, we find evidence to support Hypothesis MH. The evidence indicates deteriorating credit ratings and higher frequency of falling into possible bankruptcies for a borrower that switches from a collateralized loan to a non-collateralized loan. The results for financial performance are tenuous, but taking into account the theoretical discussion in Section 3.2., these findings might suggest that risky project might not necessarily be an inefficient project.

6.2. Results for Test AS1: Collateralized Borrowers before and after August 2008

In Table 6, we report the results of the OLS regressions for Test AS1 in four panels that correspond to the four performance variables that we use as the dependent variables. The variable of our interest is $I(Elapsed\ Days \geq 0)$. When we use credit risk for the dependent variables (Panels (a) and (b)), the effect of $I(Elapsed\ Days \geq 0)$ are weak and mostly insignificant. The coefficient is statistically significant and negative in Column (1) of Panel (a), indicating a lower probability of possible bankruptcy for firms borrowing collateralized loans after August 2008. This finding is consistent with Hypothesis AS1. However, the coefficients on $I(Elapsed\ Days \geq 0)$ are statistically insignificant in the other columns.

When we use financial performance as dependent variables (Panels (c) and (d)), the coefficients for *I*(*Elapsed Days*≥0) are negative and statistically insignificant in most cases. The exception is a positive and significant effect on ROA two years after the collateralized loan contract (Column 2 in Panel (c)), which is consistent with the prediction in Hypothesis AS1. On balance, the overall results from the OLS analysis are mixed, and we find only weak evidence for the presence of adverse selection.

Results using the regression discontinuity design is shown in Figure 2. Each dot indicates a sample average of firms' ex post performance within each bin. The horizontal axis indicates ELAPSED_DAYS, the number of days between the date of loan contracting and the date when the non-collateralized loans are introduced. The vertical axis indicates values of the dependent variable, which differ in the four panels. Each panel has three columns that correspond to the three different time windows to measure ex post performance. We also depict the fitted lines that might vary above and below the threshold value of ELAPSED_DAYS=0. Note that when we depict these panels, we do not include covariates, which is equivalent to omitting X_{it} in estimating the equation (7).

Almost all the panels in Figure 2 show substantial discontinuity in ex post performance before and after the introduction of non-collateralized loans, although the direction of the effect is not necessarily consistent with each other. On the one hand, the probability of possible bankruptcy for borrowers of collateralized loans decreases and the credit rating improves after the introduction. On the other hand, the effect on financial performance is different in the short-run and in the long-run. Both sales growth and ROA one year after the loan provision are substantially smaller for firms that borrow collateralized loans immediately after the introduction than for those that borrow them shortly before. However, the results for time-windows of two to three years are the opposite.

To assure the ceteris paribus assumption behind the theoretical model in Section 3, we take into

account the difference in the characteristics of borrowers by including the covariates (X_{it} in equation (7)).[24] The results are reported in Table 7. After controlling for different factors, we find that there is no jump in ex post performance among borrowers of collateralized loans due to the introduction of non-collateralized loans. We can thus conclude that we find little evidence to support Hypothesis AS1.

6.3. Results for Test AS2: Non-collateralized Borrowers with and without Assets to Pledge as Collateral

Table 8 shows the results for Test A2 based on the ordinary OLS regression. As in Table 6 for Test AS1, the table reports the results in four panels that correspond to the four dependent variables to measure ex post firm performance. In this test, we focus on the effect of the variable $I(MARGIN_{it} \geq 1)$, because its coefficient represents μ in equation (8) in Section 4.3. Hypothesis AS2 predicts that the variable has a negative effect on ex post performance, because among the borrowers with sufficient amount of asset, only risky borrowers self-select non-collateralized loans, but among those without, all borrowers borrow non-collateralized loans.

We first find that when we use credit risk variables on the left-hand side (Panels (a) and (b)), the coefficient for $I(MARGIN_{it} \geq 1)$ is negative and statistically significant in Panel (b). This finding indicates that the ex post credit risk for borrowers of non-collaterilized loans is lower when they have sufficient amount of collateralizable assets than when they do not. This finding is inconsistent with Hypothesis AS2. Turning to the financial performance (Panels (c) and (d)), the coefficient on $I(MARGIN_{it} \geq 1)$ is statistically significant in the case of sales growth (Panel (d)), and its sign is positive.

[24] Specifically, we use lnSALES, LEVERAGE, ROA, TANGIBILITY, lnAGE, NUMBANK, and CREDIT as our covariates.

This finding is again inconsistent with the prediction under adverse selection.

Considering the possibility that the OLS regression fails to correctly identify the impact of MARGIN due to the confounding factors far above or below the threshold value of unity, we also conducted the analysis by regression discontinuity design. Figure 3 reports a simple comparison of the performance variables above or below the threshold value of MARGIN without controlling for covariates. We find that the probability of falling into possible bankruptcy is smaller, and the credit rating is better, for borrowers with sufficient amount of asset than without. Also, sales growth and ROA are higher for borrowers with sufficient amount of assets. These findings are all inconsistent with Hypothesis AS2.

Finally, Table 9 reports the results from the regression discontinuity design when we add covariates to control for differences in characteristics of borrowers to assure the underlying assumption of ceteris paribus in the model in Section 3.3.2. After the control, we see weaker results for the discontinuity in the performance variables. Although we still find that credit rating is better and sales growth is higher for borrowers with sufficient amount of funds, we also find that ROA is worse and no difference is found in the performance in other cases.

On balance, we do find no strong evidence supporting Hypothesis AS2. We rather find some evidence against it. That is, some of our findings suggest that borrowers that could have chosen collateralized loans tend to perform better than that are forced to choose non-collateralized loans. These results suggest that actual borrower behavior is different from what a typical adverse selection model predicts.

7. Conclusion

In this paper, we empirically examine whether adverse selection and moral hazard matter in financial contracting. Our analysis is unique because it uses comprehensive data from a public bank in Japan that

introduced non-collateralized loans, and takes advantage of the quasi-natural experiment of the bank's introduction of non-collateralized loans. From our tests to identify adverse selection and moral hazard, we find results that are consistent with moral hazard. Our findings suggest that collateralized and non-collateralized loans provide different incentives for borrowers' risk taking. However, we find no supportive evidence, and rather some counter evidence, on adverse selection.

Our empirical examination makes an important contribution to the academic literature, by shedding new lights on the significance of adverse selection and moral hazard. Our findings are also important from practical viewpoints. Based on our findings in support for moral hazard rather than adverse selection, we can draw an important implication that banks should exert more effort in ex post monitoring of borrowers than ex ante screening.

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Figures

Figure 1: Amount of loans extended by JASME (-September 2008) and JFC-SME (October 2008-)

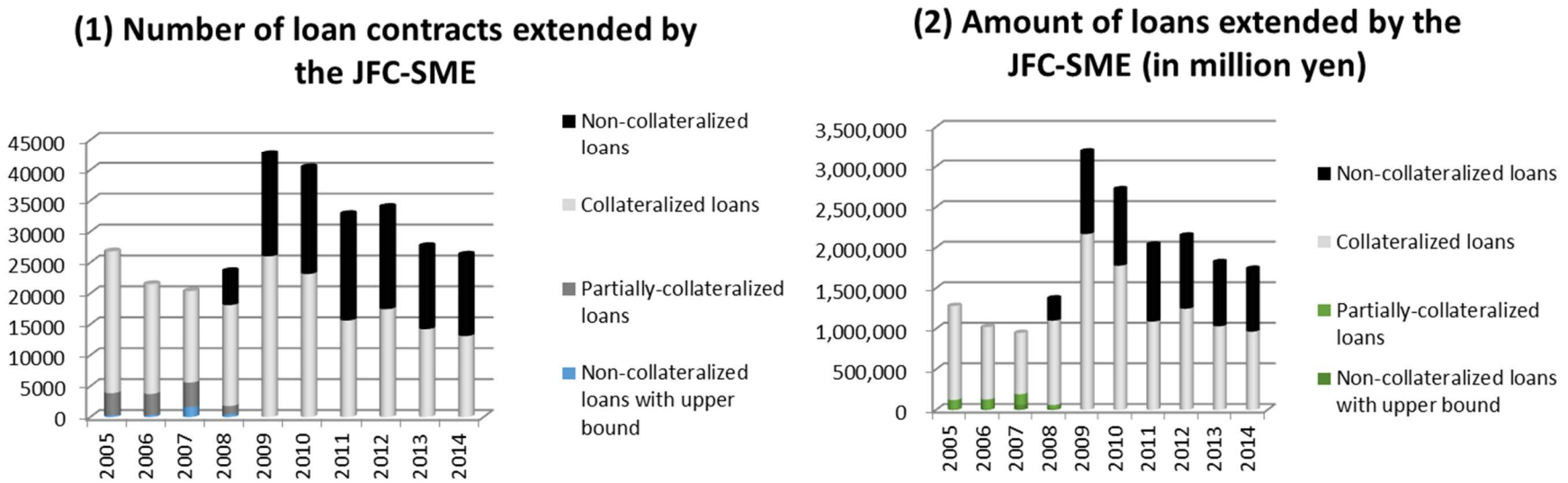
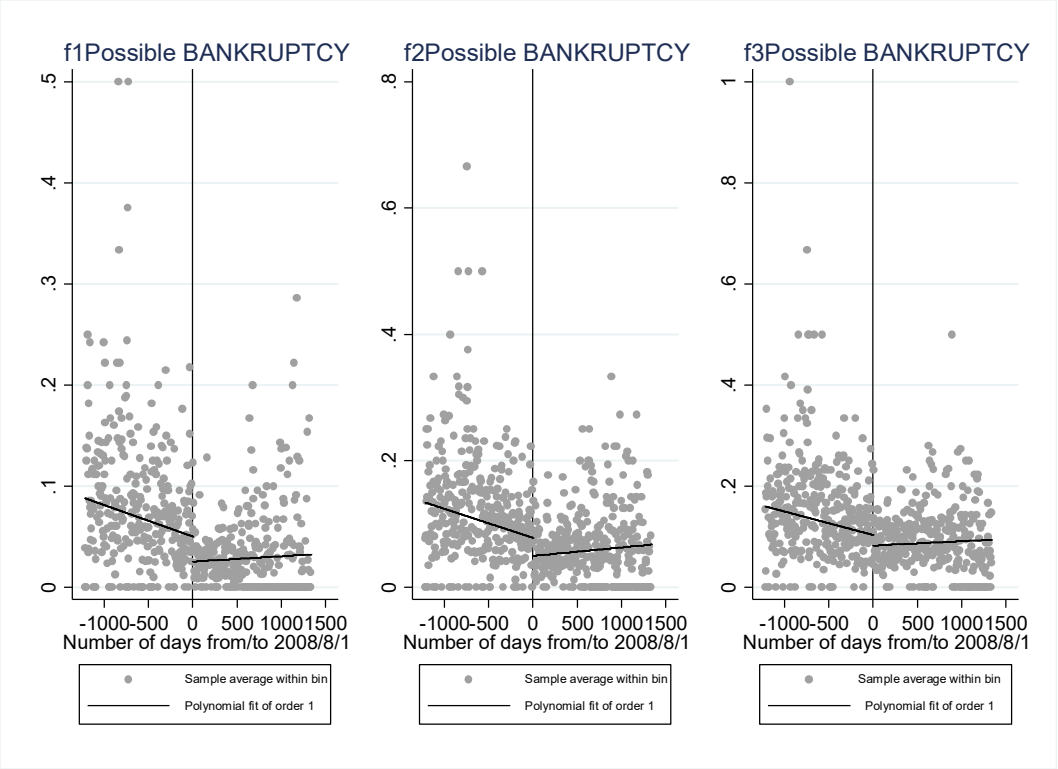


Figure 2: Regression discontinuity before and after introduction of non-collateralized loans

(a) Possible bankruptcy



(b) Credit score

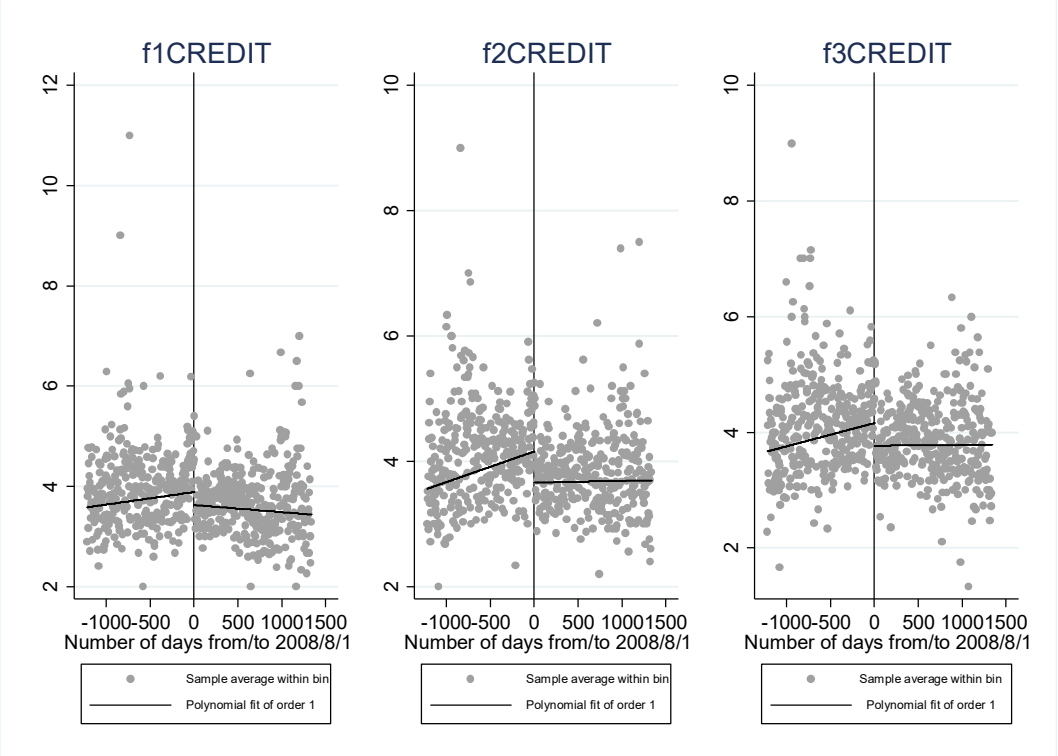
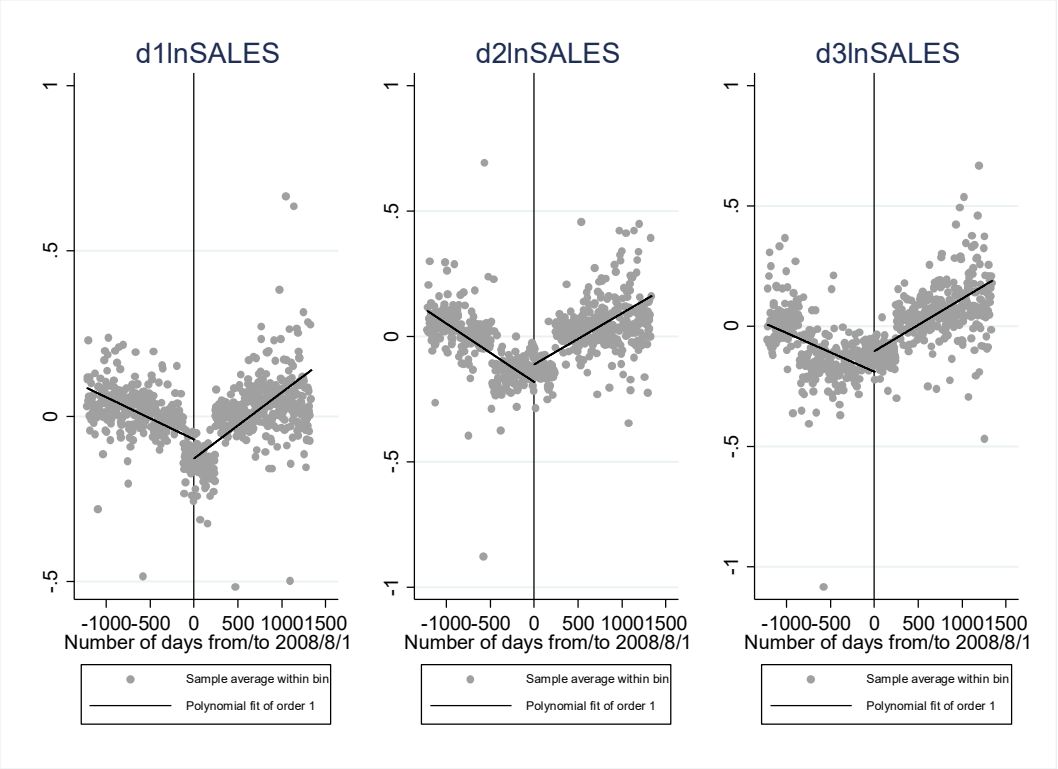


Figure 2 (continued)

(c) Sales growth



(d) ROA

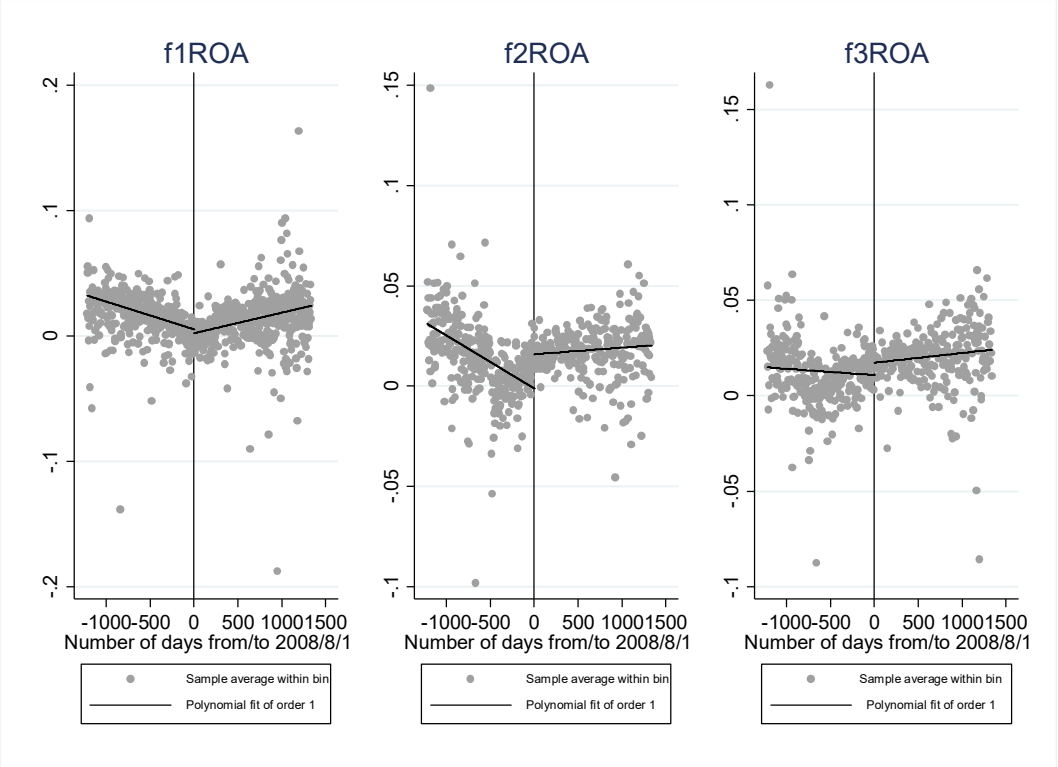
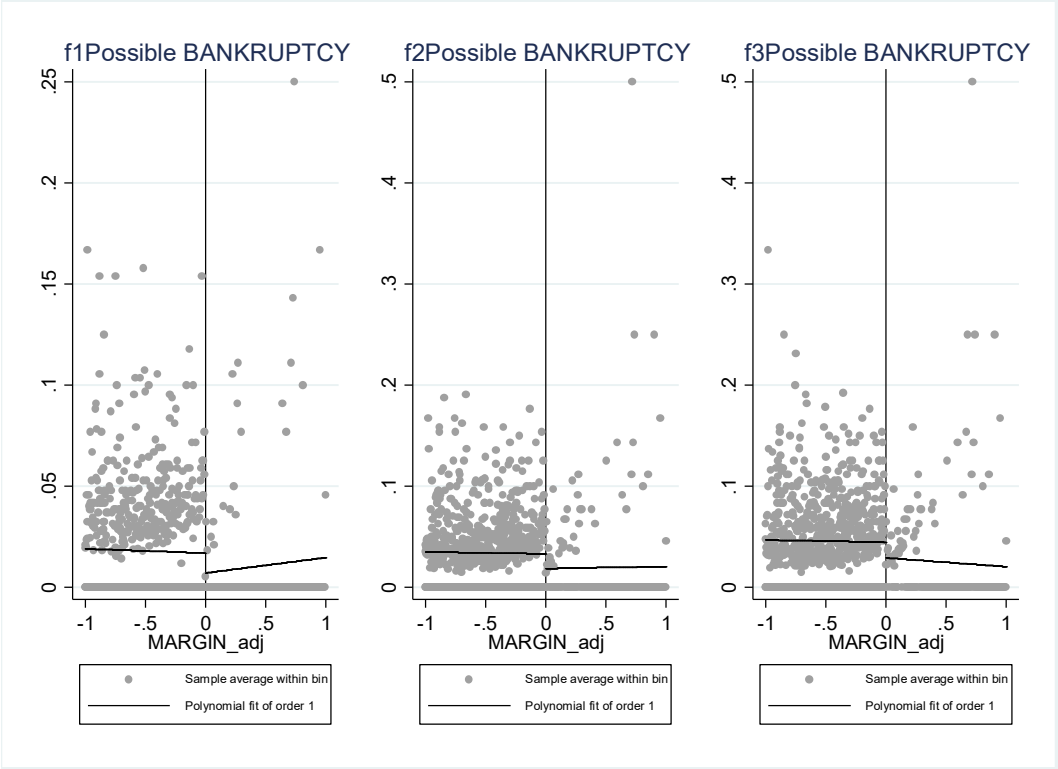


Figure 3: Regression discontinuity around the collateral margin of unity

(a) Possible bankruptcy



(b) Credit score

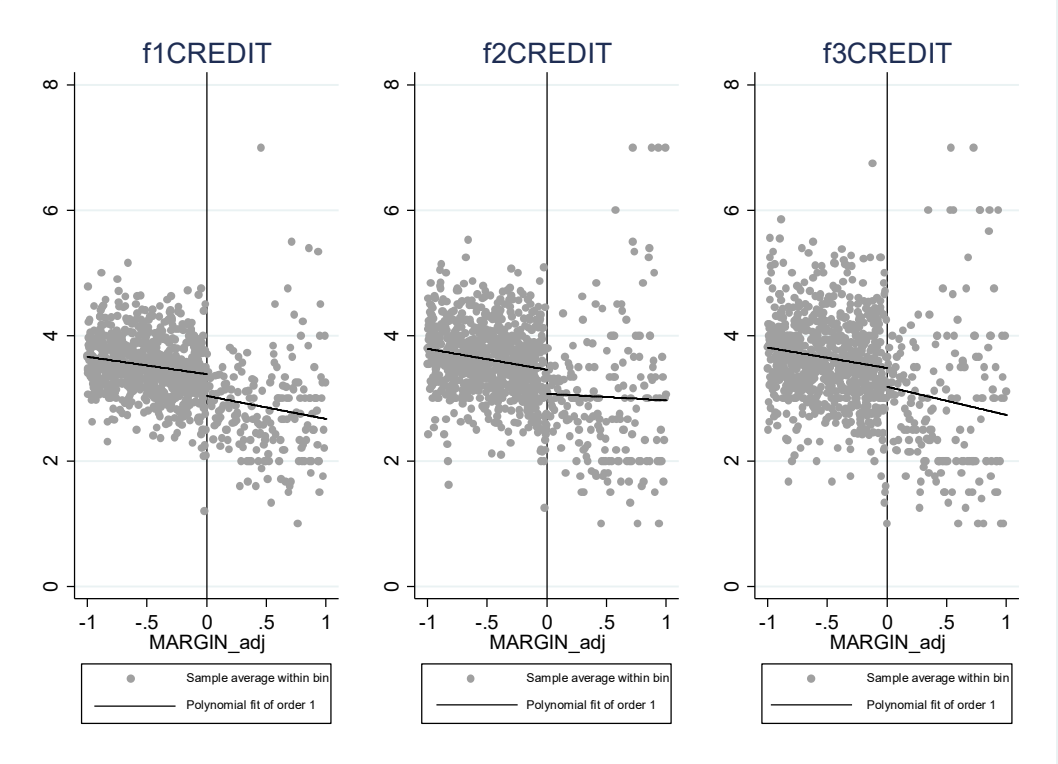
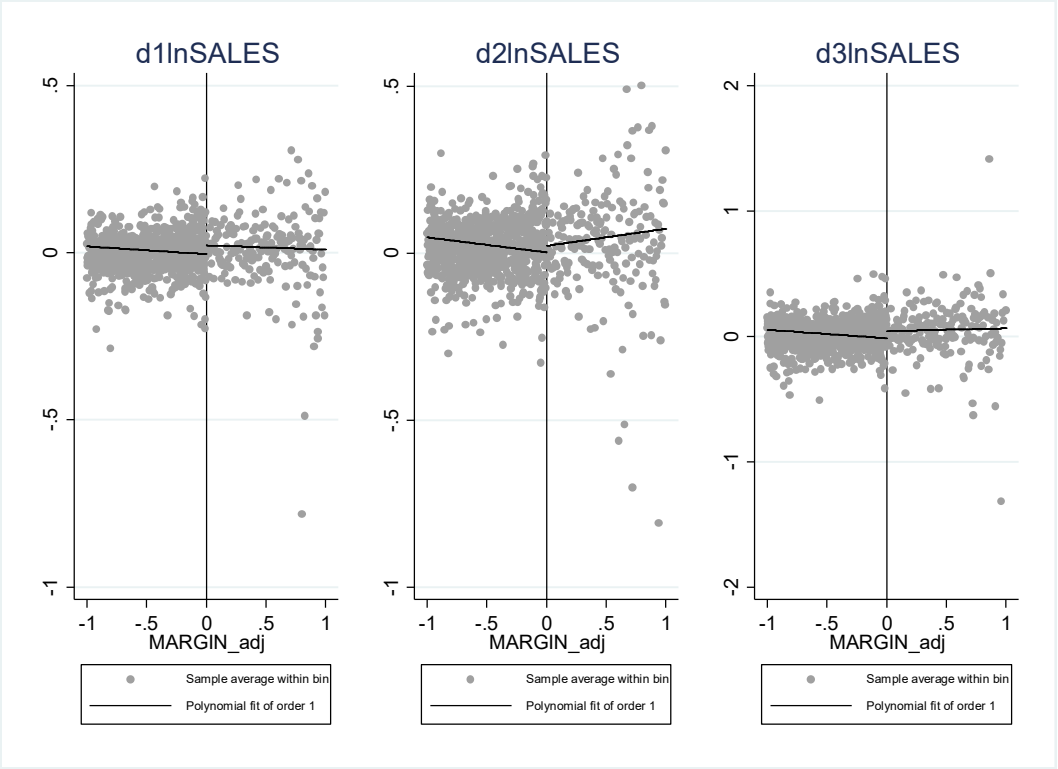
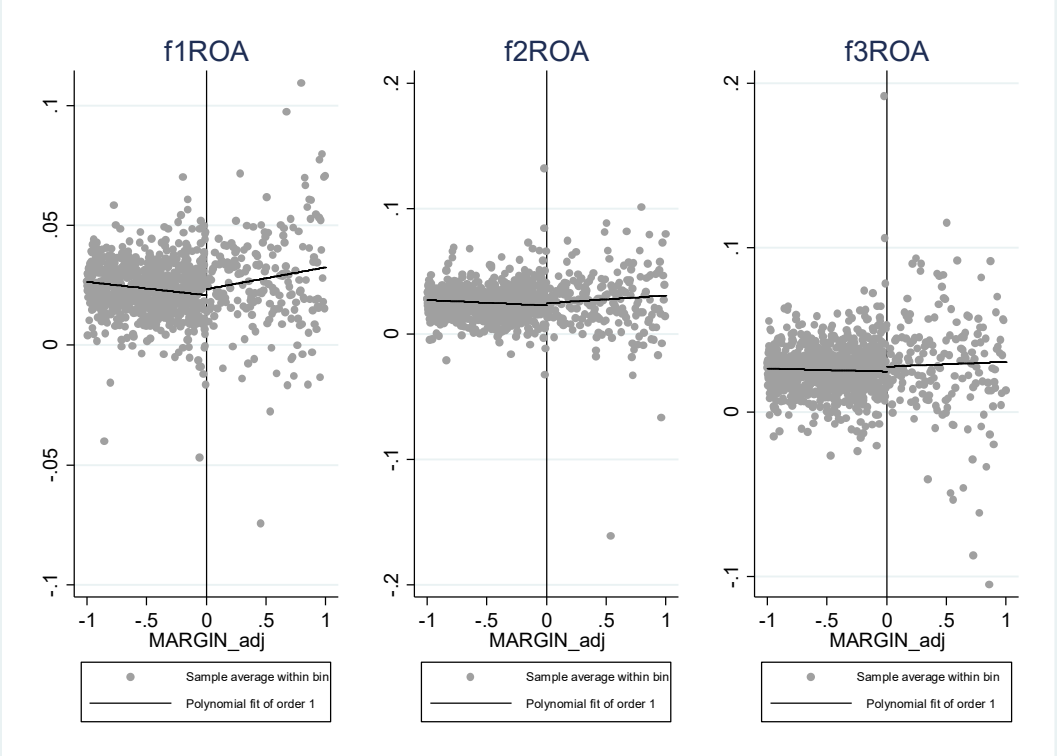


Figure 3 (continued)

(c) Sales growth



(d) ROA



Tables

Table 1: Definitions of variables

Variable names	Definitions
NONCOLL	Dummy for the use of non-collateralized loan extended by the JFC-SME. 1 if the firm obtains the non-collateralized loan and 0 otherwise.
ELAPSED_DAYS	Number of days between the date of a loan contract with JFC-SME and the date of the introduction of noncollateralized loans by JFC-SME, which is August 1, 2008. Numbers are negative when contract dates come before August 1, 2008.
I(ELAPSED_DAYS>=0)	Dummy for a loan contract after the introduction of noncollateralized loans. 1 if ELAPSED_DAYS is larger than or equal to zero, and 0 otherwise.
	Dummy after the institutional change on non-collateralized loans. 1 if the firm receives the loan from JFC-SME after August 2008 and 0 otherwise.
MARGIN	The ratio of collateralizable asset amount to the amount of loan. The variable is unity if the collateralizable asset amount equals to the loan amount. JFC-SME loan officers investigate collateralizable asset amount each borrower firm may pledge. The amount of assets already pledged for collateral for other loans is deducted from the collateralizable assets.
I(MARGIN>=1)	Dummy for the relative size of collateralizable asset amount to that of the loan amount. 1 if the variable being larger than or equal to one, which indicates that the asset value is no smaller than the loan amount, and 0 otherwise.
CREDITj(t+k)	Internal credit ratings develped and reported by JFC-SME loan officers, ranging from 1 (most creditworthy) to 12 (least creditworthy and bankrupt) in year t+k.
Possible BANKRUPTCY(t+k)	Dummy for the possible bankrupt status of a firm. 1 if the firm has fallen into the category of severe financial distress that is close to bankruptcy or worse (in terms of internal ratings, CREDIT is between 9 and 12) at least once between year t and year t+k and 0 if the firm reports their credit status for all the years between t and year t+k and has never fallen into the category of severe financial distress or worse.
d_lnSALES(t+k)	Difference in the log of sales amount between year t and t+k
ROA(t+k)	Ratio of business profit to total assets in year t+k
LEVERAGE	Ratio of sum of short- and long-term loans to total assets
TANGIBILITY	Ratio of tangible assets to total assets
lnAGE	Log of firm age
NUMBANK	Number of lenders for each firm including JFC-SME
INDj	Industry dummies: j = 1 (agriculture, fishery, and forestry), 2(construction), 3(manufacturing), 4(utilities, information technology, communications, transportation), 5(wholesale and retail), 6(finance and insurance), 7(real estate), 8(services)
REGIONj	Region dummies: j = 1(Hokkaido and Tohoku), 2(Kanto), 3(Hokuriku and Koshinetsu), 4(Tokai), 5(Kinki), 6(Chugoku), 7(Shikoku), 8(Kyushu and Okinawa)
YEARj	Year dummies: j = from 2003 to 2014

Table 2: Summary statistics for firms that obtain two loans before and after August 2008

Panel (a) Firms that obtain collateralized loans both before and after August 2008

	(1) From April 2007 to March 2008				(2) From August 2008 to March 2010				(1)+(2) Both periods				(2)-(1)			
	N	mean	median	std.	N	mean	median	std.	N	mean	median	std.	Diff.	SE		
Possible BANKRUPTCY t+1	3591	0.018	0	0.131	3588	0.023	0	0.149	7179	0.020	0	0.141	0.005	0.003321	1.599105	
t+2	3591	0.031	0	0.172	3588	0.045	0	0.208	7179	0.038	0	0.191	0.015	0.004504	3.223114	***
t+3	3591	0.051	0	0.220	3588	0.076	0	0.264	7179	0.063	0	0.243	0.025	0.005739	4.280911	***
LEVERAGE	3591	0.558	0.564	0.219	3588	0.581	0.585	0.231	7179	0.569	0.575	0.225	0.023	0.005316	4.351138	***
ROA	3591	0.029	0.023	0.051	3588	0.013	0.016	0.055	7179	0.021	0.019	0.054	-0.016	0.001255	-12.3971	***
lnSALES	3591	6.853	6.822	1.138	3588	6.783	6.736	1.160	7179	6.818	6.782	1.149	-0.070	0.027121	-2.5843	***
TANGIBILITY	3591	0.578	0.576	0.201	3588	0.588	0.591	0.201	7179	0.583	0.582	0.201	0.010	0.004745	2.129488	**
lnAGE	3591	3.880	3.951	0.574	3588	3.908	3.970	0.560	7179	3.894	3.951	0.567	0.028	0.013387	2.110749	**
NUMBANK	3589	3.388	4	0.847	3578	3.397	4	0.839	7167	3.392	4	0.843	0.008	0.019913	0.410834	
CREDIT=1	3591	0.162	0	0.368	3588	0.144	0	0.351	7179	0.153	0	0.360	-0.018	0.008488	-2.15118	**
CREDIT=2	3591	0.261	0	0.439	3588	0.300	0	0.458	7179	0.280	0	0.449	0.039	0.010593	3.704024	***
CREDIT=3	3591	0.270	0	0.444	3588	0.212	0	0.408	7179	0.241	0	0.428	-0.059	0.010071	-5.81707	***
CREDIT=4	3591	0.088	0	0.284	3588	0.098	0	0.298	7179	0.093	0	0.291	0.010	0.006866	1.471983	
CREDIT=5	3591	0.068	0	0.252	3588	0.081	0	0.273	7179	0.075	0	0.263	0.013	0.006204	2.07583	**
CREDIT=6	3591	0.128	0	0.334	3588	0.114	0	0.318	7179	0.121	0	0.326	-0.014	0.007702	-1.7953	*
CREDIT=7	3591	0.017	0	0.129	3588	0.044	0	0.205	7179	0.031	0	0.172	0.027	0.004048	6.68183	***
CREDIT=8	3591	0.004	0	0.062	3588	0.003	0	0.050	7179	0.003	0	0.057	-0.001	0.001334	-1.04221	
CREDIT=9	3591	0.002	0	0.044	3588	0.004	0	0.062	7179	0.003	0	0.054	0.002	0.001275	1.531523	

Panel (b) Firms that switch from collateralized to non-collateralized loans after August 2008

	(1) From April 2007 to March 2008				(2) From August 2008 to March 2010				(1)+(2) Both periods				(2)-(1)			
	N	mean	median	std.	N	mean	median	std.	N	mean	median	std.	Diff.	SE		
Possible BANKRUPTCY t+1	2269	0.015	0	0.120	2264	0.033	0	0.179	4533	0.024	0	0.153	0.019	0.004525	4.107065	***
t+2	2269	0.032	0	0.176	2264	0.067	0	0.250	4533	0.049	0	0.217	0.035	0.006422	5.376191	***
t+3	2269	0.057	0	0.232	2264	0.105	0	0.307	4533	0.081	0	0.273	0.048	0.008075	5.977465	***
LEVERAGE	2269	0.599	0.610	0.184	2264	0.631	0.633	0.192	4533	0.615	0.621	0.189	0.033	0.005582	5.826209	***
ROA	2269	0.031	0.025	0.044	2264	0.015	0.019	0.054	4533	0.023	0.022	0.050	-0.016	0.001464	-11.0906	***
lnSALES	2269	7.231	7.230	1.058	2264	7.156	7.147	1.077	4533	7.194	7.184	1.068	-0.075	0.031708	-2.36616	**
TANGIBILITY	2269	0.531	0.537	0.193	2264	0.540	0.546	0.194	4533	0.535	0.540	0.194	0.008	0.005754	1.45724	
lnAGE	2269	3.762	3.850	0.615	2264	3.802	3.871	0.578	4533	3.782	3.850	0.597	0.039	0.017716	2.214973	**
NUMBANK	2266	3.579	4	0.742	2260	3.611	4	0.711	4526	3.595	4	0.727	0.032	0.021596	1.464377	
CREDIT=1	2269	0.089	0	0.285	2264	0.064	0	0.245	4533	0.077	0	0.266	-0.025	0.0079	-3.2179	***
CREDIT=2	2269	0.253	0	0.435	2264	0.286	0	0.452	4533	0.269	0	0.444	0.033	0.013173	2.490204	**
CREDIT=3	2269	0.309	0	0.462	2264	0.249	0	0.433	4533	0.279	0	0.448	-0.059	0.013294	-4.46751	***
CREDIT=4	2269	0.129	0	0.335	2264	0.130	0	0.336	4533	0.129	0	0.336	0.001	0.009976	0.072867	
CREDIT=5	2269	0.102	0	0.303	2264	0.097	0	0.296	4533	0.099	0	0.299	-0.006	0.008893	-0.62031	
CREDIT=6	2269	0.100	0	0.300	2264	0.121	0	0.326	4533	0.111	0	0.314	0.021	0.009312	2.253173	**
CREDIT=7	2269	0.012	0	0.110	2264	0.041	0	0.199	4533	0.027	0	0.161	0.029	0.004773	6.021031	***
CREDIT=8	2269	0.004	0	0.063	2264	0.004	0	0.063	4533	0.004	0	0.063	0.000	0.001869	0.004709	
CREDIT=9	2269	0.001	0	0.036	2264	0.003	0	0.051	4533	0.002	0	0.045	0.001	0.001323	1.003821	

Table 3: Summary statistics for firms that obtain collateralized loans before and after the introduction of non-collateralized loans

	(1) From April 2008 to July 2008				(2) From August 2008 to March 2009				(1)+(2) All firms that obtain collateralized loans				(2)-(1)	
	N	mean	p50	sd	N	mean	p50	sd	N	mean	p50	sd	Diff.	
Possible BANKRUPTCY t+1	3315	0.047	0	0.212	7224	0.025	0	0.155	10539	0.032	0	0.175	-0.022	***
t+2	3315	0.071	0	0.257	7224	0.047	0	0.212	10539	0.055	0	0.227	-0.024	***
t+3	3315	0.104	0	0.306	7224	0.077	0	0.267	10539	0.086	0	0.280	-0.027	***
LEVERAGE	3315	0.612	0.615	0.265	7224	0.574	0.584	0.223	10539	0.586	0.594	0.238	-0.038	***
ROA	3315	0.013	0.016	0.067	7224	0.020	0.019	0.061	10539	0.017	0.018	0.063	0.007	***
lnSALES	3315	6.844	6.863	1.199	7224	6.984	7.016	1.207	10539	6.940	6.963	1.206	0.141	***
TANGIBILITY	3315	0.585	0.588	0.202	7224	0.570	0.570	0.201	10539	0.575	0.575	0.202	-0.014	***
lnAGE	3315	3.824	3.932	0.642	7224	3.814	3.932	0.659	10539	3.818	3.932	0.654	-0.010	
NUMBANK	3315	3.458	4	0.826	7224	3.453	4	0.830	10539	3.455	4	0.829	-0.005	
CREDIT	3315	3.614	3	1.982	7224	3.115	3	1.695	10539	3.272	3	1.805	-0.499	***

Table 4: Summary statistics for firms that obtain non-collateralized loans after their introduction

	(1) Without collateral margin				(2) With collateral margin				(1)+(2) All firms with non-collateralized loans				(2)-(1)	
	N	mean	p50	sd	N	mean	p50	sd	N	mean	p50	sd	Diff.	
Possible Bt+1	47331	0.019	0	0.137	3847	0.009	0	0.094	51178	0.018	0	0.134	-0.010	***
t+2	47331	0.036	0	0.185	3847	0.019	0	0.138	51178	0.034	0	0.182	-0.016	***
t+3	47331	0.048	0	0.214	3847	0.027	0	0.161	51178	0.046	0	0.210	-0.021	***
LEVERAGE	47331	0.584	0.597	0.236	3847	0.579	0.592	0.221	51178	0.584	0.597	0.235	-0.006	
ROA	47331	0.028	0.024	0.063	3847	0.031	0.023	0.052	51178	0.028	0.024	0.062	0.003	***
lnSALES	47331	6.956	6.970	1.174	3847	7.152	7.176	1.146	51178	6.971	6.986	1.174	0.196	***
TANGIBILITY	47331	0.489	0.492	0.225	3847	0.573	0.571	0.192	51178	0.495	0.499	0.223	0.084	***
lnAGE	47331	3.624	3.807	0.787	3847	3.811	3.932	0.662	51178	3.638	3.829	0.780	0.187	
NUMBANK	47331	3.544	4	0.787	3847	3.536	4	0.781	51178	3.543	4	0.786	-0.008	
CREDIT	47331	3.365	3	1.752	3847	2.624	2	1.474	51178	3.309	3	1.744	-0.741	***

Table 5: Regression results for Test MH

Panel(a)

Dependent variable: Δ Possible BANKRUPTCY

First period: 2007/4-2008/3, Second period: 2008/8-20103

	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Δ NONCOLL	0.019	0.005	***	0.023	0.005	***	0.027	0.006	***
Δ LEVERAGE	-0.012	0.027		-0.010	0.031		0.059	0.034	*
Δ ROA	-0.287	0.048	***	-0.207	0.055	***	-0.139	0.061	**
Δ lnSALES	-0.008	0.011		-0.025	0.013	**	-0.018	0.014	
Δ TANGIBILIT	0.004	0.033		0.043	0.038		-0.035	0.042	
Δ lnAGE	0.037	0.044		0.183	0.051	***	0.206	0.056	***
Constant	10.347	4.733	**	2.089	5.434		-10.717	5.976	*
Δ Credit Dumm	Yes			Yes			Yes		
Industry Dumm	No			No			No		
Fixed effects	Yes			Yes			Yes		
F-value	9.0			15.4			14.7		
NOB	11712			11712			11688		
R-squared	0.03			0.04			0.04		

Panel(b)

Dependent variable: Δ CREDIT

First period: 2007/4-2008/3, Second period: 2008/8-20103

	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Δ NONCOLL	0.268	0.041	***	-0.039	0.041		0.059	0.044	
Δ LEVERAGE	1.014	0.235	***	0.477	0.234	**	0.008	0.253	
Δ ROA	-5.462	0.421	***	-1.460	0.419	***	0.896	0.451	**
Δ lnSALES	-0.218	0.095	**	0.030	0.095		0.155	0.102	
Δ TANGIBILIT	0.693	0.291	**	0.294	0.288		-0.086	0.312	
Δ lnAGE	0.655	0.387	*	1.023	0.389	***	0.592	0.420	
Constant	23.611	41.274		-148.149	40.986	***	-196.682	44.207	***
Δ Credit Dumm	Yes			Yes			Yes		
Industry Dumm	No			No			No		
Fixed effects	Yes			Yes			Yes		
F-value	43.6			11.1			5.1		
NOB	11688			11635			11504		
R-squared	0.11			0.03			0.01		

Panel(c)

Dependent variable: Δ ROA

First period: 2007/4-2008/3, Second period: 2008/8-20103

	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Δ NONCOLL	-0.002	0.002		0.004	0.002	***	-0.001	0.001	
Δ LEVERAGE	0.033	0.010	***	0.032	0.009	***	0.042	0.008	***
Δ ROA	0.106	0.018	***	-0.308	0.016	***	-0.108	0.014	***
Δ lnSALES	-0.025	0.004	***	-0.011	0.004	***	0.007	0.003	**
Δ TANGIBILIT	-0.015	0.012		0.021	0.011	*	-0.015	0.010	
Δ lnAGE	-0.018	0.017		0.027	0.015	*	0.025	0.014	*
Constant	14.903	1.769	***	-2.873	1.576	*	-1.988	1.409	
Δ Credit Dumm	Yes			Yes			Yes		
Industry Dumm	No			No			No		
Fixed effects	Yes			Yes			Yes		
F-value	15.0			63.1			11.1		
NOB	11661			11585			11446		
R-squared	0.04			0.16			0.03		

Panel(d)

Dependent variable: Δ dlnSALES

First period: 2007/4-2008/3, Second period: 2008/8-20103

	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
Δ NONCOLL	-0.012	0.007	*	0.012	0.007	*	0.002	0.006	
Δ LEVERAGE	-0.245	0.040	***	0.017	0.039		0.025	0.037	
Δ ROA	0.355	0.071	***	-0.586	0.069	***	-0.317	0.065	***
Δ lnSALES	-0.892	0.016	***	-1.141	0.016	***	-0.940	0.015	***
Δ TANGIBILIT	-0.265	0.049	***	0.054	0.048		-0.086	0.045	*
Δ lnAGE	0.175	0.065	***	0.042	0.065		0.085	0.062	
Constant	170.471	6.979	***	32.991	6.808	***	-12.574	6.409	**
Δ Credit Dumm	Yes			Yes			Yes		
Industry Dumm	No			No			No		
Fixed effects	Yes			Yes			Yes		
F-value	227.7			517.2			402.7		
NOB	11661			11582			11442		
R-squared	0.40			0.61			0.55		

Table 6: Results for Test AS1 (1): Regression

Panel(a)

	Dependent variable: Possible BANKRUPTCY								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(Elapsed Days≧	-0.008	0.004	**	-0.003	0.005		0.000	0.006	
lnSALES	0.025	0.008	***	0.052	0.010	***	0.070	0.012	***
LEVERAGE	-0.236	0.027	***	-0.266	0.034	***	-0.324	0.042	***
ROA	-0.003	0.002	**	-0.009	0.002	***	-0.017	0.002	***
TANGIBILITY	-0.032	0.009	***	-0.067	0.011	***	-0.086	0.014	***
lnAGE	-0.016	0.003	***	-0.019	0.003	***	-0.020	0.004	***
NumBANK	0.006	0.002	***	0.009	0.003	***	0.014	0.003	***
CREDIT	0.024	0.001	***	0.033	0.001	***	0.042	0.002	***
Constant	0.030	0.016	*	0.068	0.020	***	0.106	0.025	***
Industry dummies	No			No			No		
F-value	134.7			161.1			178.5		
NOB	10539			10539			10539		
Adj. R-squared	0.0922			0.1084			0.1187		

Panel(b)

	Dependent variable: CREDIT								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(Elapsed Days≧	-0.005	0.030		0.016	0.037		0.027	0.042	
lnSALES	0.894	0.068	***	1.187	0.083	***	1.325	0.095	***
LEVERAGE	-3.642	0.230	***	-3.079	0.285	***	-3.263	0.326	***
ROA	-0.040	0.014	***	-0.121	0.017	***	-0.137	0.019	***
TANGIBILITY	-0.402	0.076	***	-0.681	0.092	***	-0.424	0.105	***
lnAGE	-0.081	0.022	***	-0.042	0.027		-0.018	0.031	
NumBANK	0.066	0.018	***	0.114	0.022	***	0.100	0.026	***
CREDIT	0.797	0.009	***	0.740	0.011	***	0.750	0.012	***
Constant	1.239	0.137	***	1.735	0.167	***	1.561	0.191	***
Industry dummies	No			No			No		
F-value	1617.8			992.5			794.7		
NOB	10488			10358			10200		
Adj. R-squared	0.5523			0.4337			0.3837		

Panel(c)

	Dependent variable: ROA								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(Elapsed Days≧	-0.002	0.001		0.003	0.001	**	-0.001	0.001	
lnSALES	-0.011	0.003	***	0.000	0.003		-0.003	0.003	
LEVERAGE	0.474	0.010	***	0.330	0.010	***	0.259	0.009	***
ROA	0.007	0.001	***	0.007	0.001	***	0.004	0.001	***
TANGIBILITY	0.037	0.003	***	0.028	0.003	***	0.006	0.003	**
lnAGE	0.001	0.001		-0.002	0.001	***	-0.006	0.001	***
NumBANK	0.001	0.001		0.002	0.001	**	0.002	0.001	***
CREDIT	0.002	0.000	***	-0.001	0.000	***	-0.001	0.000	***
Constant	-0.081	0.006	***	-0.051	0.006	***	-0.002	0.005	
Industry dummies	No			No			No		
F-value	350.3			210.3			137.5		
NOB	10441			10327			10179		
Adj. R-squared	0.2111			0.1395			0.0969		

Panel(d)

	Dependent variable: dlnSALES								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(Elapsed Days≧	-0.008	0.006		0.000	0.006		-0.003	0.007	
lnSALES	-0.037	0.013	***	0.011	0.015		0.001	0.017	
LEVERAGE	-0.252	0.044	***	-0.462	0.050	***	-0.307	0.058	***
ROA	-0.028	0.003	***	-0.018	0.003	***	-0.016	0.003	***
TANGIBILITY	0.099	0.014	***	0.110	0.016	***	0.086	0.018	***
lnAGE	-0.032	0.004	***	-0.045	0.005	***	-0.055	0.005	***
NumBANK	-0.004	0.003		-0.007	0.004	*	-0.011	0.004	**
CREDIT	0.010	0.002	***	-0.005	0.002	***	-0.011	0.002	***
Constant	0.121	0.026	***	0.140	0.029	***	0.233	0.034	***
Industry dummies	No			No			No		
F-value	63.6			55.8			39.8		
NOB	10442			10325			10178		
Adj. R-squared	0.0458			0.0407			0.0296		

Table 7: Results for Test AS1 (2): Regression discontinuity design

	Possible BANKRUPTCY			CREDIT		
	t+1	t+2	t+3	t+1	t+2	t+3
I(Elapsed Days≧0)	-0.001	0.007	0.008	-0.133	-0.064	0.036
p-value	0.923	0.335	0.341	0.092	0.453	0.626
Bandwidth	335.797	347.696	408.109	140.974	152.758	252.548
EFF.NOB (Left)	9625	9852	10820	4336	4831	7274
EFF.NOB (Right)	10301	10566	11814	4329	4525	7623
Total NOB	43112	43112	43112	42743	42050	41026

	ROA			dlnSALES		
	t+1	t+2	t+3	t+1	t+2	t+3
I(Elapsed Days≧0)	0.003	0.000	-0.003	-0.013	0.005	-0.004
p-value	0.393	0.877	0.197	0.429	0.809	0.774
Bandwidth	146.597	205.176	248.706	125.736	123.473	211.302
EFF.NOB (Left)	4753	5741	7216	3307	3262	5655
EFF.NOB (Right)	4507	5633	7184	3605	3502	5798
Total NOB	42551	41695	40732	42567	41708	40735

Table 8: Results for Test AS2 (1): Regression

Panel(a)

	Dependent variable: Possible BANKRUPTCY								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(MARGIN≧1)	0.000	0.002		-0.001	0.003		-0.004	0.003	
lnSALES	0.000	0.001		-0.002	0.001	***	-0.002	0.001	***
LEVERAGE	0.003	0.003		0.010	0.004	***	0.015	0.005	***
ROA	-0.184	0.010	***	-0.244	0.013	***	-0.267	0.015	***
TANGIBILITY	-0.006	0.003	*	-0.010	0.004	**	-0.014	0.005	***
lnAGE	-0.004	0.001	***	-0.005	0.001	***	-0.007	0.001	***
NumBANK	-0.001	0.001		0.000	0.001		-0.001	0.001	
CREDIT	0.012	0.000	***	0.018	0.001	***	0.021	0.001	***
Constant	0.027	0.032		0.016	0.044		0.011	0.050	
Industry dummi	Yes			Yes			Yes		
F-value	133.5			155.8			159.1		
NOB	51178			51178			51178		
Adj. R-squared	0.0374			0.0434			0.0443		

Panel(b)

	Dependent variable: CREDIT								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(MARGIN≧1)	-0.058	0.025	**	-0.087	0.035	**	-0.112	0.046	**
lnSALES	-0.010	0.007		-0.013	0.009		-0.004	0.012	
LEVERAGE	0.986	0.033	***	1.266	0.046	***	1.417	0.059	***
ROA	-3.040	0.110	***	-2.793	0.156	***	-1.919	0.204	***
TANGIBILITY	-0.413	0.034	***	-0.612	0.047	***	-0.671	0.062	***
lnAGE	-0.060	0.009	***	-0.090	0.013	***	-0.094	0.018	***
NumBANK	0.026	0.009	***	0.040	0.013	***	0.052	0.017	***
CREDIT	0.721	0.004	***	0.634	0.006	***	0.598	0.008	***
Constant	1.605	0.332	***	2.199	0.528	***	2.320	0.818	***
Industry dummi	Yes			Yes			Yes		
F-value	3210.1			1390.5			727.8		
NOB	43271			33465			23356		
Adj. R-squared	0.5266			0.3838			0.3182		

Panel(c)

	Dependent variable: ROA								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(MARGIN≧1)	-0.002	0.001		-0.002	0.001		-0.001	0.002	
lnSALES	0.003	0.000	***	0.003	0.000	***	0.003	0.000	***
LEVERAGE	0.012	0.001	***	0.011	0.002	***	0.017	0.002	***
ROA	0.485	0.005	***	0.316	0.006	***	0.245	0.007	***
TANGIBILITY	-0.007	0.001	***	-0.004	0.002	**	-0.001	0.002	
lnAGE	0.001	0.000	**	-0.002	0.000	***	-0.002	0.001	***
NumBANK	0.000	0.000		-0.001	0.000	*	-0.002	0.001	***
CREDIT	-0.002	0.000	***	-0.002	0.000	***	-0.002	0.000	***
Constant	-0.043	0.015	***	-0.031	0.019	*	0.046	0.030	
Industry dummi	Yes			Yes			Yes		
F-value	826.6			270.6			118.6		
NOB	40933			31207			20979		
Adj. R-squared	0.2323			0.1147			0.0776		

Panel(d)

	Dependent variable: dlnSALES								
	t+1			t+2			t+3		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
I(MARGIN≧1)	0.024	0.005	***	0.030	0.007	***	0.044	0.010	***
lnSALES	-0.024	0.001	***	-0.030	0.002	***	-0.035	0.003	***
LEVERAGE	-0.006	0.006		0.003	0.009		0.024	0.013	*
ROA	-0.256	0.021	***	-0.298	0.031	***	-0.205	0.046	***
TANGIBILITY	-0.043	0.006	***	-0.047	0.010	***	-0.040	0.014	***
lnAGE	-0.033	0.002	***	-0.056	0.003	***	-0.069	0.004	***
NumBANK	0.000	0.002		0.007	0.003	***	0.013	0.004	***
CREDIT	-0.002	0.001	***	-0.006	0.001	***	-0.010	0.002	***
Constant	0.404	0.066	***	0.891	0.104	***	0.975	0.196	***
Industry dummi	Yes			Yes			Yes		
F-value	100.0			94.5			64.9		
NOB	40937			31212			20975		
Adj. R-squared	0.035			0.043			0.0437		

Table 9: Results for Test AS2: Regression discontinuity design

	Possible BANKRUPTCY			CREDIT		
	t+1	t+2	t+3	t+1	t+2	t+3
I(MARGIN≧1)	-0.003	-0.003	-0.010	-0.155 **	0.118	0.159
p-value	0.539	0.69	0.375	0.045	0.232	0.266
Bandwidth	0.373	0.282	0.216	0.268	0.313	0.25
EFF.NOB (Left)	7192	5111	3664	4082	3863	2057
EFF.NOB (Right)	1867	1672	1490	1404	1202	791
Total NOB	47481	47481	47481	40004	30808	21343

	ROA			dlnSALES		
	t+1	t+2	t+3	t+1	t+2	t+3
I(MARGIN≧1)	-0.002	-0.005	-0.010 **	0.030 **	0.027	0.060 *
p-value	0.467	0.135	0.028	0.031	0.203	0.065
Bandwidth	0.222	0.235	0.203	0.357	0.281	0.278
EFF.NOB (Left)	3056	2539	1440	5499	3180	2121
EFF.NOB (Right)	1255	1012	661	1525	1095	747
Total NOB	37804	28700	19159	37808	28705	19155

Appendix A. Test for Asymmetric Information

Although the main contribution of this paper is to propose the three new tests to identify adverse selection and moral hazard, in this appendix we follow a coarser approach in the previous literature to test the existence of information asymmetry in general (with no identification between adverse selection and moral hazard). By applying the method proposed by Chiappori and Salanié (2000) that study the existence of asymmetric information in the French car insurance market, we examine whether the choice of collateralized loans is associated with ex post borrower performance, as both the ex post and the ex ante theories suggest.

A.1. Empirical approach

We estimate the following bivariate probit model.[25]

$$y_{it} = 1_y(X_{it}\beta + \varepsilon_{it}) \tag{1-1}$$

$$z_{it+k} = 1_z(X_{it}\gamma + \eta_{it}), \tag{1-2}$$

where y_{it} represents a dummy variable to indicate that firm *i*'s loan in year *t* is non-collateralized (*y*=1) or collateralized (*y*=0); z_{it+k} represents a dummy variable for firm *i*'s ex post performance in year *t*+*k* with *k* that takes the values of 1, 2, or 3; $1_x(\cdot)$ is a function that determines the probability that a dummy variable x takes the value of one; and the vector X_{it} represents firm *i*'s attributes in year *t*.[26] After estimating the two equations and obtaining the error terms, we test the null hypothesis of no correlation between the error terms, or $\mathrm{corr}(\varepsilon_{it}, \eta_{it}) = 0$. If the null hypothesis is rejected, we

[25] Chiappori and Salanie (2000) propose and estimate not only the bivariate parametric model but also non-parametric models for the conditional correlations. We do not report the results for such non-parametric tests in this appendix, but they are qualitatively the same as those for the bivariate model.

[26] When we use continuous variables for firm performance, z_{it+k}, we use a linear equation instead of the probit model equation,

infer that there is asymmetric information in the loan market.[27] Note that X_{it} should contain all the relevant information that the lender uses when it extends loans. In our context, we should include the information on the lender's internal credit ratings and other characteristics of borrowers that the JFC-SME uses for their loan screening.

As for the variables for ex post firm performance, z_{it+k}, we use two types of variables: those that measure a firm's credit risk, and those that measure financial performance. If moral hazard takes the form of inefficient managerial effort or asset substitution (a choice of risky project), or if adverse selection works, we should observe higher ex post risk and poorer ex post financial performance for borrowers of non-collateralized loans. However, it is theoretically possible in a setting of moral hazard that the risky project is more profitable than a safer one, and the asset substitution may result in higher risky but better financial performance.

A.2. Results

A.2.1. Sample description

Table A1 reports the summary statistics for the variables for the sample constructed for this test for asymmetric information. We have almost 177,000 observations in this sample. The average (mean) firm size as measured in logarithms are 7.029 in lnSALES and 7.076 in lnASSETS, which correspond to the sales and asset of JPY1.13 billion and JPY1.18 billion, respectively. The average age measured in logarithms is 3.859, which corresponds to 47 years. For the average firm, the leverage ratio (LEVERAGE) is 58.2%, the ratio of tangible assets is 55.3%, and ROA is 2.3%. The highest frequency for IND 3 among the industry dummies and REGION 2 among the regional dummies indicate that the number of observations is the largest for firms in the manufacturing industry, and located in the Kanto

[27] Theoretically, a one-sided test is more preferable, but we simply follow the convention in the field of insurance to conduct a two-sided test. However, we will check the direction of the correlation as well.

area (including Tokyo).

The most frequent internal credit rating is 2, i.e., the second best rating among the 12 grades. Regarding the ex post credit risk of firms, the ratios of firms that fall into the categories of possible, virtual, and actual bankruptcies (respectively Possible BANKRUPTCY, Virtual BANKRUPTCY, and BANKRUPTCY) between year t and t+1 are 0.021, 0.001, and 0.001. These ratios increase when we extend the time window to t+2 and t+3.

The table also reports the statistics when we split the sample into the subsamples of collateralized (almost 99,000 observations) and non-collateralized borrowers (almost 77,000 observations), together with the results for the differences in means of the variables between the two samples. We can see substantial differences between these samples. In terms of size and age, collateralized firms are smaller and older than non-collateralized ones. In terms of leverage, tangibility, and credit risk, collateralized firms are less leveraged, more endowed with tangible assets, and more creditworthy. Collateralized firms are more concentrated in manufacturing (IND3), and are less geographically concentrated in the Kanto area (REGION2).

When comparing ex post performance as a univariate analysis, we find that in terms of ex post credit risk, the collateralized firms tend to be less risky than non-collateralized ones, regardless of what variables to use and of what time period to take. These findings suggest that firms obtaining collateralized loans are less risky than those obtaining non-collateralized ones. Although this finding is consistent with the presence of asymmetric information, we need to conduct multivariate analysis to obtain more reliable results.

A.2.2. Multivariate Results

Table A2 shows the results for the conditional correlation test that we explained in Section 3.1. The correlation coefficients for each of the 18 estimations (6 dependent variables for 3 time periods)

are reported together with the results for the test of no correlation.

As for the results on credit risk, in each of the estimations using the four credit risk variables for the three different time windows, the conditional correlation coefficients are positive and are statistically different from zero. They are also substantially larger in size. These findings strongly support the existence of asymmetric information.

Turning to the results on financial performance, the results for sales growth (d_lnSALES) indicate that the conditional correlation coefficient is positive and statistically significant when we take the window from t to t+2 or t+3. These findings again suggest that the existence of asymmetric information becomes evident a few years after lending. As for the other financial performance variable, ROA, the correlation coefficient is marginally significant three years after the loan provision.

Overall, we find that not only the firms' credit risk but also their performance is significantly correlated with the use of non-collateralized loans. These findings are consistent with the presence of asymmetric information in the loan market.

A.3. Appendix Tables

Table A1: Summary statistics for firms that obtain loans (collateralized and non-collateralized) from JFC-SME after August 2008

		(a)+(b) All loans				(a) Collateralized loans				(b) Non-collateralized loans				(a)-(b)
		N	mean	median	std	N	mean	median	std	N	mean	median	std	diff
Possible BANKRUPTCY	t+1	150,908	0.021	0	0.144	86,132	0.018	0	0.132	64,776	0.025	0	0.157	-0.008***
	t+2	123,112	0.057	0	0.231	71,330	0.047	0	0.212	51,782	0.070	0	0.254	-0.022***
	t+3	94,632	0.107	0	0.309	56,348	0.089	0	0.284	38,284	0.134	0	0.340	-0.045***
Virtual BANKRUPTCY	t+1	147,935	0.001	0	0.037	84,669	0.001	0	0.029	63,266	0.002	0	0.046	-0.001***
	t+2	116,650	0.004	0	0.066	68,154	0.003	0	0.053	48,496	0.006	0	0.080	-0.004***
	t+3	85,296	0.009	0	0.095	51,677	0.006	0	0.078	33,619	0.014	0	0.116	-0.007***
BANKRUPTCY	t+1	147,844	0.001	0	0.028	84,641	0.001	0	0.023	63,203	0.001	0	0.033	-0.001***
	t+2	116,401	0.002	0	0.047	68,061	0.001	0	0.038	48,340	0.003	0	0.057	-0.002***
	t+3	84,907	0.005	0	0.067	51,520	0.003	0	0.056	33,387	0.007	0	0.082	-0.004***
lnSALES		176,941	7.029	7.032	1.097	99,445	6.967	6.973	1.132	77,496	7.109	7.102	1.045	-0.142***
LEVERAGE		176,949	0.582	0.598	0.200	99,451	0.562	0.574	0.208	77,498	0.607	0.624	0.186	-0.045***
ROA		176,949	0.023	0.02	0.044	99,451	0.021	0.019	0.044	77,498	0.025	0.022	0.044	-0.005***
lnASSETS		176,949	7.076	7.071	0.981	99,451	7.072	7.062	0.992	77,498	7.081	7.078	0.966	-0.009**
TANGIBILITY		176,949	0.553	0.555	0.197	99,451	0.576	0.577	0.192	77,498	0.523	0.526	0.201	0.053***
lnAGE		175,094	3.859	3.951	0.556	98,351	3.928	3.989	0.505	76,743	3.770	3.871	0.604	0.158***
LENDERS		149,428	5.470	6	1.083	83,987	5.387	6	1.067	65,441	5.576	6	1.094	-0.189***
LENGTH		176,949	16.831	20	5.693	99,451	17.909	20	4.852	77,498	15.448	18	6.356	2.461***
CREDIT1		176,891	0.140	0	0.347	99,414	0.171	0	0.376	77,477	0.100	0	0.300	0.071***
CREDIT2		176,891	0.290	0	0.454	99,414	0.303	0	0.460	77,477	0.274	0	0.446	0.029***
CREDIT3		176,891	0.234	0	0.423	99,414	0.217	0	0.412	77,477	0.255	0	0.436	-0.039***
CREDIT4		176,891	0.100	0	0.300	99,414	0.086	0	0.280	77,477	0.119	0	0.323	-0.033***
CREDIT5		176,891	0.068	0	0.252	99,414	0.065	0	0.246	77,477	0.073	0	0.261	-0.009***
CREDIT6		176,891	0.126	0	0.332	99,414	0.121	0	0.326	77,477	0.133	0	0.340	-0.013***
CREDIT7		176,891	0.039	0	0.194	99,414	0.037	0	0.188	77,477	0.042	0	0.201	-0.005***
CREDIT8		176,891	0.002	0	0.048	99,414	0.002	0	0.040	77,477	0.003	0	0.056	-0.002***
IND1		176,949	0.002	0	0.047	99,451	0.002	0	0.042	77,498	0.003	0	0.053	-0.001***
IND2		176,949	0.065	0	0.246	99,451	0.061	0	0.239	77,498	0.070	0	0.255	-0.009***
IND3		176,949	0.504	1	0.500	99,451	0.519	1	0.500	77,498	0.485	0	0.500	0.034***
IND4		176,949	0.085	0	0.279	99,451	0.080	0	0.271	77,498	0.091	0	0.288	-0.012***
IND5		176,949	0.205	0	0.404	99,451	0.202	0	0.401	77,498	0.209	0	0.407	-0.007***
IND6		176,949	0.000	0	0.016	99,451	0.000	0	0.008	77,498	0.000	0	0.022	-0.000***
IND7		176,949	0.034	0	0.182	99,451	0.032	0	0.175	77,498	0.037	0	0.190	-0.006***
IND8		176,949	0.047	0	0.212	99,451	0.043	0	0.202	77,498	0.053	0	0.225	-0.011***
REGION1		176,949	0.117	0	0.321	99,451	0.109	0	0.311	77,498	0.127	0	0.332	-0.018***
REGION2		176,949	0.331	0	0.471	99,451	0.324	0	0.468	77,498	0.341	0	0.474	-0.016***
REGION3		176,949	0.064	0	0.245	99,451	0.064	0	0.244	77,498	0.065	0	0.246	-0.001
REGION4		176,949	0.088	0	0.283	99,451	0.090	0	0.286	77,498	0.085	0	0.279	0.005***
REGION5		176,949	0.200	0	0.400	99,451	0.203	0	0.403	77,498	0.195	0	0.396	0.008***
REGION6		176,949	0.070	0	0.255	99,451	0.072	0	0.258	77,498	0.067	0	0.251	0.004***
REGION7		176,949	0.036	0	0.186	99,451	0.039	0	0.194	77,498	0.032	0	0.175	0.008***
REGION8		176,949	0.092	0	0.288	99,451	0.096	0	0.294	77,498	0.086	0	0.280	0.010***

Table A2: Conditional correlation between firm characteristics and use of non-collateralized loans

		Correlation coefficient	Chi2(1)	p-value	
Possible BANKRUPTCY	t+1	0.0375	9.479	0.0002	***
	t+2	0.0565	34.615	0	***
	t+3	0.0693	56.684	0	***
Virtual BANKRUPTCY	t+1	0.0922	6.372	0.0116	**
	t+2	0.0722	8.140	0.0043	***
	t+3	0.0480	4.601	0.0320	**
BANKRUPTCY	t+1	0.0946	4.111	0.0426	**
	t+2	0.0822	7.364	0.0067	***
	t+3	0.0537	3.403	0.0651	*
CREDIT	t+1	0.0196	45.414	0	***
	t+2	0.0295	84.846	0	***
	t+3	0.0341	86.000	0	***
d_lnSALES	t+1	0.0039	1.796	0.1802	
	t+2	0.0073	5.249	0.0220	**
	t+3	0.0086	5.496	0.0191	**
ROA	t+1	0.0045	2.452	0.1174	
	t+2	0.0033	1.061	0.3031	
	t+3	0.0067	3.279	0.0702	*

Note: The statistics to test conditional correlations are the Wald test statistics when we employ Possible BANKRUPTCY, Virtual BANKRUPTCY, and BANKRUPTCY for dependent variables and Breusch-Pagan test statistics of independence when we employ CREDIT, d_lnSALES, and ROA for dependent variables.

Appendix B. Model for Moral Hazard (Ex Post Theory): Hypothesis MH

In addition to the model of asset substitution that we present in Section 3.2, it is also common to demonstrate a problem of moral hazard using the model of costly effort exertion by borrowers. In this appendix, we formulate such a model, and demonstrate that we can also establish a similar testable hypothesis for moral hazard (Hypothesis MH in Section 3.2) based on this model.

Building on the baseline setting in Section 3.1., let us assume that after a borrower signs a lending contract and before the project return realizes, the borrower can exert costly effort to increase the probability of success. Suppose that $\overline{p}$ is the success probability when a borrower exerts effort, but the effort produces disutility e in a monetary term to the borrower. When a borrower does not exert effort, there is no disutility but the success probability decreases to $\underline{p}$ ($< \overline{p}$). To focus on relevant cases where the analysis is meaningful, we assume that $\overline{p}R-1-e>0$, i.e., the net present value of the investment project is positive when a borrower efforts effort, and that $\overline{p}R-1-e>\underline{p}R-1$, i.e., it is more efficient to exert effort than not to do so. We introduce informational asymmetry by assuming that whether or not a borrower exerts effort is not observable to lenders. Due to this asymmetry, no contract can be contingent on whether the effort is exerted or not, and we can focus on the collateralized and non-collateralized loan contracts explained above.

In this setting, we examine the effort choice by a borrower. If a borrower chooses a non-collateralized loan, the incentive compatibility condition for the borrower to exert effort is $\overline{p}(R-t)-e \geq \underline{p}(R-t)$, or

$$t \leq R-\frac{e}{\overline{p}-\underline{p}}.$$

However, to satisfy the lender's participation constraint, t must be large enough. If we denote by $\underline{t}$ the minimum value of t that satisfies the participation constraint, no equilibrium with effort exertion exists if $R-e/(\overline{p}-\underline{p})<\underline{t}$. This is the case where the problem of moral hazard takes place in this model.

In contrast, the incentive compatibility condition for the borrower to exert effort in the case of a collateralized loan is $\overline{p}(R-s)-(1-\overline{p})C-e \geq \underline{p}(R-s)-(1-\underline{p})C$, or

$$s \leq R + C - \frac{e}{\overline{p}-\underline{p}}.$$

Thus, even if there is no equilibrium with effort exertion in the case of a non-collateralized loan (or $R-e/(\overline{p}-\underline{p}) < \underline{t}$), such an equilibrium exits if C is set to satisfy $\underline{t} \leq R + C - e/(\overline{p}-\underline{p})$.[28] Thus, under some parameter settings, collateralized loans can provide greater incentives for borrowers to exert more effort. We can thus establish the following testable hypothesis.

Hypothesis MH': The ex post performance of firms borrowing collateralized loans is better than that of firms borrowing non-collateralized loans.

[28] The borrower's participation constraint also needs to be satisfied, although we abstract it for expositional simplicity.