Program for Promoting Social Science Research

Aimed at Solutions of Near-Future Problems

Design of Interfirm Network to Achieve Sustainable Economic Growth

Working Paper Series No.19

A Close Look at Loan-To-Value Ratios: Evidence from the Japanese Real Estate Market

Arito Ono
Hirofumi Uchida
Gregory Udell
and
Iichiro Uesugi

This version: February 2013

Research Center for Interfirm Network
Institute of Economic Research, Hitotsubashi University
Naka 2-1, Kunitachi-city, Tokyo 186-8603, JAPAN
Tel: +81-42-580-9145
E-mail: hit-tdb-sec@ier.hit-u.ac.jp
http://www.ier.hit-u.ac.jp/ifn/

A Close Look at Loan-To-Value Ratios: Evidence from the Japanese Real Estate Market[†]

Arito Ono
Mizuho Research Institute

Hirofumi Uchida[‡]
Graduate School of Business Administration, Kobe University

Gregory Udell
Kelley School of Business, Indiana University

and

Iichiro Uesugi
Institute of Economic Research, Hitotsubashi University

This version: February 2013

[†] This study is a product of the project "Design of Interfirm Networks to Achieve Sustainable Economic Growth" under the program for Promoting Social Science Research Aimed at Solutions of Near-Future Problems conducted by the Japan Society for the Promotion of Science (JSPS) and the Study Group on Financial and Inter-firm Networks at the Research Institute of Economy, Trade, and Industry (RIETI). Earlier versions of this paper have been presented at the HIT-TDB-RIETI international workshop. The authors thank Yukihiro Yasuda and Yuki Teranishi for useful comments. The authors are also grateful to Chihiro Shimizu and Yumi Saita for providing land price data, Makoto Hazama, Takaya Kimiwada, Wakana Toyama, Sohei Mizohata, Kana Matsuda, and Charee Kwak for superb research assistance, and Teikoku Databank, Ltd. for data provision. H. Uchida thanks the Grant-in-Aid for Scientific Research (B, #24330103) from JSPS for financial support. The views expressed in this paper are ours and do not necessarily reflect those of any of the institutions with which we are affiliated.
[‡] Graduate School of Business Administration, Kobe University, 2-1 Rokkodai, Nada, Kobe 657-8510, Japan. Tel.&Fax.: 81-78-803-6949, E-mail: uchida@b.kobe-u.ac.jp.

A Close Look at Loan-To-Value Ratios: Evidence from the Japanese Real Estate Market

Abstract

Using a unique micro dataset compiled from official real estate registries in Japan, we examine the evolution of loan-to-value (LTV) ratios for business loans over the 1975 to 2009 period, the determinants of these ratios, and the ex post performance of the borrowers. We find that the LTV ratio exhibits counter-cyclicality, implying that the increase (decrease) in loan volumes is smaller than the increase (decrease) in land values during booms (busts). Most importantly, the median LTV ratios are at their lowest during the bubble period in the late 1980s and early 1990s. The counter-cyclicality of LTV ratios is robust to controlling for various characteristics of loans, borrowers, and lenders. We also find that borrowers that obtained high-LTV loans performed no worse ex-post than those with low-LTV loans, and performed better during the bubble period. These findings cast doubt on the conventional wisdom that banks adopted more lax lending standards during the bubble period, although we have other evidence in support of that story. We also draw some implications for the ongoing debate on the use of LTV ratio caps as a macroprudential policy measure.

Keywords: loan-to-value (LTV) ratios, pro-cyclicality, bubble

JEL classification codes: G21, G32, R33

1. Introduction

The recent financial crisis with its epicenter in the U.S. followed on the heels of a disastrous financial crisis in the world's second largest economy, Japan, less than a decade before. It is probably not an exaggeration to argue that these crises shattered the illusion that the Basel framework – specifically Basel I and Basel II – had ushered in a new era of financial stability. Following the Japanese crisis the search began for policy tools that would reduce the probability of future crises and minimize the damage when they occur. Consensus began to build in favor of countercyclical macro-prudential policy levers (e.g., Kashyap and Stein 2004). For example, there was great interest and optimism associated with the introduction by the Bank of Spain of dynamic loan loss provisioning in 2000. Also, Basel III adopted a countercyclical capital buffer to be implemented when regulators sensed that credit growth has become excessive.

More recently, however, doubt has emerged about these tools. Not only did dynamic loan loss provisioning fail to prevent the Spanish banking crisis, new evidence suggests that it may have promoted risk-taking (Illueca, Norden and Udell 2012). Likewise, doubts about capital requirements in general as a macro-prudential tool to smooth credit fluctuations have also been raised in light of "leaks" in the banking system including the existence of shadow banking (Aiyar, Calomiris and Wieladek 2012, Kim and Mangla 2013). In this paper we focus on another macro-prudential policy lever that has received a great deal of attention recently – the LTV (loan-to-value) ratio.

An important common feature of the financial crises in the Japan and the U.S. was their reflection of the historical pattern that credit booms and busts are often accompanied by surges in real estate prices. It is often claimed that these surges invite excessive risk-taking based on lax bank lending standards including in real estate lending (e.g., Borio et al., 2001; Horvath, 2002; Borio and Lowe, 2002: Berger and Udell 2004). Loan-to-value (LTV) ratios, i.e., the ratio of the amount of a loan to the value of assets pledged as collateral, are typically used to measure the amount of this sort of bank behavior, because these ratios represent lenders' risk exposure. LTV ratios play an important role in the mechanism of the amplification of shocks to borrowers within an economy, and might also amplify the effect of income shocks on the housing market (Stein 1995).[1] For example, using a country-level panel dataset, IMF (2011) and Almeida, Campello, and Liu (2006) find that the effects of income shocks on house prices and/or mortgage borrowing are larger in countries and in periods where LTV ratios are higher. These studies indicate that the strength of a "financial accelerator" mechanism is positively associated with LTV ratios.

In the policy arena, efforts are underway to construct an effective framework to deal with excessively risky secured loans, and/or to block the banking sector's amplification of shocks to the market and/or the economy. Restrictions (caps) on LTV ratios are one proposed measure for macroprudential policy (see, for instance, FSB 2012).[2] In fact, restrictions on LTV ratios have already been applied in a number of countries to tame real estate booms and busts.[3]

Although the current debate on LTV caps is centered around residential mortgages, there is much to be learned by studying the LTV ratios of firms. Using real estate as collateral is also common for business loans, often articulated as a "fixed-asset lending" technology in the literature on bank lending (Berger and Udell 2006). Excessive bank risk-taking through secured business loans is considered one of the primary causes of the credit bubbles and the bad loan problems in Japan during the late 1980s through the 1990s (e.g., Ueda 2000). As is the case in U.S. SME lending, using real estate as collateral for business loans has long been a common practice in Japan. During the bubble period, banks were

[1] Some studies, including Stein (1995), focus on down-payment ratios, which are the inverse of LTV ratios.

[2] FSB (2012) states that "(f)rom an historical perspective, high-LTV ratio loans consistently perform worse than those with a high proportion of initial equity. While it is common for individual lenders to apply a cap on LTV ratios, it is not necessary for regulators and supervisors to mandate such a cap if they satisfy themselves that the underwriting standards are sufficiently prudent and are unlikely to be eroded under competitive pressure. However, jurisdictions may consider imposing or incentivising limits on LTV ratios according to specific national circumstances."

[3] According to a survey conducted by the IMF in 2010, 20 out of 49 countries, especially those in Asia (Hong Kong, Korea, Singapore, etc.) and Europe (Norway, Sweden, etc.), use caps on LTV ratios as macroprudential instruments (Crowe, et al. 2011, Lim, et al. 2011). Some countries do not impose such "hard limits" on LTV ratios, but try to incentivize LTV limits by offering lower capital charges to loans with lower LTV ratios (FSB 2011).

thought to have underwritten business loans with lax lending standards, in anticipation of further surges in real estate prices. Thus, it is an interesting thought experiment to ask whether a cap on the LTV ratio could have curbed banks' excessive risk-taking and the appreciation of land prices during the bubble period in Japan. The answer to this question will have important implications both for policy and for industry practice.

To the best of our knowledge, empirical evidence on LTV ratios, especially for business loans, is sparse. We are not aware of any studies using disaggregated data to examine how actual LTV ratios evolve throughout the business or credit cycle; it is unclear even whether the LTV ratio is procyclical. No studies have directly examined the anecdotes that banks in Japan actually set higher LTV ratios and took excessive risk during the bubble period. It is therefore impossible to infer whether a cap on LTV ratios could have constrained banks' risk taking and thus weakened the vicious cycle between real estate prices and bank lending. Also, LTV ratios are likely to depend on a number of factors. Without understanding what determines the observed LTV ratios, it will be difficult to know whether regulators should impose caps on LTV ratios as a means of macroprudential policy, because there is the possibility that doing so might restrict the availability of credit for creditworthy borrowers.[4]

The aim of this paper is to answer these questions by presenting various empirical facts regarding LTV ratios. We examine the evolution of LTV ratios, their determinants, and the ex post performance of borrowers, using unique loan-level data obtained from Japan's official real estate registry. The data include detailed information on over 400,000 secured mortgages for business loans established from 1975 to 2009. Of particular importance is the availability of information for the amount of loans and the identity of land pledged as collateral. Following a widely used approach in the field of real estate economics, we obtain the land values by estimating a hedonic model, and use these together with the

[4] There are some studies that have examined the relationship between *aggregate* lending and property prices and the implications of imposing an LTV cap (e.g., Gerlach and Peng 2005, Iacoviello 2005, Igan and Kang 2011).

amount of loans secured by the relevant land to calculate the LTV ratios. Using these ratios, we investigate their cyclicality, their determinants, and the relationship between these ratios and the ex-post performance of borrowers. Despite the richness of this data set, there are some shortcomings in our data. The most important of these is that the mortgages registered from 1975 to 2009 in our data set are still registered in 2008 or afterwards. This might create survival bias in our analysis. However, we also have rich information regarding loan, firm, and lender characteristics, which allows us to deal with such problems and to make the best use of our data.

Our main findings are twofold. First, from the analysis on the evolution of the LTV ratio throughout the sample period, we find that the LTV ratio exhibits counter-cyclicality. This finding is especially intriguing because both the numerator (the amount of loans) and the denominator (the value of lands pledged as collateral) exhibit *pro*-cyclicality. The counter-cyclicality of the LTV ratio is also robust to controlling for various loan-, borrower-, and lender characteristics, and to controlling for survival bias.

Second, our analysis of the relationship between LTV ratios and ex post performance of borrowers yields another intriguing finding. Comparing the difference in differences of the ex post performance of borrowing firms that obtained high LTV loans with those that obtained low LTV loans, we find that the performance of high LTV borrowers are not poor on average. Rather, their performance was better than that of low LTV borrowers during the bubble period.

Conventional wisdom claims that during the bubble Japanese banks employed lax lending standards in underwriting loans, which resulted in the bad loan problems. Our findings above urge some caution for this simplistic story. However, we also find some evidence that might be consistent with the conventional wisdom. For example, we find that some marginal lenders (i.e., those for which the LTV ratios are high and encountered a surge in the price of land pledged as collateral) extended larger loans in absolute terms at the peak of the bubble period. Also, we find that the share of junior lien loans increased during the bubble period. These findings suggest that lenders might have extended loans under more lax standards during the bubble. Taken together, our findings call for the need for a more nuanced view of bank behavior during the bubble period in Japan, and in credit booms in general.

Our findings have important policy implications. Caps on the LTV ratios are a hot topic of debate in the policy arena, with proponents arguing that curbing high LTV ratio loans will enable us to reduce bank risk and dampen the financial amplification of economic shocks. Our findings do not support this view. First, a simple cap on the LTV ratio is unlikely to impose a binding constraint on bank lending during the boom period, because the LTV ratio exhibits counter-cyclicality. This finding is consistent with one of the conclusions in Goodhart et al. (2012)'s theoretical study, which indicates that LTV ratio caps might be ineffective in boom periods because of large increases in asset prices.[5] Second, the ex post performance of firms with high LTV loans was not poor, and was in fact better during the bubble period. Had there been a cap on the LTV ratio during the bubble period in Japan, such firms could not have been able to obtain financing.

The reminder of this paper is composed as follows. The next section details our data. Section 3 analyzes the LTV ratio and its determinants. In this section we report the changes in the LTV ratio, and conduct univariate and multivariate analyses for the determinants of the ratio. In section 4, we investigate ex post performance of the loans with high versus low LTV ratios. Section 5 concludes the paper with a discussion of the policy implications of our findings.

[5] Goodhart et al. (2012) construct a general equilibrium model and calibrate the effects of different macroprudential policy measures on credit expansion and house prices. Regarding the cap on the LTV ratio, they conclude that "it is difficult to impose higher loan to value requirements [...] enough to slow down credit expansion (and house price appreciation)" because "the boom brings large increases in asset prices," "[t]he high prices deliver capital gains to all the existing owners of the assets," and "[t]he gains to current mortgage holders [...] lower the loan to value ratio on their mortgages" (all citations are from p.42 of Goodhart et al. 2012).

2. Data and the definition of LTV ratios

2.1. Data

Our dataset is constructed from the database on nearly 400,000 Japanese firms, compiled by the Teikoku Databank (TDB), the largest credit information provider in Japan. For its sample of firms, the TDB database contains extremely detailed information on mortgage registrations that were established from 1975 to 2009. TDB obtained this information from the official real estate registry. For a particular real property, the TDB database provides its address, acreage, type of district (i.e., residential, commercial, and industrial) that the real property is located in, and its ownership. Most importantly for our analysis, we have detailed information about mortgages.

Mortgage information includes its type (i.e., revolving or non-revolving), the date of transfer of its ownership, the mortgagee(s), the debtor(s), and the amount of loans (or the maximum amount in case of revolving mortgages). Unfortunately, however, the TDB database does not contain information on the seniority among multiple mortgagees (i.e., first lien, second lien, and so on). Thus, following a common practice, we assume in our analysis that a mortgagee is senior to other mortgagees if the date of its registry predates those of the others. If there are several loans with the same registry date, we assume that they have the same priority.

As noted above, we focus on the LTV ratios of business loans. Because the TDB database does not specify whether the relevant mortgages are those for business loans or for the CEOs' (i.e., the firm's owner's) residential loans, we distinguish them based on the following criteria. First, we classify all the revolving mortgages as business loans, because revolving mortgages are usually not used for residential loans.[6] Second, loans are also classified as business loans if their debtors are firms (not their CEOs). Third, if the debtor(s) are the CEOs or individual board members of a firm, we then

[6] See section 3.2.1 for a detailed account on revolving mortgages.

check whether the firm uses these personal properties as collateral.[7] If this is the case, we classify them as business loans. Finally, if debtor(s) are neither firms, CEOs, nor board members, we exclude the observation from the sample because it is difficult to determine whether the relevant loan is a business or a residential one. As a result, the number of observations on the LTV ratio for business loans is 443,379, and the number for residential loans is 37,798. For the rest of this paper, we focus only on business loans.[8]

Although the rich information on real estate registries in the TDB database is unprecedented in the literature, there are several caveats in using these data stemming from their sample selection. First, our sample firms are mostly small and medium-sized enterprises (SMEs), because SMEs are the target for TDB's credit research on real estate registries.[9]

Second, TDB's database does not cover all the real estate that a firm (and its CEO) possesses. In principle, TDB always obtains registries on a firm's headquarter and the CEO's residential real estate, but TDB's data on the other real estate that the firm or its CEO possesses is generated on demand only. Note that the personal real property of the CEOs is often pledged as collateral for business loans to CEO's SME. This highlights the fact that SME loans in Japan (and elsewhere in the world can – and routinely are – collateralized by both business assets ("inside collateral") and personal assets ("outside collateral").

Third, and most importantly, although we have data on mortgages that were registered from 1975 to 2009, but only if they appear in the most recent credit report that TDB compiled during the period

---

[7] As discussed below, CEOs' personal real properties are often pledged as collateral for business loans to SMEs. Hence, other than the information obtained from the real estate registry, the TDB researches what types of assets a firm pledges to its creditors, including a CEO's personal real estate.

[8] The evolution of LTV ratios for residential loans is discussed in the Appendix B.

[9] Although the TDB's research on real estate registries is mandatory for SMEs, for listed and/or large firms (those with the amount of capital larger than 100 million yen (roughly $1.25 million) and with the number of employees larger than 100), the research is conducted based upon requests of customers (i.e., those who need such information).

from 2008 to 2010.[10] To put it differently, all the registrations in our sample consist of those that existed from 2008 to 2010, and so those registered before 2007 are included only when they *remain* registered in 2008 or afterwards.[11] Thus, in a sense our dataset is cross-section like.[12]

The cross-section like nature of our data creates two shortcomings to our analysis. First, we cannot exploit data variation in time series dimensions to control for loan, borrower, or lender fixed effects in our analysis. Second, we might suffer from the problem of survival bias in a sense that "bad" firms that already went bankrupt and liquidated before 2008 are not included in our dataset. In the regression analysis below, we try to address this problem by controlling for as many firm- and loan-characteristics as possible. A bias might also appear *among* our sample firms, depending on when the registrations were made. Because older firms have survived longer, they are likely more creditworthy than those with younger registration dates. In order to circumvent this problem, we control for firm age at the time of registration.

As explained above, we have 443,379 secured mortgages that were registered during the period from 1975 to 2009. For the 288,472 of them that were registered from 1981 through 2009, we also have information about basic characteristics of the borrowing firms, e.g., the number of employees, their industry, location, and the identity of mortgagees they transact with. For a subset of such firms (73,454 firms), we also have their financial statement information. For a further subset of these firms, we can even link to the financial variables of their lenders (mortgagees). We note, however, that these variables are only available for depository financial institutions.[13]

---

[10] We do have some observations for mortgages that were registered before 1975 and after 2009, but we do not use them because of the small number of observations.
[11] A mortgage made in 1999, for example, would be removed from the registry if the loan was paid off and the security interest in the property was terminated as a result. Likewise a bankrupt firm would be removed.
[12] In cases where the TDB conducted credit searches on a firm for several times during the period from 2008 to 2010, we only employ the most recent one because no information to identify each land is available and so we cannot construct a panel data set.
[13] We obtained data of financial statements for depository financial institutions from the Nikkei Financial Quest for commercial banks, and from Kin-yu Tosho Consultant Inc. for Shinkin banks.

2.2. Definition of LTV ratios

LTV ratios are defined as the ratio of the amount of a loan, either being extended or committed, to the current value of real estate being pledged as collateral. It represents the exposure of each lender, because if the value (V) decreases by 1-LTV percent, then the lender may suffer a loss given default if the debtor has a negative equity position. To calculate the LTV ratio, the information about its numerator (L) is available from the TDB database as already explained above. We thus need information about V, the denominator. To obtain land values, we follow an approach that is widely used in the field of real estate economics and estimate a hedonic model. Because the estimation procedure is complex, we defer its details to Appendix A. We calculate an *origination LTV ratio,* i.e., the LTV ratios based L and V *at the time of loan origination*. We calculate the LTV ratio at origination for two reasons. First, from a bank management point of view this is the LTV ratio that is relevant to the loan underwriting decision. Second, the policy debate principally relates to LTV caps imposed at the time of origination.

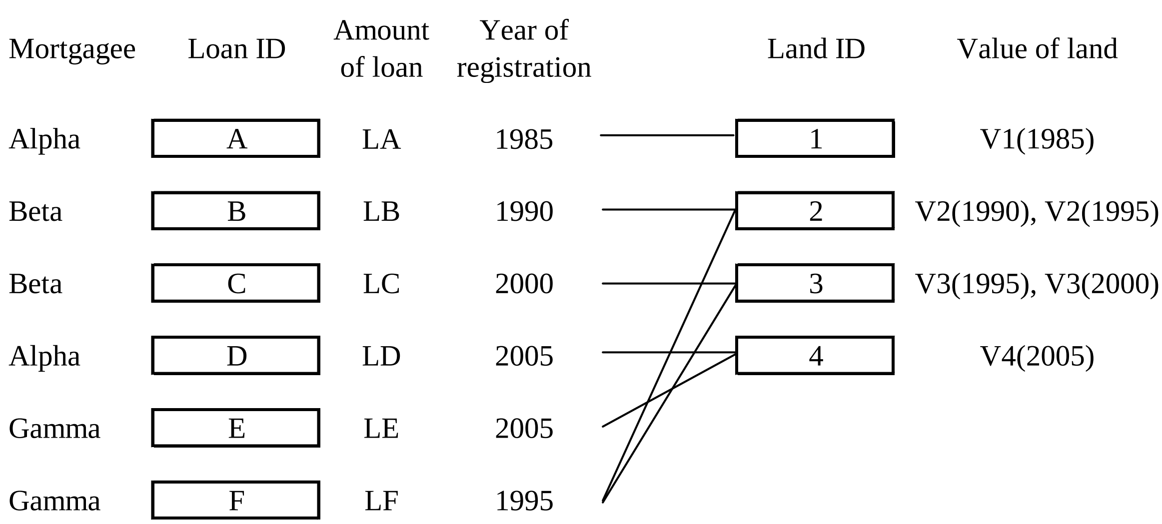
Note that buildings as well as land are commonly pledged as collateral in Japan. However, we have no information on the value of building. Thus, below we focus on the land value only. Note that this does not likely create a serious problem, because in practice bankers in Japan put smaller emphasis on the value of buildings than lands when taking collateral. This is because in Japan, the value of buildings rapidly depreciates in a few years, presumably because the market for used building is not very liquid, and their durable years are far shorter than those in Europe or the U.S.[14]

The calculation of the LTV ratio is complicated when many loans and many lenders with different levels of priority are involved. Thus, we explain how we calculate the LTV ratio by illustration (Figure 1). Suppose that a firm owns four pieces of real estate (numbered from 1 to 4), and borrows using six

[14] For instance, Bank of Japan (2012) shows that the depreciation rate of structures per annum for a single-family detached house with land is 11.4 percent (based on the National Survey of Family Income and Expenditure), while land prices decline by 3.4 percent per annum on average during the last 20 years).

loans, two from Bank Alpha, two from Bank Beta, and two from Bank Gamma. The firm pledges its properties as collateral to these banks: Land 1 is mortgaged to loan A extended by Bank Alpha in year 1985; land 2 is mortgaged to loan B extended by Beta in 1990 and is also mortgaged to loan F extended by Gamma in 1995; land 3 is mortgaged to loan C extended by Beta in 2000 and is also mortgaged to loan F by Gamma in 1995; and land 4 is mortgaged to loan D extended by Alpha and is also mortgaged to loan E extended by Gamma, and both mortgages are registered on the same date in 2005.

Figure 1 Illustrative setting for LTV calculation



Calculation is fairly simple if a land is pledged to only one mortgagee. In the example above, this is the case for loan A. Information about the amount of loan A, represented by LA, is provided by TDB database. The value of land A in year 1985, V1(1985), is estimated by the hedonic approach described in Appendix A. The LTV ratio for loan A (LTV_A(1985)) is simply obtained by dividing LA by V1(1985).

If a piece of land is pledged to multiple mortgagees (and loans) and/or if multiple pieces of land are pledged to one mortgagee, the calculation of the LTV ratio becomes complicated. The calculation differs depending on the seniority among different loans. As noted above, we assume that a mortgagee is senior to other mortgagees if the date of its registration predates those of the others. In the example above, land 2 is pledged to loan B as well as to loan F. Because loan B (originated in year 1990) was extended prior to loan F (in year 1995), we assume that loan B is senior to loan F. The LTV ratio of loan B is calculated in the same manner as in the case with one mortgagee: LTV_B(1990)=LB/V2(1990).

The calculation also differs for junior loans. In this example, land 3 is pledged to loan C as well as to loan F, and the former (underwritten in year 2000 by Beta) is subordinated to the latter (underwritten in year 1995 by Gamma). In this case, the amount of the senior loan (loan F) should be taken into account when calculating the LTV ratio for loan C. That is, the LTV ratio that properly expresses the exposure defined above for Bank Beta is LTV_C(2000)=(LF+LC)/V2(1995). The calculation is similar if there are several loans with the same registration date, in which case we assume that they have the same rank of priority. In the example above, land 4 is pledged to loan D and loan E that are extended respectively by Alpha and Gamma on the same date. In this case, LTV_D(2005)=LTV_E(2005)=(LD+LE)/V4(2005).

The most complicated is the LTV ratio for a loan with multiple mortgaged properties. In our example, Loan F extended by Gamma is backed by two mortgaged properties, land 2 and land 3. As for land 2, Gamma is junior to Beta, whereas for land 3, it is the most senior lender. In this case, we cannot define the LTV ratio in a suitable manner, because the ratio cannot be conceptualized in terms of bank exposure in this a situation. Thus, we decided to eliminate such observations from the sample of our empirical analysis. The number of observations eliminated in this manner is, however, small. Also note that the LTV ratio of a loan with multiple mortgaged properties can be well defined as long as the rank of seniority is the same among all mortgaged properties. For example, if loan F were a senior loan for both land 2 and land 3, then LTV_F(1995) = LF/(V2(1995)+V3(1995)). In a similar vein, if instead loan F were junior, then LTV_F(1995) = (LB+LC+LF)/ (V2(1995)+V3(1995)).

3. LTV ratio and its determinants

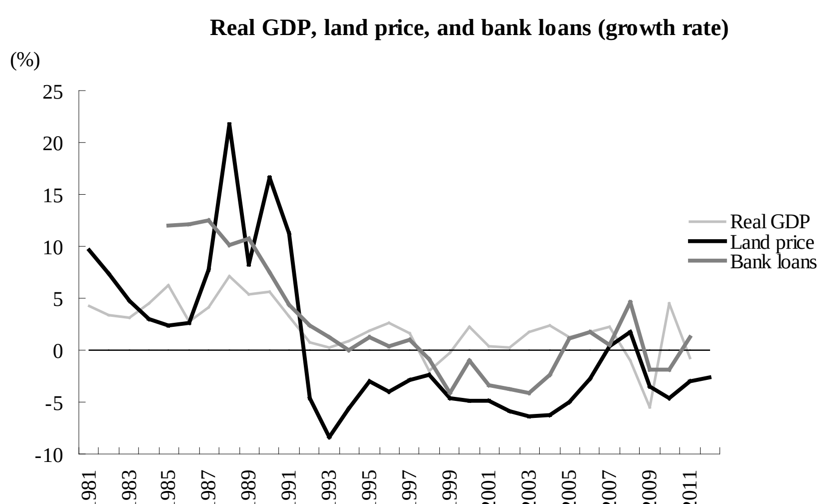
In this section, we examine the changes in the LTV ratios defined above and their determinants, with particular emphasis on whether the ratios exhibit pro-cyclicality. Below, we first report the changes in the LTV ratios over the business cycle in section 3.1, after providing some background information for the business fluctuation in Japan and the bubble in land prices. Section 3.2 and 3.3 examine factors that drive the changes in the LTV ratios. In section 3.2, we report the results for various univariate analyses that compare the LTV ratios with different factors that might affect them including loan characteristics, borrower characteristics, and lender (mortgagee) characteristics. In section 3.3 we conduct a multivariate analysis running a regression of the LTV ratios with various variables used in section 3.2 as independent variables.

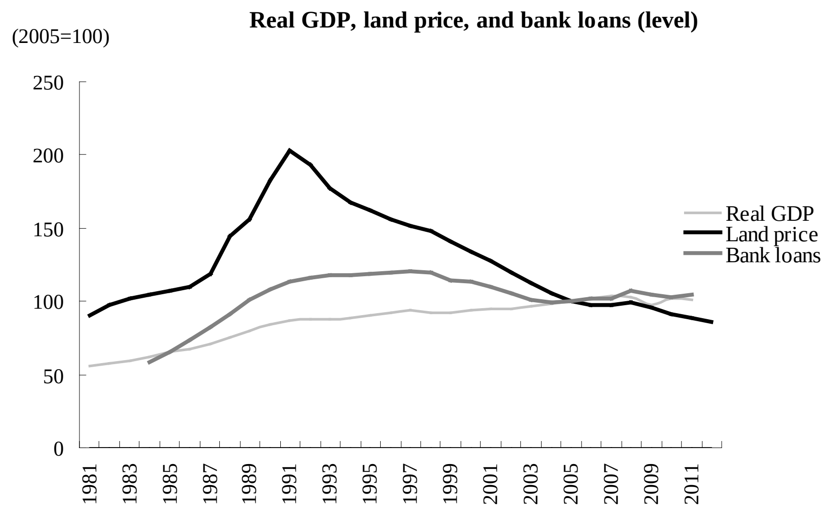
3.1. LTV ratios over the business cycle

3.1.1. Background information: business cycle and bubble

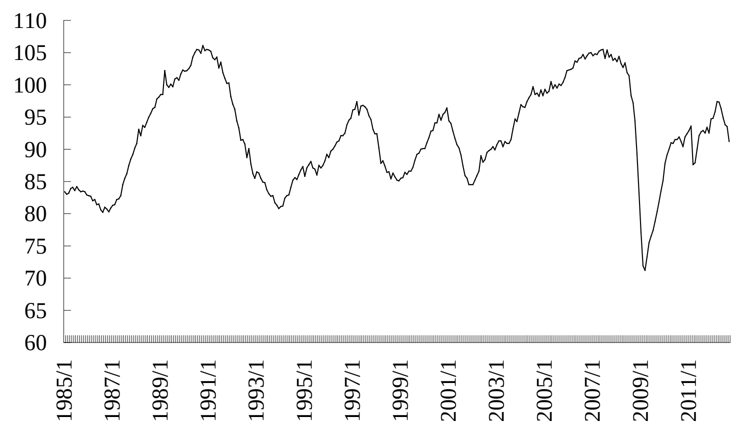
Figure 2 GDP, land price, bank loans, and business cycle

(A) Real GDP, land price, and bank loans





(B) Business conditions index



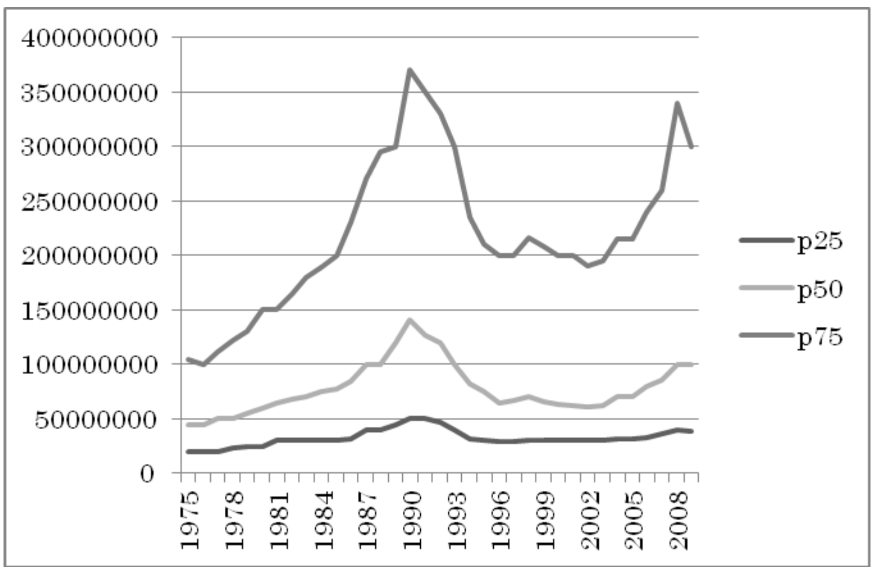
Before showing the LTV ratio, let us first confirm the business cycle and the land price bubble in Japan during the late 1980s to the early 1990s. Panels in figure 2 shows the time-series path in Japan of real GDP, the average land price, bank loans and the business conditions index which is used to define peaks and troughs of Japan's business cycles. Real GDP growth rate during the latter half of 1980s, so-called the "bubble" period, was about 5 percent on average, while that of land price was more than 10 percent and that of bank loans also exhibited double-digit growth. The surge in land price was especially remarkable during the last few years of the bubble period.

After the burst of the bubble, real GDP growth rate has never exceeded its level during the bubble period, although Japan encountered several economic expansions and recessions. The growth rate of bank loans exhibited a similar cyclical pattern after the burst of the bubble, but the rate was smaller on average than the GDP growth rate. Finally, the land price showed a steady decline over these twenty years, finishing with a price level comparable to that in the early 1980s.

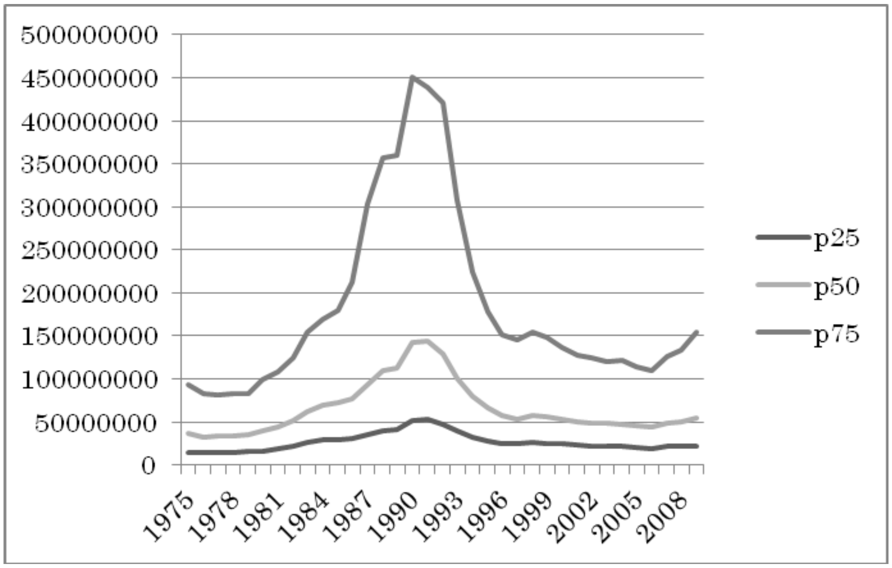
3.1.2. Loans, values, and the LTV ratios

Figure 3 Loans and values over the business cycle

(A) Amount of Loans (L)



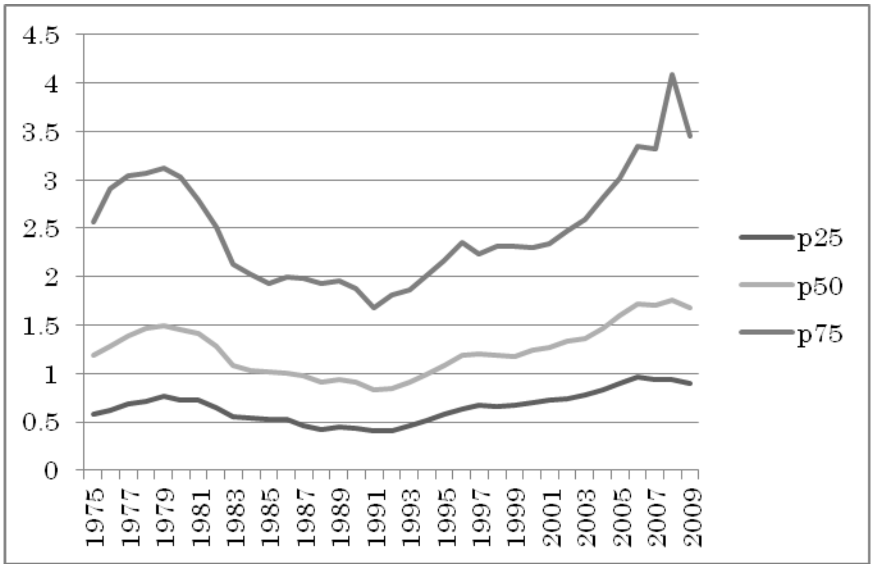
(B) Values of Land (V)



(Unit: in 1 Japanese yen)

We begin by examining the evolution of the size of individual loans and the values of the collateralized land that are respectively a numerator and a denominator of the LTV ratio. Figure 3 shows the changes in the 25, 50, and 75 percentiles of our L and V through the business cycle. These figures reflect a familiar pattern. Both loans and land values fluctuate in a pro-cyclical manner. They have an increasing trend until 1991 when the asset price bubble burst in Japan, and an decreasing one until mid 2000s. They go up afterwards, and the increase in the loan amount is larger than that in the land value. A finding of pro-cyclicality in LTV ratios would be consistent with existing evidence the general pro-cyclicality in lending (e.g., Borio et al., 2001; Horvath, 2002; Borio and Lowe, 2002; Berger and Udell 2004). Also, changes in the land value is consistent with what we found using macro statistics in panel (A) of figure 2.

Figure 4 LTV ratios over the business cycle



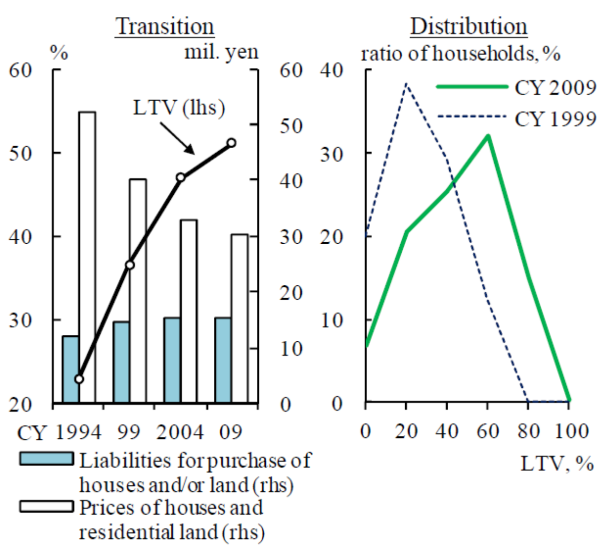
Now we turn to the LTV ratio. Figure 4 shows the LTV ratio by percentile (25th, 50th, and 75th percentile). The finding is striking and counter-intuitive. Notwithstanding that its numerator and the denominator fluctuate in a pro-cyclical manner, the LTV ratio clearly exhibits counter-cyclicality, at least until early 2000s. We also find that the counter-cyclicality is no longer observed from the mid 2000s. The LTV ratio increases as L and V do, so the counter-cyclicality is less obvious. During this period, the land value does not increase much, while the loan size increase, which makes the LTV ratio increase.

Note that our finding of a counter-cyclical LTV ratio until early 2000s is not driven by the stickiness of the land prices. As shown above, V does exhibit pro-cyclicality. The fact that loans and land values are both pro-cyclical means that the counter-cyclicality of the LTV ratio is not due to data problems.

One might also suspect that the counter-cyclicality of the LTV ratio stems from any survival bias that our data would have. As noted above, our sample firms are those that survived until 2008 or afterwards, and so the LTV ratios in earlier years are those for a longer-lived firms that are likely to be more creditworthy. However, if there were such survival bias in our data, the LTV ratio should have a monotonically decreasing trend, because, for better-quality firms, banks would like to lend more for the same amount of collateral. This is not the case in figure 4. As we will show below, the counter-cyclicality is still found even after controlling for observable characteristics of loans, borrowers and banks.

Our finding is not as peculiar as one might think, because the counter-cyclicality of the LTV ratios implies that a bank's marginal propensity to lend with an incremental increase in collateral value is less than one. In fact, our finding of counter-cyclical LTV ratios is consistent with one of the conclusions in Goodhart et al. (2012)'s theoretical study. They construct a general equilibrium model and calibrate the effects of different policy measures on credit expansion and house prices. As for the cap on the LTV ratio, they conclude that because the boom brings large increases in asset prices and lowers the LTV ratio on the mortgages, it is difficult to "lean against the wind to reduce the credit expansion and house prices in the boom via regulation" (Goodhart et al. 2012, p.42).

Figure 5 LTV ratios for housing loans



Source: Bank of Japan (2012, Chart IV-3-10)

It is worthwhile to note that there is some other empirical evidence that is consistent with our finding. Figure 5, from Bank of Japan (2012), shows the evolution of the LTV ratios for housing loans as defined as the ratio of liabilities for purchase of houses and/or land to prices of houses and residential land. There is a clear increasing trend in the transition of the LTV ratio in the residential market (left-hand side of figure 5), which is highly consistent with the business loan market reflected in figure 4. Of course, we cannot directly compare these ratios with the ones in this paper because our focus is on business loans in a longer time period. The LTV ratios in figure 5 are also different from ours because these ratios reflect changes in liabilities and land prices after the origination of the loans (as opposed to our "origination LTV ratio"). However, these differences do not negate a general comparability of the two LTV ratios and the similar increasing trend they both reflect.

The counter-cyclicality of the LTV ratio means that the increase in loan amounts during the bubble period was more than offset by the increase in the value of land that is pledged as collateral, and consequently banks' real time exposure was increasing during the bubble period in terms of current pricing (i.e., bank exposure was not increasing conditional on lenders lacking contemporaneous knowledge of being in a bubble period). This suggests that a simple cap on the LTV ratio as macroprudential measures may not work as a binding constraint on bank lending during the boom period.

3.1.3. LTV ratios with different definitions of V

Because our finding of counter-cyclical LTV ratios is counter-intuitive, a concern might arise that our definition of the LTV ratio may be inappropriate. The most plausible criticism would be that lenders might be taking into account the expectation of future land values when underwriting loans, which makes it inappropriate to use the current value of land in calculating the LTV ratio as we did above. As an exercise to deal with such a concern, we calculate and compare the LTV ratios under different definitions of V.

First, we calculate the LTV ratios with the value of land evaluated one year later, V(t+1). This is a benchmark case where lenders could perfectly foresee and underwrite their loans based on the value of land realized one year later. Using this lagged value of V might also be appropriate for a different reason, because there might be a lag in reporting the official land price data that we used to predict the land values. Second, lenders might alternatively underwrite based on the value of collateral that is somewhat naively predicted based on its past values. To consider such a case, we calculate V that is interpolated from its previous year's growth rate, i.e., $V(t-1)\cdot\{V(t-1)/V(t-2)\}$.

Figure 6 Medians of LTV ratio with different definitions

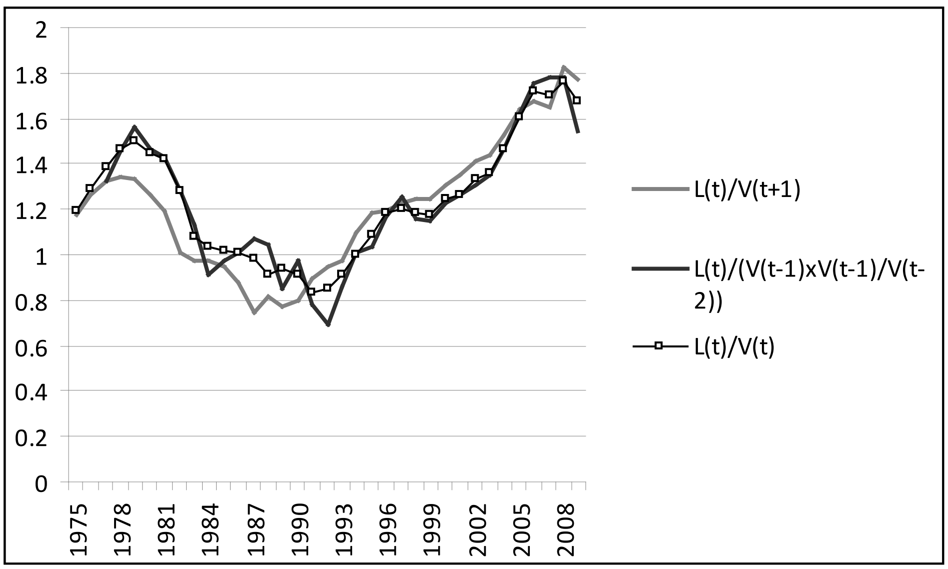


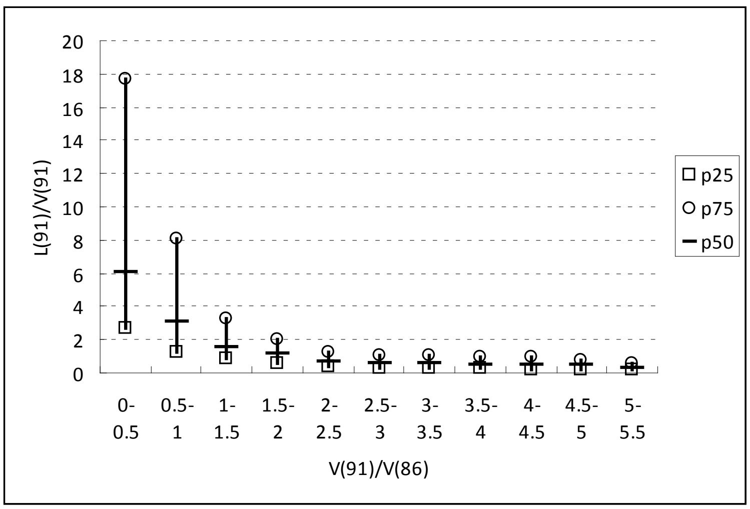
Figure 6 compares the medians of the LTV ratios under such definitions with the one used above. It is evident that the counter-cyclicality of the LTV ratios remains even if we employ different Vs. Thus, our finding of the counter-cyclical LTV ratio is robust to different assumptions about V.

3.1.4. LTV ratios at the peak of the bubble and land price appreciation during the bubble period

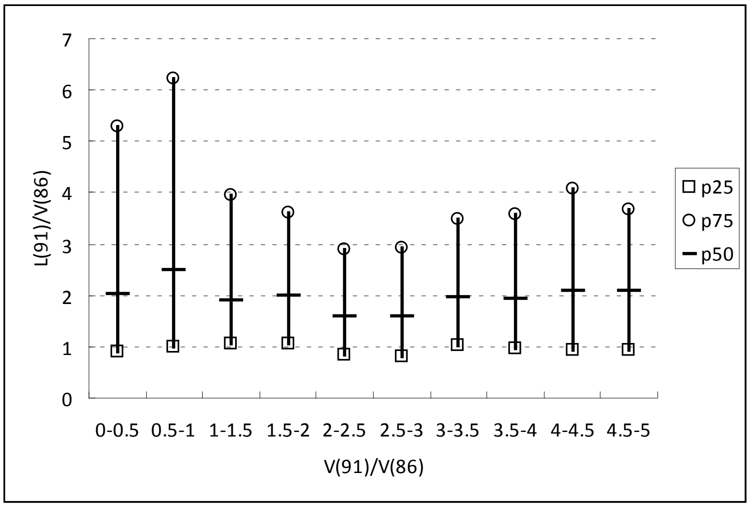
Our finding that the LTV ratios of business loans in Japan are counter-cyclical implies that the lending standard during the bubble period was not lax. To shed more light on lending behavior during this period, we now focus on a subsample of mortgages registered in 1991, the year in which the real estate boom peaked and the actual LTV ratio was at its lowest. Here, we examine whether the LTV ratios differ depending on the rate of increase in land prices. If the surge in the land price induced risky lending, we would observe that the LTV ratios are higher for loans for which the price of the land pledged increased more. We thus calculate the rates of appreciation in land that was pledged in our sample from the bubble period, i.e., 1986 to 1991 (V(91)/V(86)), and compare the LTV ratios in 1991 (L(91)/V(91)) depending on the appreciation rates of the associated lands. The number of observations for this exercise is 17,713.

Figure 7 LTV ratios in 1991 and land value appreciation in 1986-91

(A) Actual LTV ratios: L(91)/V(91)



(B) Counterfactual LTV ratios: L(91)/V(86)



The results are shown in panel (A) of figure 7, which shows the 25, 50, and 75 percentiles of the LTV ratios plotted against different subsamples of actual land value appreciation during 1986-91 (V(91)/V(86)). The figure clearly exhibits a negative relationship between actual LTV ratios and past land value appreciation. That is, lenders extended smaller amount of loans relative to the value of land pledged as collateral as the price of the land surged.[15] This might imply that lenders who had observed a rapid increase in the price of a land that is pledged as collateral might have been reluctant to extend more loans as compared to the land value. This finding is consistent with the counter-cyclicality of the LTV ratios found from the time-series comparison above, in the sense that in both cases, the change in the value of real estate far exceeds the amount of the loans extended.

Note, however, that because the LTV ratio is a relative measure, the negative relationship between the ratio and land price appreciation does not necessarily imply that the absolute amount of loans extended by lenders who had observed a surge in the value of collateralized land was smaller than that by those observing no surge. To put it differently, the denominator of the LTV ratio is larger for a larger value of V(91)/V(86), so even if the ratio is small, the numerator L might be large in absolute terms. Panel (A) of figure 7 suggests that this might have actually been the case, because the negative

[15] Dynan (2012) also reports the negative relationship between the LTV ratio and home price appreciation using a data set of the residential mortgages in the United States during the 2000s.

relationship between the LTV ratios and the land price appreciation is less obvious for those with a higher rate of land value appreciation, suggesting the conjecture above might have actually been the case.

To pursue such a possibility, panel (B) of figure 7 depicts the relationship between the LTV ratios and the land price appreciation that is similar to panel (A), but the LTV ratios here are counterfactual ones using the pre-bubble land price in 1986 (i.e., L(91)/V(86)). That is, this panel shows the LTV ratios if there were not the bubble, or if the land prices in 1991 suddenly fell to their 1986 levels. This exercise is similar to that in Dynan (2012) that used residential mortgage data in the United State during the 2000s.

We find that both the 25 and the 50 percentiles of the counterfactual LTV ratios are comparable across different levels of V(91)/V(86). This means that the lenders were exposed to similar levels of risks and that the risk exposure for lenders observing a surge in the land price was not lower if the LTV ratios were evaluated at the pre-bubble land prices. We also find that for the 75 percentiles of the counterfactual LTV ratio and V(91)/V(86) above 2.5, lenders incurred more risk for a greater surge in the price of the lands pledged as collateral. These findings suggest that during the bubble period, *marginal* lenders (i.e., those for which the LTV ratios are high and observed a surge in the price of lands to be pledged) took higher risks in the form of large absolute amounts of loans, although such behavior is not observed for average lenders.

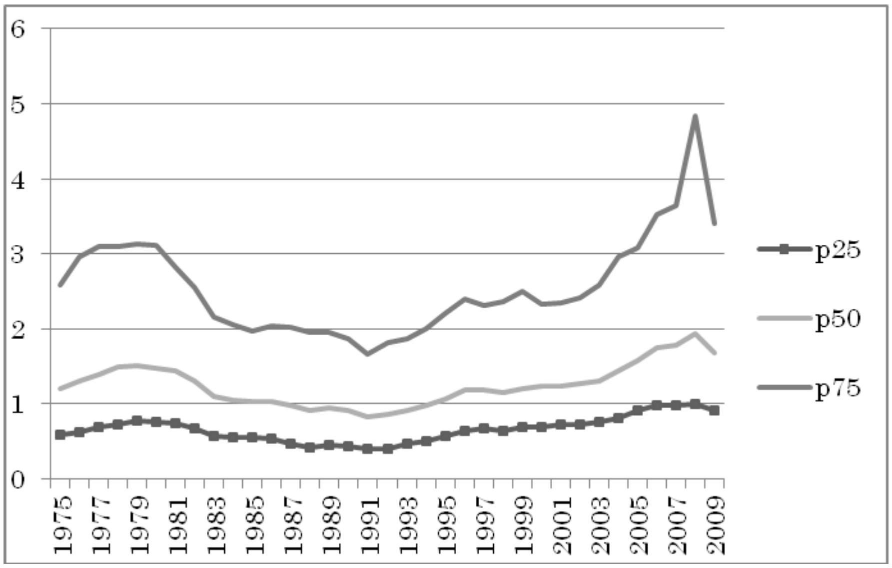
3.2. Univariate analysis

3.2.1. Type of mortgage: revolving versus non-revolving

In this subsection, we examine differences in the LTV ratio depending on loan-, borrower- and bank-characteristics. First we compare the LTV ratios by type of mortgages. In Japan, mortgages take one of two forms: revolving and non-revolving loans. Revolving mortgages are those that specify a ceiling loan amount that a debtor can borrow up to in the future, but no specific date of maturity is set. This type of mortgage is typically used for working capital purposes in order to avoid the transactions cost with borrowing serially in a spot market.

Figure 8 LTV ratios for revolving and non-revolving mortgages

(A) LTV ratios of revolving mortgages



(B) LTV ratios of non-revolving mortgages

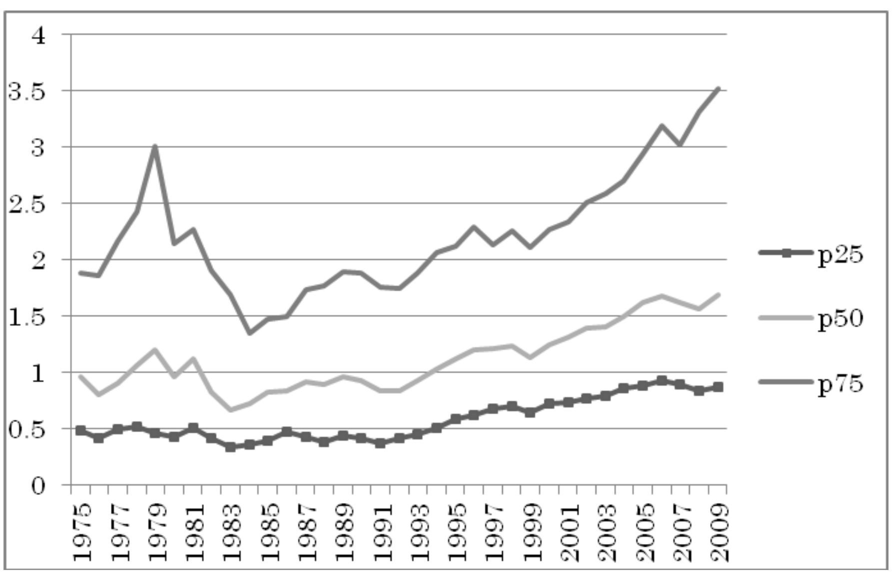
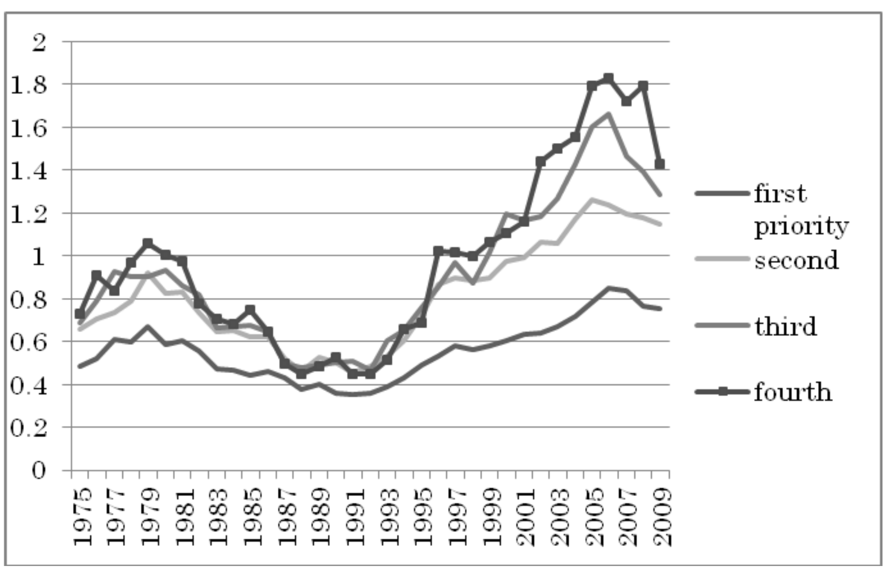


Figure 8 shows the 25, 50, and 75 percentiles of the LTV ratios for revolving and non-revolving mortgages. Before the peak of the land price bubble in 1991, the LTV ratios for revolving mortgages are on balance higher than those of non-revolving ones. After 1991, the ratios of these two types are comparable. We thus find that before the bubble burst, the ceilings for loans set for revolving mortgages were higher than the amounts of loans extended for non-revolving mortgages given the same amount of collateral. This suggests that, before the burst of the bubble, lenders might not have been careful enough in bearing the risk associated with revolving mortgages. Note, however, that the number of observations for non-revolving mortgages is very small before 1990. Thus, some caution should be exercised in comparing the two types of mortgages in this period. As we noted above, we can only observe mortgages that are in existence between 2008-2010. This means that the maturity of non-revolving mortgages before 1990 shown in this figure exceed more than twenty years, which is rare in business loans.

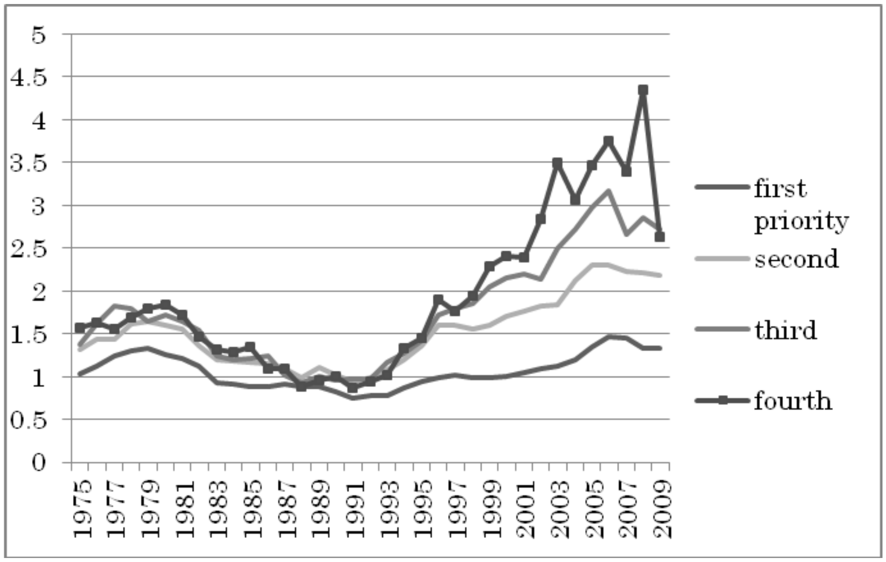
3.2.2. By priority (1st, 2nd, ... lien)

Figure 9 LTV ratios by priority

(A) LTV ratios by priority (25 percentile)



(B) LTV ratios by priority (50 percentile)



(C) LTV ratios by priority (75 percentile)

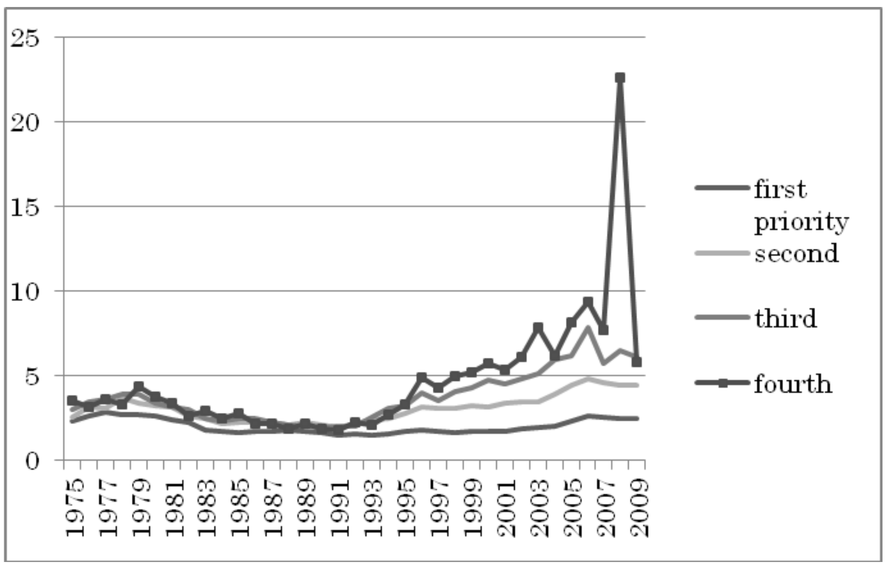
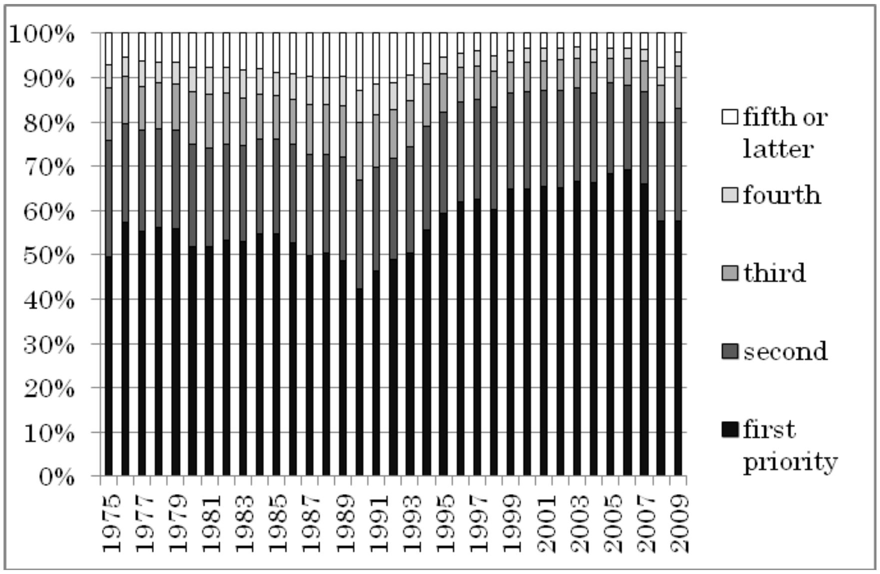


Figure 9 shows the 25, 50, and 75 percentiles of the LTV ratios for mortgages with different priorities. It is straightforward to see that the mortgages that are superior in priority have lower LTV ratios. This is a natural consequence of the definition of LTV ratios. For the same amount of collateral, the numerator of the LTV ratio is larger for lower-priority loans.[16] However, the extent of the increasing trends of the LTV ratios after 1990 is more substantial for loans with lower priority, and

[16] For example, if a land with V=200,000 is pledged for two loans and their loan amounts are L1=150,000 for the first priority one and L2=40,000 for the second, the LTV ratio is 0.75 (150,000/200,000) for the first-priority loan and 0.95 ((150,000+40,000)/200,000) for the second.

their differences are the smallest at the end of the 1980s when the land price bubble was forming.

Figure 10 Share of secured loans with different priorities



We can also extract informative information from the priority itself. In figure 10 we show the shares of loans with different priorities. During the bubble period in the latter half of the 1980s, the share of first lien loans decreased while that of junior ones increased. Incidentally, this finding coincides with the increase in second-liens (i.e., most commonly home equity lines of credit typically referred to as HELOCs) found for the residential mortgage market in the United States during the 2000s (Lee, Mayer, and Tracy, 2012).

It is interesting to compare this finding with the one in figure 9 that the difference in the LTV ratios among different priorities diminished during the bubble period. Taken together, these findings suggest that the deterioration of the lending standard in Japan during the bubble period might have emerged not as an increase in the LTV ratio but as an increase in junior lien loans.[17] This might also suggests that lenders may have tried to compensate for their aggressive lending practice of extending more low-priority loans by lowering the LTV ratios of those loans during the late 1980s. After the

---

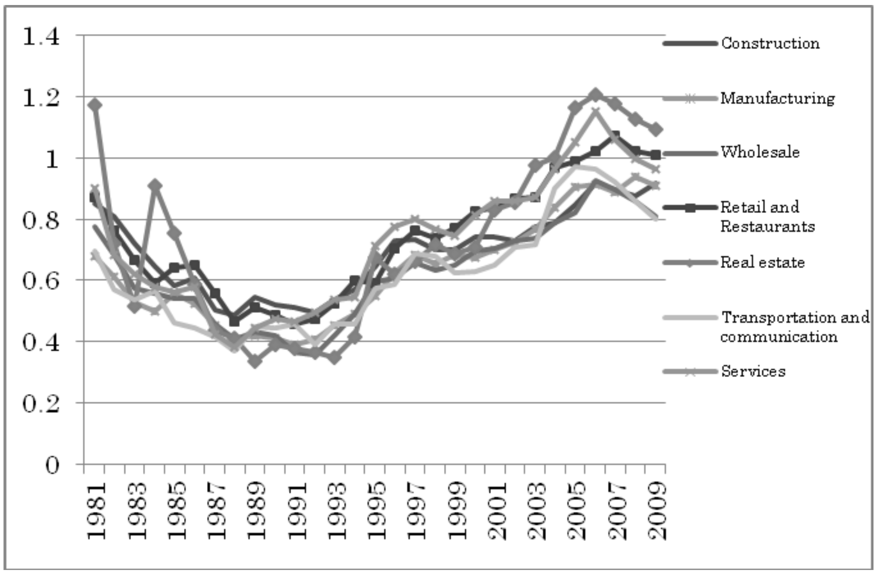
[17] This also has a parallel to the U.S. residential market where a large fraction of the MBS subprime losses were associated with HELOC loans.

burst of the bubble, both the share of first liens loans and the average LTV ratio increased moderately.

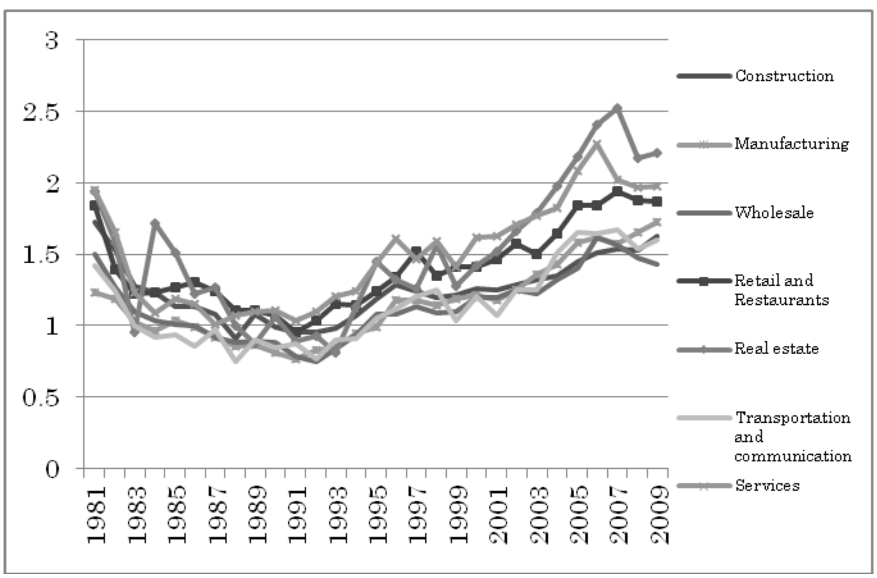
3.2.3. By industry

Figure 11 LTV ratios by industry

(A) LTV ratios by industry (25 percentile)



(B) LTV ratios by industry (50 percentile)



(C) LTV ratios by industry (75 percentile)

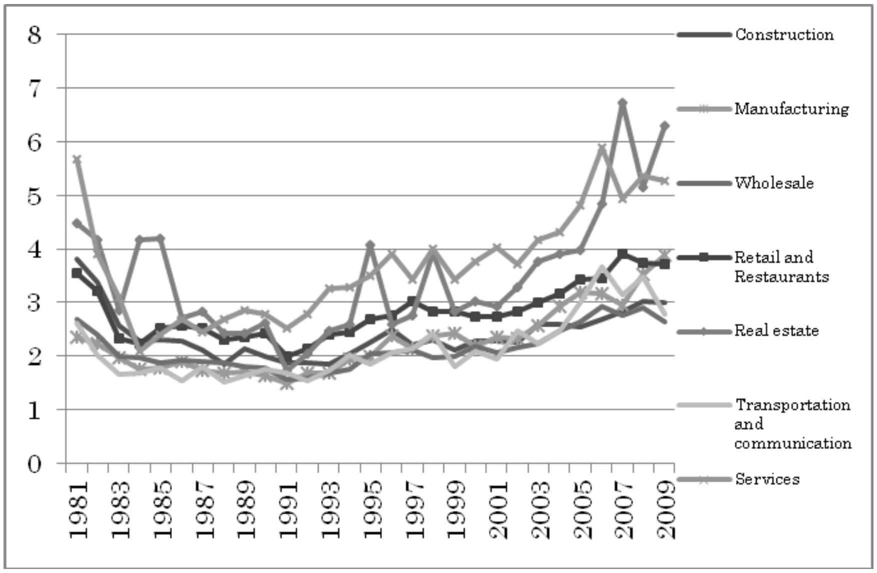


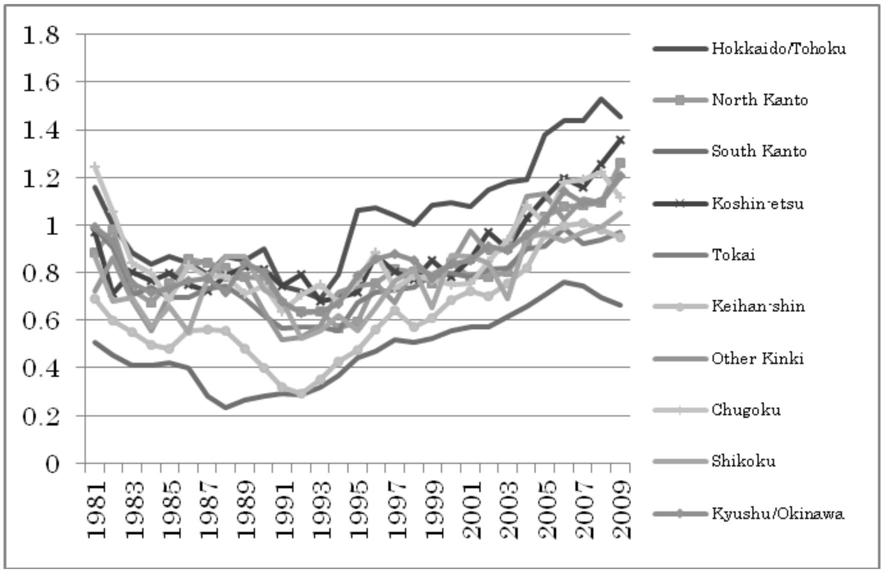
Figure 11 shows the 25, 50, and 75 percentiles of the LTV ratios for loans to firms in different industries. Note that due to the data availability, the figures start from 1981. On average, LTV ratios are higher for Real estate, Services, and Retail and restaurants, especially after the burst of the bubble. The LTV ratio of loans to Construction firms is also relatively higher until the early 1990s, but since then, its level was comparable to other industries. It is also worth noting that the LTV ratio of the Real estate industry is volatile, presumably because land that these real estate firms owned included land used for commercial purposes (i.e., as inventories).

Real estate and Construction are two major industries to which banks extended loans aggressively during the bubble period and after the burst of the bubble. Loans to these two industries were in hindsight at the core of the bad loan problem during the so-called lost decades in Japan (see e.g., Hoshi and Kashyap 2001). However, we find that the LTV ratios for loans to these two industries during the bubble period are lower than those to other industries.

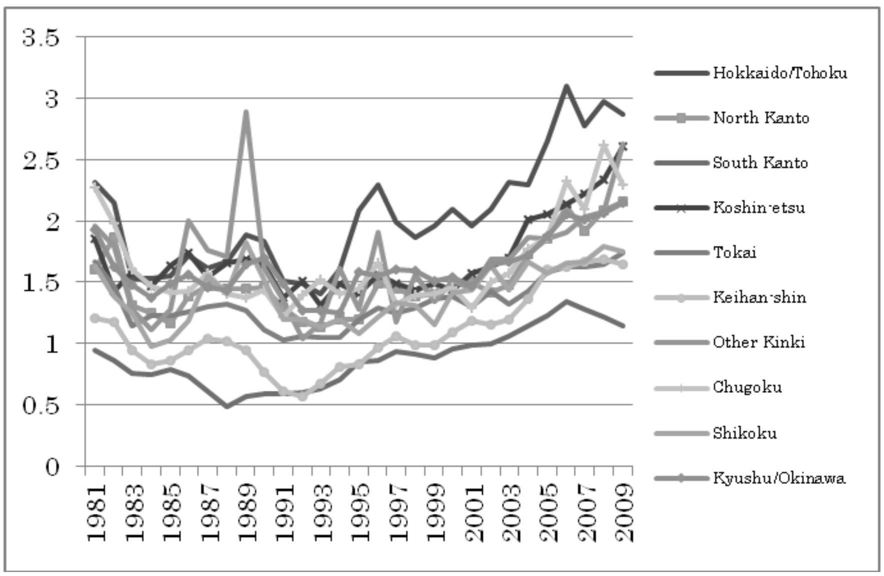
3.2.4. By region

Figure 12 LTV ratios by region

(A) LTV ratios by region (25 percentile)



(B) LTV ratios by region (50 percentile)



(C) LTV ratios by region (75 percentile)

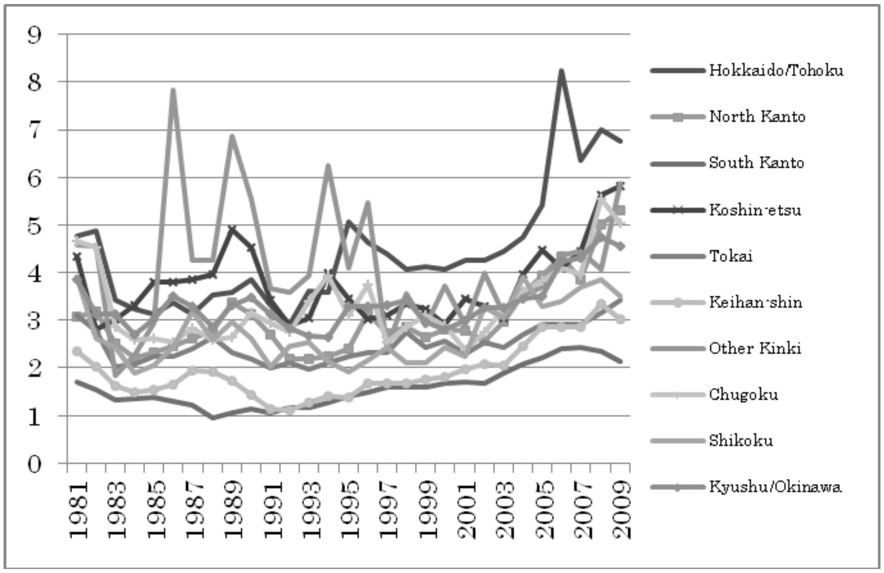
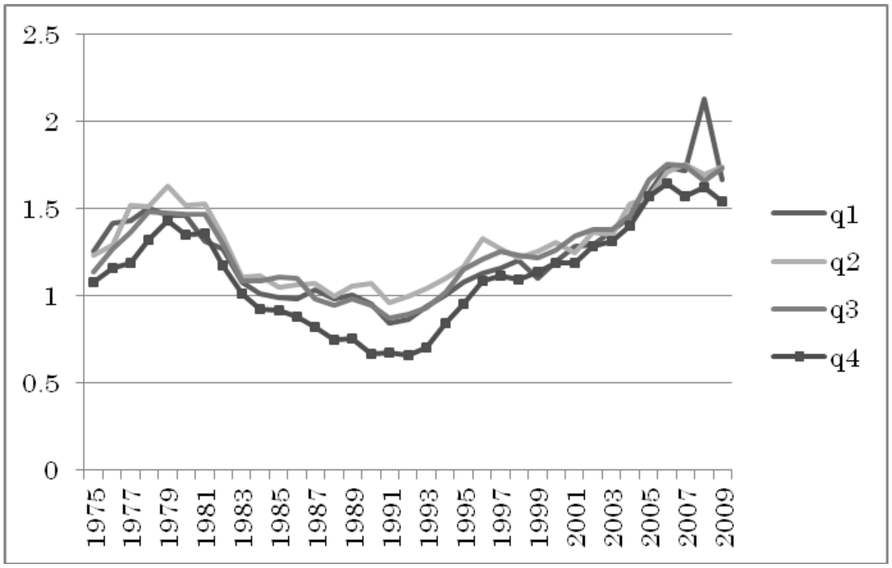


Figure 12 shows the 25, 50, and 75 percentiles of the LTV ratio by the region that a firm's headquarter is located (starting from 1981). In general, LTV ratios of urban areas are lower and more stable than those of rural areas. For example, the LTV ratio of loans to firms in the South Kanto (Metropolitan) area (including Tokyo) is the lowest throughout the period. The LTV ratio of the Keihanshin area (the second largest business focal point in Japan including Kyoto, Osaka, and Kobe) is also low. It is worth noting that the clear decreasing trend of the LTV ratios during the bubble period (late 1980s) is observed only in these two urban areas. In contrast, the increasing trends of LTV ratios after the bubble period are commonly observed among all the regions. Also note that the year when the LTV ratios hit the bottom during the bubble period seems to be earlier in the South Kanto area (i.e., year 1988) than that in Keihanshin or compared with a national average (figure 4).

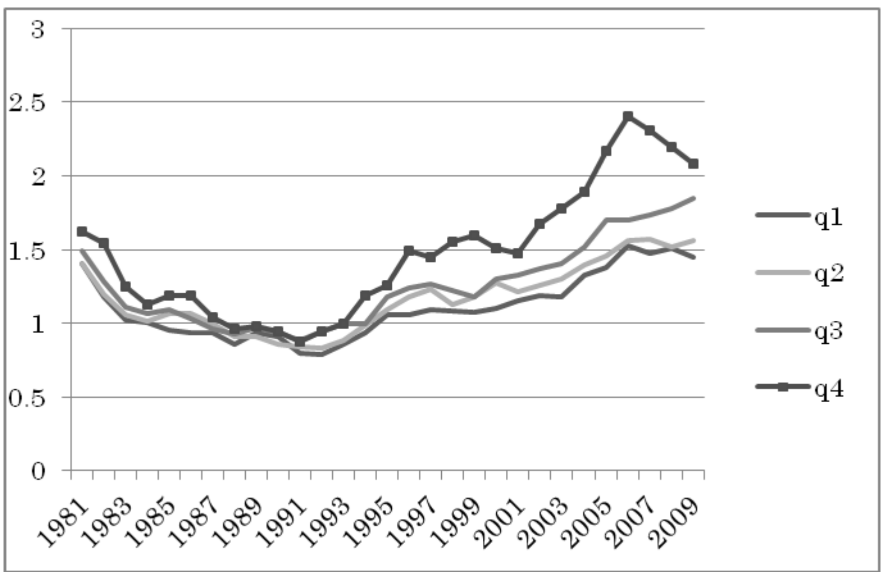
3.2.5. By firm (borrower) characteristics

Figure 13 LTV ratios by firm characteristics

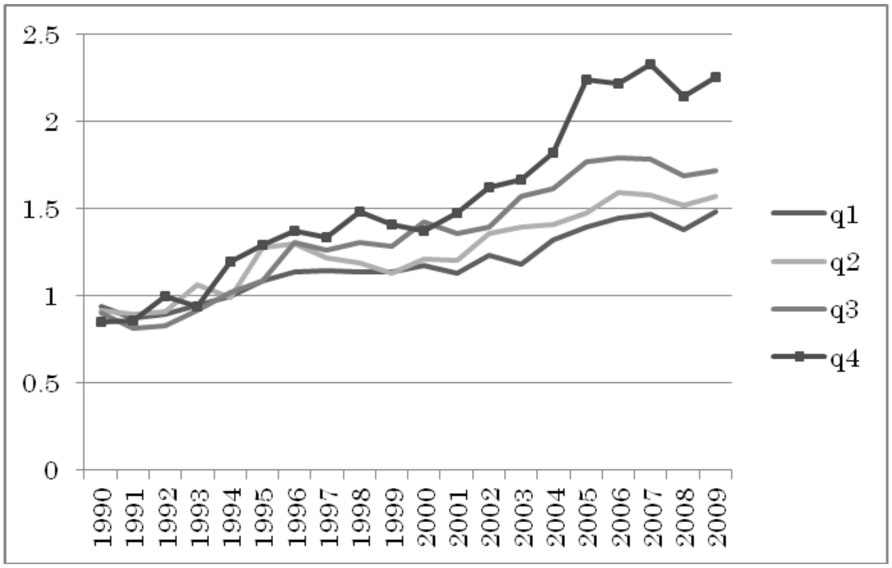
(A) Median LTV ratios by firm age quartiles



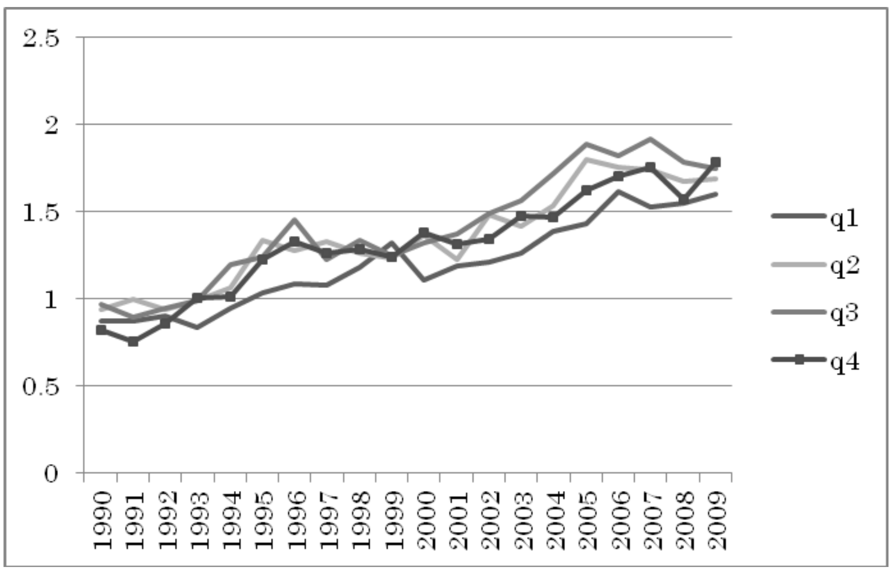
(B) Median LTV ratios by employee size quartiles



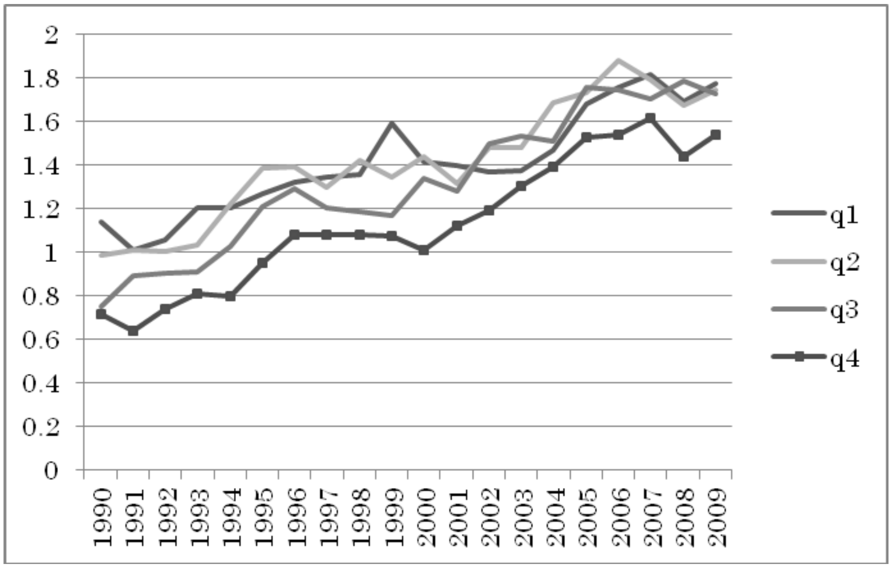
(C) Median LTV ratios by sales quartiles



(D) Median LTV ratios by ROA quartiles



(E) Median LTV ratios by capital ratio quartiles



The five panels of figure 13 show the median of the LTV by five firm characteristics: firm age, employee size (the number of employee), gross sales, ROA defined as the ratio of operating profit to total asset, and the capital-asset ratio.[18] Firm age can be considered as a proxy for riskiness, the number of employee and gross sales represent size (riskiness and transparency), ROA is a profitability measure, and the capital-asset ratio represents soundness of the firm. Four lines in a figure represent the medians of each quartile (q1-q4) of the respective firm characteristics. In order to circumvent the simultaneity, we take the firm characteristics variables as of one year prior to the origination of the mortgages. Note that due to data availability, the starting year of each panel is not consistent. The panels for firm age and the number of employee include the bubble period as they respectively start from 1975 and 1981 while those for others start from 1990 when the LTV ratio turned to an increasing trend.

First, regarding the firm age (panel (A)), the fourth quartile (older) firms exhibit the lowest median LTV ratios compared with the other quartiles, especially from the 1980s to the early 90s. That is, the LTV ratio is the lowest for oldest firms, especially during the bubble period. At first blush this

[18] For the remaining part of this subsection, we only report results for medians, because the results for 25 percentiles and 75 percentiles are qualitatively the same.

seems counterintuitive given the general finding that older firms are generally observed to be safer (e.g., Berger and Udell 1995). However, this finding might suggest that such firms have more assets to pledge and/or they might have lower loan demand.

Second, the median LTV ratio is positively correlated with the number of employees and the gross sales in each year (panels (B) and (C)). This indicates that larger firms can obtain larger amount of loans given the value of land (collateral), especially from the mid 2000s. This is presumably because larger firms are more creditworthy and thus less financially constrained by the amount of real estate they own. Similar relationships are found between the median LTV ratio and the amount of assets (unreported). Note, however, that the difference in the LTV ratio among firms with different size is smaller before the bubble period than after. This might reflect laxer lending standards on the part of lenders.

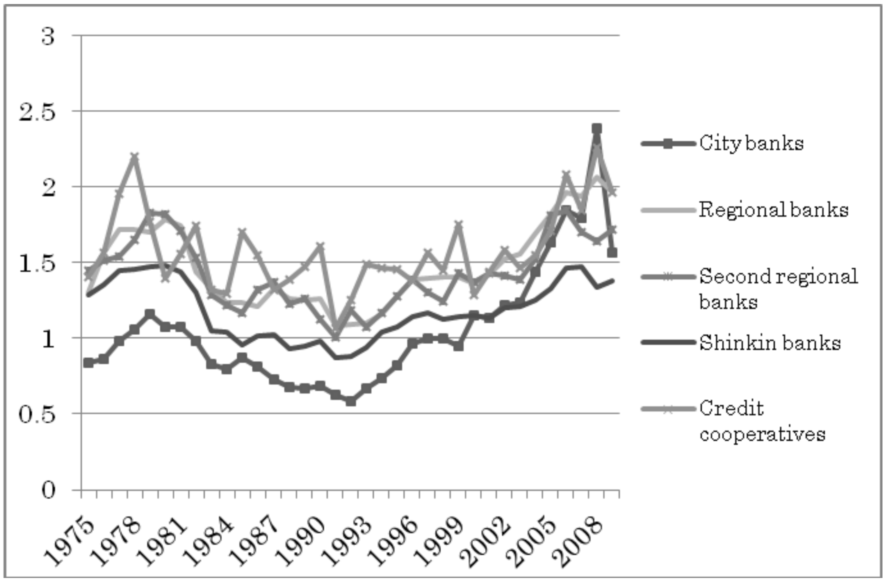
Third, the relationship between the median LTV ratio and a firm's ROA is ambiguous (panel (D)). The same holds for the relationship between the median LTV ratio and profit/sales ratio (unreported). Thus, the LTV ratios do not have a clear relationship with firm profitability.

Fourth and finally, the median LTV ratio is negatively associated with a firm's capital-asset ratio (panel (E)). The figure shows that the median ratios for the fourth quartile firms are the smallest throughout the period. This finding is consistent with what we found in panel (A). As the capital-asset ratio measures the safety of a firm, the result implies that a riskier firm obtains a larger amount of loans given the same value of land. However, the negative correlation between the LTV ratio and the capital-asset ratio might also emerge when a firm that did not borrow in the past (thereby having a lower capital-asset ratio) does not need to borrow much even if the firm has sufficient real estate to back up the new loan.

3.2.6. By lender type

Figure 14 LTV ratios by lender type

(A) Median LTV ratios for private deposit-taking financial institutions



(B) Median LTV ratios for other lenders

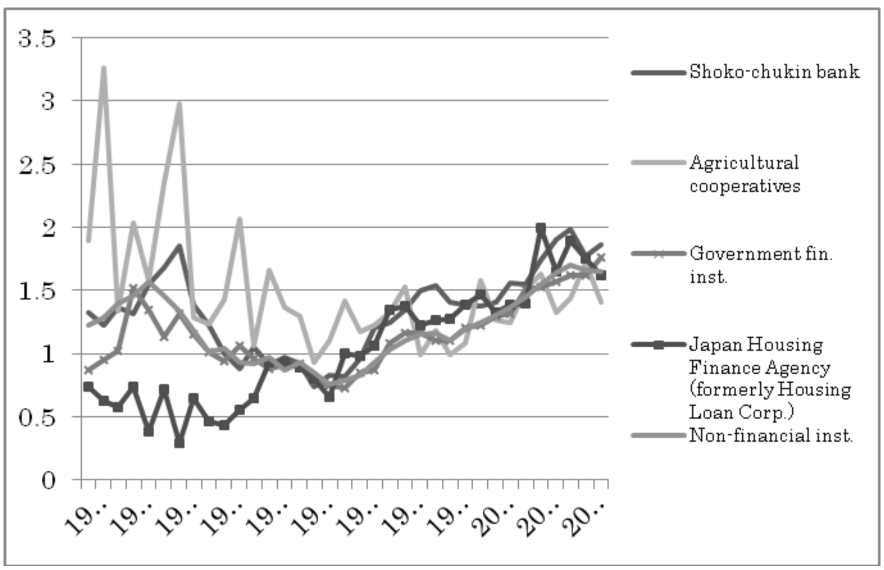
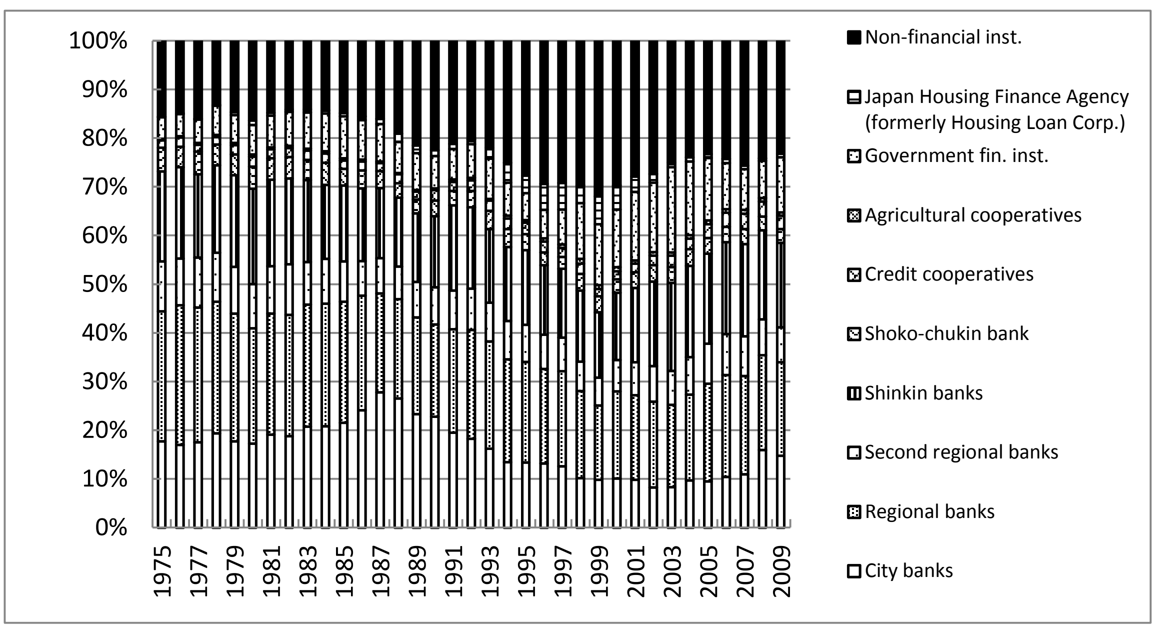


Figure 14 shows the median of the LTV ratio by the type of lender. Panel (A) shows the LTV ratios of loans extended by private deposit-taking financial institutions (FIs), whereas panel (B) shows those by government-affiliated FIs and others including Credit-Guarantee Corporations and non-financial firms.

Among deposit-taking FIs, the median LTV ratio for loans by city banks is the lowest until year 2000, but it increases substantially during the 2000s, resulting in the level of LTV ratios that is comparable to other depository FIs except for Shinkin banks. The median LTV ratio for Shinkin banks is consistently more stable and lower than that for the other FIs. Note, however, that the difference in the LTV ratio by bank type might reflect the fact that different types of banks have different customers. For example, the low LTV ratio for city banks might just be an artifact of the low LTV ratio for firms located in rural areas (see subsection 3.2.4).

The LTV ratios for government-affiliated FIs are mostly comparable to those for private depository FIs. The LTV ratios for Agricultural cooperatives and the Japan Housing Finance Agency (HFA) (formerly Housing Loan Corporation (HLC)) are either higher or lower until the 1990s in comparison with other FIs.[19] Caution should be exercised in interpreting these results given that the number of observation is small.

Figure 15 Share of secured loans by lender type



[19] Because we already eliminated mortgages for residential loans, those shown in Figure 14 for HFA are mortgages for commercial properties. HLC was the sole mortgage lender in Japan until 1970s, but due to deregulation, it shrunk their lending business. As a result, its successor (HFA) is currently only a marginal lender and rather focuses on securitization of residential mortgages originated by private banks.

It is also worth noting the changes in the composition of lenders in our data set. Figure 15 shows the share of loans by each type of lenders in our data set. We find that the share of loans by city banks increased during the mid 1980s and then decreased substantially after the collapse of the asset-price bubble. This may reflect the boom-and-bust of the credit cycle of real-estate loans by city banks during these periods. It is argued that during the 1980s large banks including city banks lost their old customers (e.g., large manufacturing firms) because of deregulation and the accompanying development of capital markets (i.e., financial disintermediation). As a result city banks turned their focus to making loans to firms in "non-traditional" industries such as real estate firms (see e.g., Hoshi and Kashyap 2001).[20] Figure 15 is consistent with this story. Note, however, that our finding above (figure 14) implies that these banks were also conservative as reflected in the low LTV ratio.

We also find that after the late 1990s, the shares of loans by government affiliated financial institutions and non-financials increased. Because this was a period during which private banks in Japan went into a crisis, this finding might imply that these private banks could not supply sufficient funds, even if a borrower has sufficient assets to pledge.

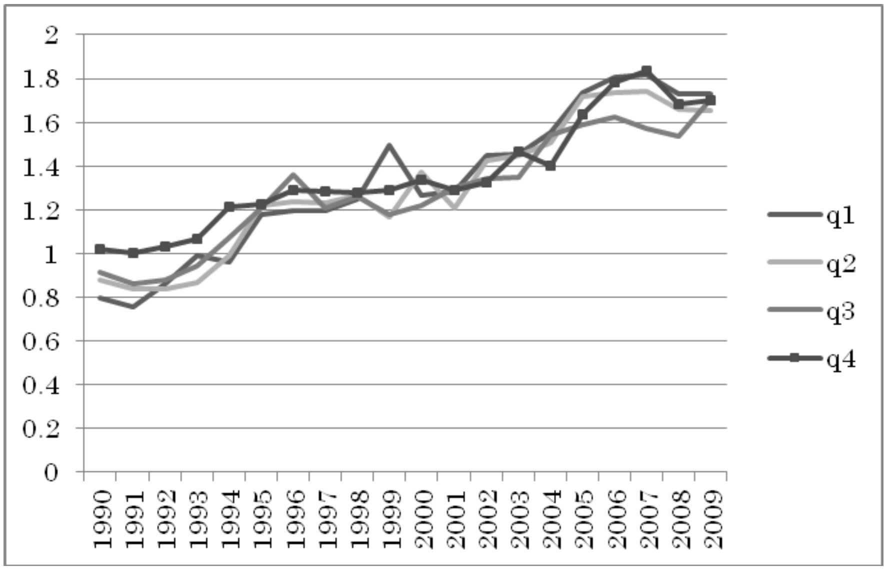
3.2.7. By whether the lender is the main bank

Figure 16 Median LTV ratios for main versus non-main banks

[20] See section 3.2.3 as well for additional information of differences in borrower industries.

Figure 16 shows the median LTV ratio by whether or not the lender is the main bank of the borrowing firm. The TDB database lists the name of banks that a firm transacts with in the order of importance that TDB subjectively evaluates, and following a conventional definition, we regard the one listed at the top as the firm's main bank. The figure shows that except for the late 2000s, the LTV ratio of the main bank is higher than that of non-main banks. This finding might be inconsistent with a bankers' conventional wisdom that a main bank takes a senior position when asking the borrower to pledge collateral. However, alternatively it could imply that they take less land as collateral consistent with the main bank relationship justifying assuming greater risk. It is also worth noting that the share of loans by main banks in our data set is only about 30 percent and it is stable throughout the period (unreported).

Figure 17 Median LTV ratios by loan share quartiles

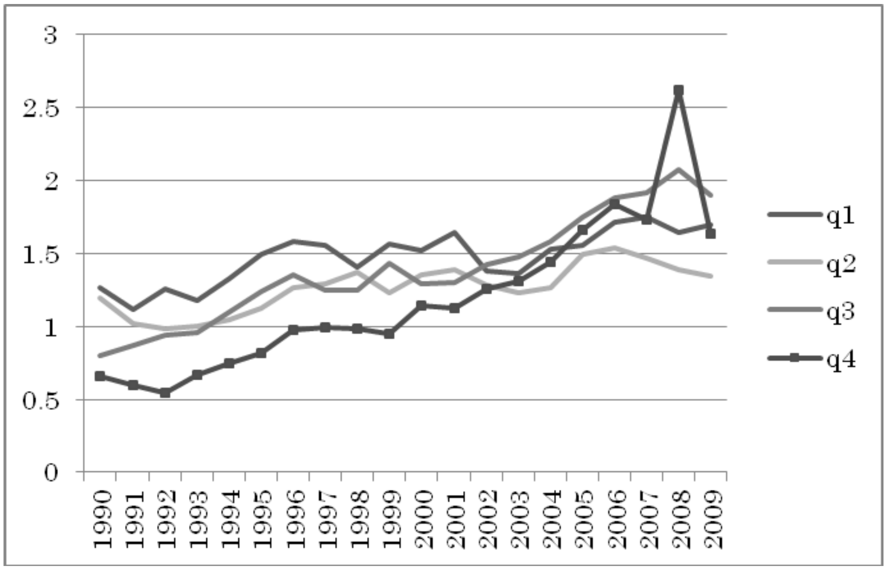


As alternative to using the definition of the main bank as the top bank listed in the TDB's data base, we can define the main bank based on a lender's loan share. Figure 17 shows the median of the LTV ratios by the ratio of the amount of loans for the mortgage to a firm's total liabilities. We used total liabilities because we do not have data of total amount of loans. Four lines in this figure represent the medians of each quartile subsample. We can observe no clear relationship between the loan shares and the LTV ratios.

3.2.8. By bank characteristics

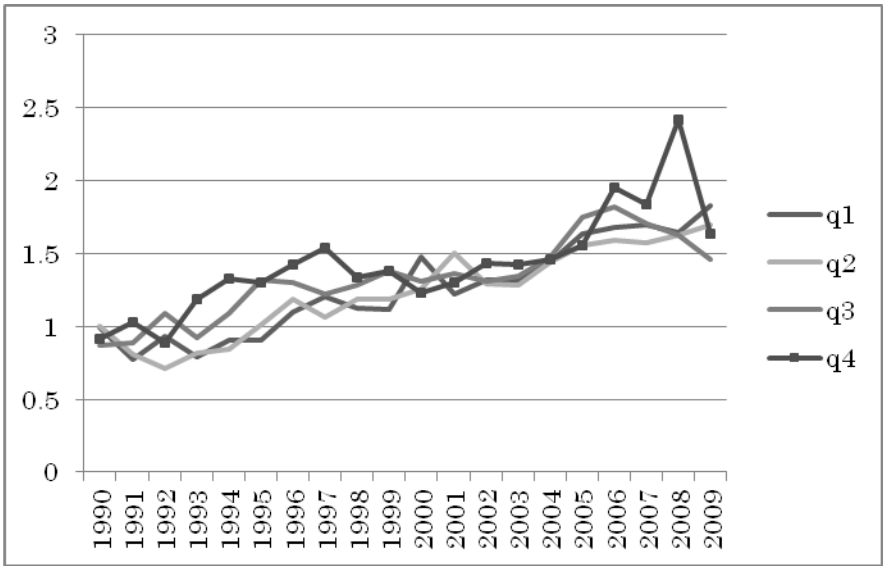
Figure 18 LTV ratios by bank characteristics

(A) Median LTV ratios by banks' asset size quartiles



(B) Median LTV ratios by banks' capital-asset ratio quartiles

(C) Median LTV ratios by bank' ROA quartiles



The three panels of figure 18 show the medians of the LTV ratios by three bank characteristics: asset size, capita-asset ratio, and ROA defined as the ratio of operating profit to total asset. In this figure, we only use the LTV ratio for deposit-taking FIs for which financial statement information is available. Four lines in each panel represent the medians of the LTV ratios for the sample in the four quartiles (q1-q4) of the respective bank characteristics. We take the bank characteristics variables as of one year prior to the origination of the mortgages.

Regarding the asset size (panel (A)), the fourth quartile banks have the lowest median LTV ratios compared with the other quartiles until early 2000s. This implies that the LTV ratio is lower for larger banks, presumably because their average client firms are larger (figure 13, panel (A)) or because larger banks are more risk-averse. However, panel (B) indicates that there is no clear relationship between a bank's capital-asset ratio and the LTV ratio. If anything, the median LTV ratio of the fourth quartile banks (those with higher capital-asset ratio) is higher than the other quartiles during the first half of 1990s. To the extent that a bank with a higher capital-asset ratio is more risk-averse, the result suggests that the lower median LTV ratio of larger banks reflects the characteristics of their borrower firms, i.e., larger size. Alternatively, the result may indicate that a bank with a higher capital-asset ratio can take more credit risks and thus extend loans with higher LTV ratios. Finally, there is no clear relationship between a bank's ROA and the LTV ratio.

3.3. Regression

3.3.1. Variables

The above univariate analyses suggest that although the LTV ratio itself is a measure for the riskiness of the loan (i.e., the exposure of a lender), it likely depends on various factors including characteristics of loans, borrower firms, and lenders. By controlling for these factors, we can see if our univariate results still hold. For consistency with the analyses in section 3.2 and to exclude any possible effect of outliers, we run median (quintile) regressions rather than ordinary least squares. To circumvent the simultaneity, we take borrower and lender characteristics variables as of one year prior to the origination/registration of loans.

Table 1 Variable Definitions

Dependent variables	
LTV	Loan-to-value ratio
Loan characteristics	
L_REV	Revolving mortgage dummy: = 1 if a mortgage is a revolving one
L_PR1-4	Loan priority dummies: *L_PRX* = 1 if the priority rank is *X*th (*X* = 1, ..., 4). The default is fifth or lower priority.
Borrower firm characteristics	
F_LN_SALES	Log of gross annual sales
F_ROA	Return on Asset: = operating profit / total asset
F_CAP	Capital-asset ratio: = net worth / total asset
F_AGE	Firm age
F_IND1-7	Borrower industry dummies: *F_INDX* = 1 if the industry is that indicated by *X* (= 1, ... , 7), where *X* = 1 for Construction, = 2 for Manufacturing, = 3 for Wholesale, = 4 for Retail and restaurant, = 5 for Real estate, = 6 for Transportation and communication, and = 7 for Services. The default is the others.
F_REG1-9	Borrower regional dummy: *F_REGX* = 1 if the headquarters of the firm is located in a region indicated by *X* (= 1, ... , 9), where *X* = 1 for North Kanto, = 2 for South Kanto (Metropolitan), = 3 for Koshin-etsu, = 4 for Tokai, = 5 for Keihanshin, = 6 for Other Kinki, = 7 for Chugoku, = 8 for Shikoku, and = 9 for Kyushu and Okinawa. The default is Hokkaido and Tohoku.
Lender characteristics	
BK_MAIN	Main bank dummy: = 1 if the lender is a main bank (top-listed bank) of a borrower firm
BK_TYPE1-6	Lender type dummies: *BK_TYPEX* (*X* = 1, ..., 6) = 1 if the type of lender is that indicated by *X* (= 1, ..., 6), where *X* = 1 for a regional or second-tier regional bank, = 2 for a Shinkin bank, = 3 for a credit cooperative, = 4 for a government-affiliated financial institution, = 5 for other bank, security company, or insurance company, etc., and = 6 for others (non-banks, credit guarantee corporations, non-financial firms, etc.). The default is city banks
BK_LN_ASSET	Log of asset size
BK_ROA	Return on Asset: ordinary profit / total asset
BK_CAP	Capital-asset ratio: net worth / total asset
Policy measure	
BK_POLICY	FSA's action program dummy: = 1 if a lender is subject to the FSA's Action Program on Relationship Banking (*YEAR* is 2004 or afterwards and the lender type is either 1, 2, or 3 (i.e., a regional, second-tier regional, or Shinkin bank, or a credit cooperative).
Registration year	
YEAR1991-2009	Registration year dummies: *L_YEARX* = 1 if the year is *X* (=1991, ..., 2009). The default is 1990.

A list of variables and their definitions are provided in Table 1. The dependent variable is the LTV ratio. We use three sets of independent variables drawn from section 3.2 as possible determinants of the LTV ratio: loan characteristics, borrower (firm) characteristics, and lender characteristics. Regarding loan characteristics variables, we use a dummy variable for revolving mortgage (*L_REV*) and four dummy variables to capture loan priority (*L_PR1-4*, the default is the loan of which the rank of priority is fifth or lower). The firm characteristics variables are the natural logarithm of sales (*F_LN_SALES*), return on Asset (*ROA*), capital asset ratio (*F_CAP*), firm age (*F_AGE*), nine regional dummies (*F_REG*1-9, Hokkaido/Tohoku is the default), and nine industry dummies (*F_IND1-9*, other industries is the default). Lender characteristics variables are a dummy variable indicating whether a loan is extended by the main bank (as opposed to that from non-main banks, *BK_MAIN*), six dummy variables representing the type of lender (*BK_TYPE1-6*, city banks are the default).

We take lender characteristics we from their financial statements. These include return on assets (*BK_ROA*), the natural logarithm of the total assets (*BK_LN_ASSET*), and the capital asset ratio (*BK_CAP*). However, these variables are available only when the lender is a city, regional, second-tier regional, or Shinkin bank. Thus, the number of observations falls when we use these financial statement variables from 71,751 to 38,017. Thus, we will report estimation results for the specification using these lender financial variables as well as those not using them. In the latter specification, we drop the bank type dummies other than *BK_TYPE1* and *BK_TYPE2*.

In addition to loan-, borrower-, and lender-characteristics, we add a dummy variable *BK_POLICY* that indicates that a lender is subject to the Action Program on Relationship Banking in 2003 by the Financial Services Agency (FSA) of the Government of Japan. We add this variable because the Action Program required that the FSA request that regional banks, Shinkin banks, and credit cooperatives avoid an “excessive” reliance on collateral and personal guarantees when extending loans to SMEs. We thus create a dummy variable that takes a value of one if the registration year is 2004 or later, and if the lender type is one of these three. To the extent that banks accepted the request and became more willing to lend to firms having less real estate, we expect the *BK_POLICY* to have a positive effect on the LTV ratio.

Finally, we use registration year dummies (L_YEAR, 1990 is default) in order to capture cyclicality in the LTV ratio that cannot be explained by the other independent variables. Using these variables we examine whether the counter-cyclicality of the LTV ratios found in section 3.1 survives after controlling for other observable factors.

3.3.2. Results

Table 2 Regression results

Estimation method: Median regression	Panel (A): w/o lender financial variables				Panel (B): w/ lender financial variables			
Dependent variable: LTV	Coef.	Std. Err.	t	P>|t|	Coef.	Std. Err.	t	P>|t|
Loan characteristics								
L_REV	-0.053 ***	0.012	-4.52	0.000	-0.034 *	0.020	-1.69	0.090
L_PR1	-0.801 ***	0.021	-37.96	0.000	-0.602 ***	0.034	-17.81	0.000
L_PR2	-0.159 ***	0.022	-7.12	0.000	0.006	0.036	0.18	0.859
L_PR3	0.097 ***	0.026	3.78	0.000	0.189 ***	0.042	4.53	0.000
L_PR4	0.100 ***	0.031	3.23	0.001	0.121 **	0.050	2.40	0.017
Firm characteristics								
F_LN_SALES	0.178 ***	0.004	40.42	0.000	0.219 ***	0.007	31.36	0.000
F_ROA	0.189 ***	0.025	7.73	0.000	0.417 ***	0.090	4.63	0.000
F_CAP	-0.049 ***	0.005	-9.33	0.000	-0.098 ***	0.019	-5.08	0.000
F_AGE	-0.008 ***	0.000	-21.62	0.000	-0.007 ***	0.001	-13.04	0.000
F_IND1	0.665 ***	0.027	24.23	0.000	0.644 ***	0.046	14.13	0.000
F_IND2	0.568 ***	0.029	19.32	0.000	0.537 ***	0.048	11.14	0.000
F_IND3	0.493 ***	0.029	17.13	0.000	0.474 ***	0.047	9.98	0.000
F_IND4	0.876 ***	0.034	25.66	0.000	0.917 ***	0.055	16.63	0.000
F_IND5	1.141 ***	0.035	32.76	0.000	1.222 ***	0.055	22.15	0.000
F_IND6	0.527 ***	0.039	13.61	0.000	0.493 ***	0.062	7.98	0.000
F_IND7	0.809 ***	0.032	25.58	0.000	0.823 ***	0.051	16.07	0.000
F_REG1	-0.623 ***	0.032	-19.54	0.000	-0.699 ***	0.051	-13.80	0.000
F_REG2	-1.131 ***	0.017	-65.27	0.000	-1.094 ***	0.029	-37.63	0.000
F_REG3	-0.305 ***	0.024	-12.87	0.000	-0.310 ***	0.038	-8.08	0.000
F_REG4	-0.717 ***	0.021	-33.87	0.000	-0.677 ***	0.034	-20.00	0.000
F_REG5	-0.898 ***	0.019	-46.82	0.000	-0.884 ***	0.032	-27.53	0.000
F_REG6	-0.515 ***	0.044	-11.75	0.000	-0.495 ***	0.072	-6.91	0.000
F_REG7	-0.490 ***	0.024	-20.52	0.000	-0.450 ***	0.039	-11.42	0.000
F_REG8	-0.734 ***	0.035	-20.96	0.000	-0.731 ***	0.054	-13.54	0.000
F_REG9	-0.459 ***	0.022	-21.20	0.000	-0.393 ***	0.034	-11.55	0.000
Lender characteristics								
BK_MAIN	-0.007	0.013	-0.54	0.592	-0.029 *	0.017	-1.73	0.084
BK_TYPE1	0.186 ***	0.019	9.84	0.000	0.158 ***	0.038	4.14	0.000
BK_TYPE2	0.126 ***	0.021	6.08	0.000	-0.004	0.055	-0.08	0.939
BK_TYPE3	0.207 ***	0.042	4.90	0.000				
BK_TYPE4	-0.006	0.019	-0.32	0.747				
BK_TYPE5	0.163 ***	0.047	3.46	0.001	0.284 ***	0.093	3.06	0.002
BK_TYPE6	0.004	0.019	0.21	0.832				
BK_POLICY	-0.075 ***	0.020	-3.68	0.000	-0.107 ***	0.038	-2.81	0.005
BK_ROA					-0.287	1.498	-0.19	0.848
BK_LN_ASSET					-0.024 **	0.011	-2.25	0.024
BK_CAP					-1.617 **	0.716	-2.26	0.024
Registration year								
YEAR1991	-0.036	0.038	-0.95	0.343	-0.057	0.057	-1.00	0.317
YEAR1992	0.002	0.038	0.05	0.960	-0.051	0.058	-0.89	0.373
YEAR1993	0.078 **	0.038	2.04	0.041	0.084	0.059	1.42	0.156
YEAR1994	0.201 ***	0.039	5.12	0.000	0.120 **	0.061	1.96	0.050
YEAR1995	0.403 ***	0.039	10.29	0.000	0.346 ***	0.062	5.60	0.000
YEAR1996	0.503 ***	0.039	12.86	0.000	0.460 ***	0.063	7.28	0.000
YEAR1997	0.471 ***	0.038	12.33	0.000	0.409 ***	0.062	6.61	0.000
YEAR1998	0.473 ***	0.038	12.51	0.000	0.438 ***	0.063	6.90	0.000
YEAR1999	0.508 ***	0.038	13.29	0.000	0.446 ***	0.067	6.68	0.000
YEAR2000	0.587 ***	0.037	15.70	0.000	0.587 ***	0.063	9.36	0.000
YEAR2001	0.608 ***	0.037	16.48	0.000	0.577 ***	0.063	9.22	0.000
YEAR2002	0.660 ***	0.037	18.03	0.000	0.652 ***	0.060	10.92	0.000
YEAR2003	0.763 ***	0.036	21.14	0.000	0.775 ***	0.058	13.28	0.000
YEAR2004	0.883 ***	0.037	23.89	0.000	0.937 ***	0.061	15.47	0.000
YEAR2005	1.014 ***	0.037	27.51	0.000	1.119 ***	0.060	18.60	0.000
YEAR2006	1.083 ***	0.037	29.66	0.000	1.193 ***	0.060	19.98	0.000
YEAR2007	1.060 ***	0.036	29.34	0.000	1.154 ***	0.059	19.47	0.000
YEAR2008	0.978 ***	0.036	27.02	0.000	1.029 ***	0.059	17.49	0.000
YEAR2009	0.983 ***	0.037	26.60	0.000	1.051 ***	0.060	17.40	0.000
constant	-0.813 ***	0.072	-11.24	0.000	-1.120 ***	0.211	-5.32	0.000
Number of Observations	71,751				38,017			
Pseudo R2	0.0197				0.0216			

Table 2 shows the regression results. In this table, column (A) represents the results for the baseline specification without lender financial variables. Column (B) shows the result for the specification with lender financial variables. At first glance, we can confirm that most of the variables are significant at high levels of significance in both specifications.

We first focus on the results in column (A). Regarding loan characteristics, the dummy variable *L_REV* representing revolving mortgages has a negative impact on the LTV ratios. This is in contrast with a somewhat ambiguous (rather positive) impact in the univariate analysis in section 3.2.1. This finding implies that when we control for other factors, lenders are more cautious in extending revolving mortgages, probably because they do not specify a maturity. As for priority, we find that the dummies for first- and second-liens (*L_PR1*, *L_PR2*) have substantial negative effects, as opposed to the most junior loans (fifth or more), on the LTV ratios. The coefficients of *L_PR1* and *L_PR2* are -0.80 and -0.16, respectively, which mean that the LTV ratios for first and second lien loans are respectively lower by 80 and 16 percentage points. However, the effects of priorities are ambiguous among loans with third or lower liens. In fact, the coefficients of *L_PR3* and *L_PR4* are significant and positive, meaning that the LTV ratios for third- and the fourth- lien loans are larger than those for lower-lien loans by almost 10 percentage point.

Findings for firm characteristics are on balance consistent with the corresponding univariate results. Firms with larger amount of sales (*F_LN_SALES*) and ROA (*F_ROA*) have higher LTV ratios. These findings imply that larger and more profitable firms are less likely to face financial constraints due to the pledgeability of collateral. Also, the coefficients for the capital asset ratio (*F_CAP*) and for firm age (*F_AGE*) are negative. This implies that sound and established firms do not need to, or do not want to, raise many funds and/or that they have sufficient real properties to pledge.

Turning to the industry dummies, we find that Real estate (*F_IND5*), Retail and restaurants (*F_IND4*), and Services (*F_IND7*) have positive and larger coefficients than the other industries.

This might imply that loans to these industries are insufficiently covered by collateral value. A higher LTV ratio for Real estate firms is consistent with the anecdote that banks that lost traditional customers lent to real estate firms with lax lending standard. As for firms in Retail and restaurants or in Services, the high LTV ratio might be a consequence of their having insufficient real properties to pledge as collateral.

As for regional dummies, we find that the coefficients for the South Kanto (*F_REG2*) and for the Keihanshin (*F_REG5*) dummies are negative and statistically significant, and take lower values than other regional dummies that are also negative and significant. This means that LTV ratios are especially lower in these urban areas. Note that these effects do not reflect differences in firm characteristics such as firm age, firm size, and profitability between urban and rural areas because we have other variables to control for these factors. The two urban dummies rather capture specificity of urban areas not captured by these variables. It may be the case that, due to agglomeration effect, the values of lands in urban areas are highly evaluated in comparison with rural areas, which results in the lower LTV ratios.

With regard to lender characteristics, we find that whether or not the lender is the main bank (*BK_MAIN*) does not materially affect the LTV ratio. Because we already control for the rank of priority, the coefficient of *BK_MAIN* is independent of whether or not the main bank takes a senior position. However, the insignificance might stem from an inappropriate definition of the main banks based on the lender list made by TDB. Coefficients on the bank type dummies indicate that, in comparison with city banks, regional banks (*BK_TYPE1*), Shinkin banks (*BK_TYPE2*), credit cooperatives (*BK_TYPE3*), and other banks and financial institutions (*BK_TYPE5*) set higher LTV ratios.

The effect of the FSA's Action Program as represented by the coefficient of *BK_POLICY* is negative, which contradicts our prior conjecture that the Program encouraged regional or Shinkin banks and credit cooperatives to lend without collateral. One possible interpretation of the result is that these banks became more conservative in extending collateralized loans in response to the Action Program, because the program also urged these banks to resolve their bad loan problems. It might also be the case that although these banks increased the amount of collateral for secured loans, they also increased unsecured loans, which are not included in our data set. Note that the value of the coefficient, -0.075, is lower than that of respective *BK_TYPE* dummies (e.g., +0.186 for regional banks), so the impact of the Program on collateral reliance appears to be small.

The most important finding in this table is that the year dummies exhibit an increasing trend in the LTV ratios from 1991 to 2009 (*L_YEAR1991-2009*). This means that the LTV ratios in the midst of or just after the bubble period were low compared with those afterwards. Thus, the regression results are consistent with the counter-cyclical LTV ratio that we found from the univariate analysis (figure 4). Note that this finding is obtained after controlling for factors represented by the other independent variables. Irrespective of observable loan characteristics and borrower characteristics, banks in Japan during the bubble period did not lend excessively compared with the value of collateral. This implies that the lending standard during the bubble period was not lax on average (evaluated at the median), although loans of larger amount were extended during this period (as shown in figure 3).

The results after controlling for other lender characteristics using the financial variables of lending banks are shown in column (B). We find that the main results are unchanged even if we add such variables, although the number of observation is reduced. Most importantly, we still find that the LTV ratio has an increasing trend during and after the bubble period, which means that the finding is very robust. Focusing on bank's financial variables, the coefficient for *BK_LN_ASSET* is significantly negative, indicating that larger banks set lower LTV ratios. The coefficient for *BK_ROA* is insignificant, but that for *BK_CAP_RATIO* is negative. This means that a bank with a larger capital buffer set lower LTV ratios, ceteris paribus.

We admit that we cannot completely rule out the possibility that unobservable time-varying factors contribute to this increasing trend in both regressions, and that the impact of the time dummies might vary if we could control for such factors. However, we have already controlled for many loan-, borrower-, and lender characteristics. We argue that, for the most part, these controls cover the most likely co-determinants. The only potentially important control that is missing is information on the value of buildings. We argue that this is not likely to materially change our findings.

4. LTV ratio and ex post performance of borrowers

In this section, we examine the relationship between the level of the LTV ratio and ex post performance of the borrowers after the loans secured by real estate are extended. At first glance, the relationship would seem to be obvious: the performance of borrowers with higher LTV ratios would be poorer. The LTV ratio measures the credit-risk exposure for a lender, because it indicates to what extent the lender cannot collect in the case of default and will suffer a loss. In this sense, a loan with a higher LTV ratio is riskier. This is why proponents for the cap on the LTV ratio argue that by setting a ceiling on the amount of loans depending on the value of collateral, we can curb the riskiness of the lender and/or prevent their excessive risk taking.

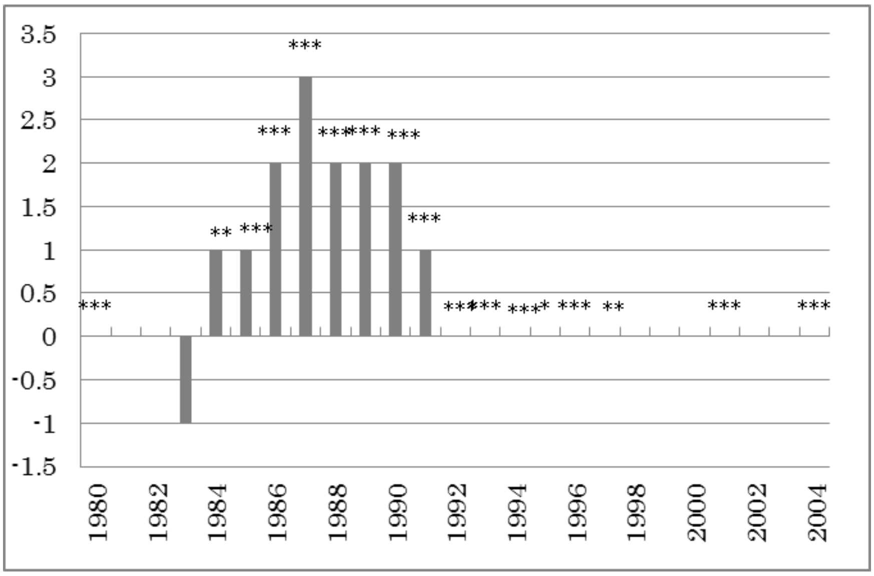
However, as examined in the previous section, the LTV ratio is determined by various factors. If the LTV ratio is optimally set by the lender depending on various factors including the creditworthiness of the borrower, the relationship between the LTV ratio and ex post performance of the borrower is not evident. For example, lenders might set a higher LTV ratio for safer borrowers because they are less likely to default. In such a case, the cap on the LTV ratio rather prevents creditworthy borrowers from borrowing.

To examine the relationship between the LTV ratio and ex post performance of the borrowers, we compare the difference in differences (DID) of the performance variables of borrowing firms. That is, we compare the differences in the performance variables between firms that obtained loans with high and low LTV ratios. We employ DID to eliminate time invariant firm-fixed effects. To do so, we first calculate the difference in each performance variable (say variable X) after five years of the registration of the mortgage (i.e., $X_{t+5} - X_t$, where t is the year of registration). We then compare the median of the difference between firms in the first LTV quartile and those in the fourth, where each quartile is defined using the entire sample firms.

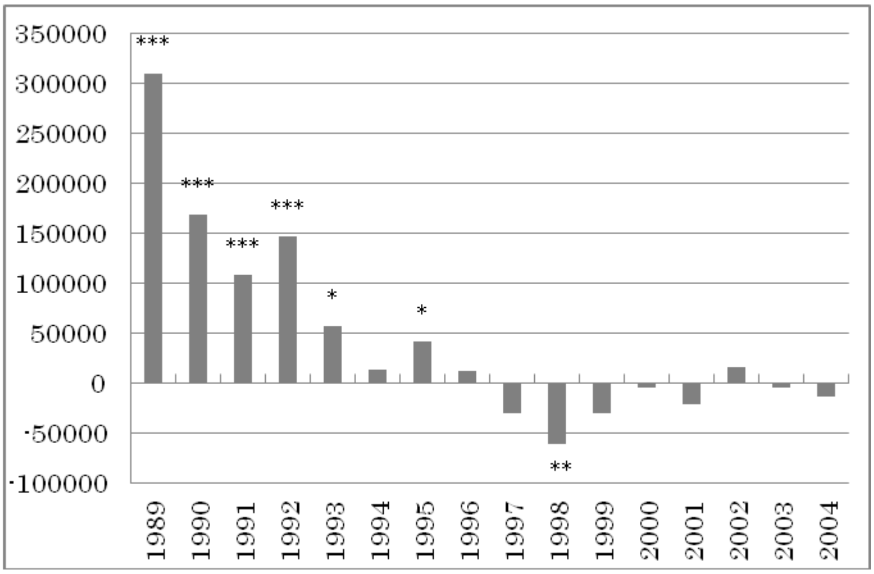
The performance variables that we employ (indicated as X above) are the number of employees, the amount of sales to represent firm growth (in terms of size), ROA to represent profitability, and the capital-asset ratio to represent risk. Other than the number of employees that is available from 1981, the starting year of the window of this analysis is 1989 when all of these variables are available from 1990.

Figure 19 Difference in post five-year performance between 4th and 1st LTV quartile firms

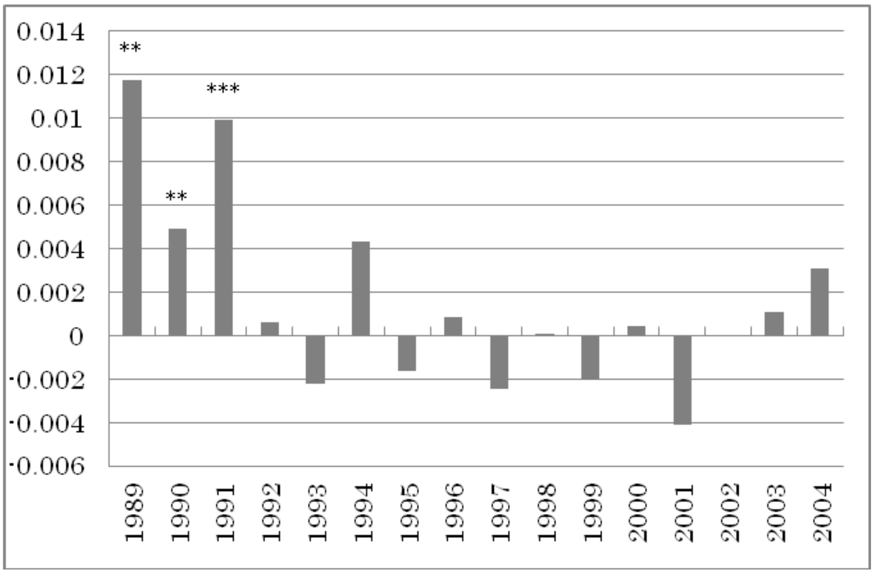
(A) Median # of employee



(B) Median sales



(C) Median ROA



(D) Median capital asset ratio

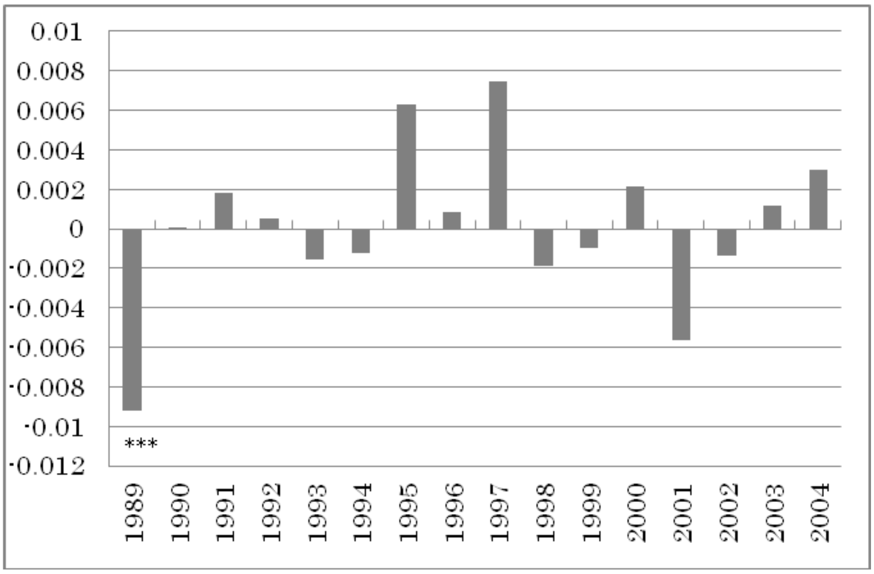


Figure 19 shows the results for the DID analysis. The bars indicate the magnitudes of the difference-in-differences, and the absence/presence of asterisks indicates the results of the chi-squared test on the equality of medians. In this test, we compare the differences in the relevant performance variable (i.e., X_{t+5} - X_t) of two subsamples: the sample of firms in the fourth LTV quartile and those in the first LTV quartile. The null hypothesis of the test is that the two samples are drawn from the populations with the same median. In the figure, ***, **, and * respectively represent that the null hypothesis is rejected at the 1%, 5%, and 10% level of significance.

We find that the results are similar across performance variables except for the capital asset ratio. For the first three variables, the ex post performance of firms obtaining loans with high LTV ratios (those in the fourth LTV quartile) is better than that of firms obtaining loans with low LTV ratios (those in the first quartile) around the peak of the asset price bubble, although such a difference is less obvious in other periods. More specifically, those firms that obtained loans from the late 1980s to the early 1990s with high LTV ratios increased their number of employees (panel (A)), sales (panel (B)), and ROA (panel (C)) as compared to firms with low LTV loans. In contrast, we do not find such superior performance of the high LTV firms after the burst of the bubble, at least to the same level. These findings mean that the performance of high LTV firms was better than that of low LTV ones only around the bubble period. If an anecdote that banks extended loans with lax lending standards during the bubble period were true, we should find poor ex post performance of loans with high LTV ratios. Our findings do not support this conjecture.

Regarding the capital-asset ratio, we find that it is significantly lower for high LTV firms than for low LTV ones in 1989. However, this might simply mean that firms with higher LTV ratios increased their leverage as compared to firms with lower LTV ratios, due to their better performance in the form of increased size and profitability.

On balance, we find that ex-post performance of firms that obtained loans with higher LTV ratios was better than those with lower LTV ratios during the bubble period, but such difference disappeared after the bubble. These findings imply that a high LTV ratio during the bubble period (as well as during the other period) do not reflect banks' lax lending standard in a sense that such loans did not afterwards perform poorly. Rather, high LTV loans originated during the bubble period performed better, at least in hindsight, implying that banks might have extended more loans relative to the collateral values in anticipation of better performance, and they were correct. After the bubble, such a positive relationship between the LTV ratio and firms' ex post performance disappeared, but our findings from this period still tell us that high LTV loans are not necessarily risky loans.

5. Conclusion

Using unique data from the official real estate registries in Japan, this paper took a close look at the LTV ratios of business loans. We find that, although the amount of loans and the value of land pledged as collateral are pro-cyclical, their ratio, i.e., the LTV ratio, exhibits counter-cyclicality. This finding is robust to controlling for various loan-, borrower-, and lender-characteristics, and to controlling for survival bias. We also find that ex post performance of borrowers that are granted loans with high LTV ratios did not perform poorly compared with those granted low LTV loans.

Conventional wisdom argues that banks in Japan employed lax lending standards during the bubble that resulted in problem loans. Our findings suggest that this story is too simplistic story. Indeed we find some evidence for banks' aggressive lending during the bubble period, including an increase in the share of junior lien loans and a larger size of loans in absolute terms extended by *marginal* lenders (i.e., those for which the LTV ratios are high and which observed a surge in the price of lands pledged as collateral). However, at least as far as the average (median) LTV ratios is concerned, we do not find strong evidence for banks' reckless lending during the bubble period. On balance, our findings call for the need for a more nuanced view of bank behavior during credit bubbles.

Our findings also have an important policy implication. Caps on LTV ratios are a hot topic of debate among policymakers. Proponents argue that curbing high LTV loans would enable us to reduce bank risk. Our findings do not support this view. First, a simple cap on LTV ratios may not work well as a practical macroprudential measure because the LTV ratio exhibits counter-cyclicality. Second, the ex post performance of firms with high LTV loans was actually better than that of firms with low LTV loans; had there been an LTV cap during the bubble, it might have prevented promising firms from borrowing.

References

Aiyar, Shekhar, Charles W. Calomiris, and Tomasz Wieladek. (2012). Does Macro-Pru Leak? Evidence from a UK Policy Experiment, NBER Working Paper Series, Working Paper 17822.

Almeida, C., M. Campello, and C. Liu. (2006). The Financial Accelerator: Evidence from International Housing Markets, Review of Finance 10, 321-352.

Bank of Japan. (2012). Financial System Report. October.

Berger, A.N., and G.F. Udell. (2004). The institutional memory hypothesis and the procyclicality of bank lending behavior, Journal of Financial Intermediation 13, 458-495.

Berger, A.N., and G.F. Udell. (2006). A more complete conceptual framework for SME finance, Journal of Banking and Finance 30, 2945-2966.

Borio, C., Furfine, C., Lowe, P., (2001). Procyclicality of the financial system and financial stability: issues and policy options. Bank for International Settlements.

Borio, C., Lowe, P., (2002). Asset prices, financial and monetary stability: exploring the nexus. Bank for International Settlements.

Dynan, Karen. (2012). Is a Household Debt Overhang Holding Back Consumption? Brookings Papers on Economic Activity, Spring.

Financial Stability Board. (2011). Thematic Review on Mortgage Underwriting and Origination Practices: Peer Review Report. 17 March.

Financial Stability Board. (2012). FSB Principles for Sound Residential Mortgage Underwriting

Practices. 18 April.

Gerlach, S., and W. Peng. (2005). Bank lending and property prices in Hong Kong, Journal of Banking and Finance 29, 461-481.

Goodhart, C. A. E., A. K. Kashyap, D. P. Tsomocos, and A. P. Vardoulakis. (2012). Financial Regulation in General Equilibrium. NBER Working Paper No. 17909, August.

Horvath, E., (2002). Lending booms, credit risk and the dynamic provisioning system. In: Studies on the Procyclical Behaviour of Banks. National Bank of Hungary Occasional Papers #10. http://www.mnb.hu/english/4_public/ocassional/opaper10.pdf.

Hoshi, T. and A. Kashyap. (2001). *Corporate Financing and Governance in Japan*. Cambridge, MA: MIT Press, 2001.

Illuecaa, Manuel, Lars Nordenb, and Gregory F. Udell. (2012). Do changes in the timeliness of loan loss recognition affect bank risk taking? Working paper.

International Monetary Fund. (2011). Global Financial Stability Report. April.

Iacoviello, M. (2005). House prices, borrowing constraints, and monetary Policy in the business cycle, American Economic Review, 739-764.

Igan, D., and H. Kang. (2011). Do loan-to-value and debt-to-income limits work? Evidence from Korea. IMF Working Paper.

Kashyap, Anil, and Jeremy Stein. (2004). Cyclical implications of the Basel-II capital standards, Federal Reserve Bank of Chicago, Economic Perspectives 28, 18-31.

Kim,Taejin, and Vishal Mangla. (2013). Optimal Capital Regulation with Two Banking Sectors, Working paper

Lee, D., C. J. Mayer, and J. Tracy. (2012). A New Look at Second Liens. NBER Working Paper No. 18269, August.

Lim, C., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyad, T. Wezel, and X. Wu. (2011). Macroprudential Policy: What Instruments and How to Use Them? IMF Working Paper 11/238.

October.

Stein, J. (1995). Prices and Trading Volume in the Housing Market: A Model with Down Payment Effects, Quarterly Journal of Economics 110, 379-406.

Ueda, K. (2000). Causes of Japan's banking problems in the 1990s. In T. Hoshi and H. Patrick (eds), Crisis and Change in the Japanese Financial System. Boston: Kluwer Academic Publishers.

Appendix A: Estimation of the current value of land

A.1 Hedonic approach

As explained in section 2.2, the denominator of LTV ratios, the value of real estate, is estimated using the hedonic approach that is widely used in the field of real estate economics. This approach assumes that the price of a land is the sum of the values of its attributes such as size, a floor area ratio, a physical distance to metropolis in the region, and so on (see Ohnishi et al., 2011). In particular, we assume that the log price of a land *i*, $\log P_i$, is the sum of K components:

$$\log P_i = \sum_{k=1}^{K} x_{ik} .$$

In the actual estimation, we follow the following steps. First, using the dataset of "Public notice of land prices (PNLP)" provided by the Land Appraisal Committee of the Ministry of Land, Infrastructure, Transport and Tourism of the Government of Japan, we estimate a hedonic model where the log price of lands complied in PNLP is explained by different explanatory variables. The explanatory variables in this estimation include the size of land in logarithm, a regulatory upper limit of the floor area ratio, an Euclidean distance from the relevant land to the one whose price is the highest in the same prefecture, the square term of the Euclidean distance, an Euclidean distance from the land to the one whose price is the highest in the same city, the square term of the distance, the latitude of the land and its square term, the longitude of the land and its square term, and dummy variables representing the type of land districts where the land is located (i.e., whether the land is located in a residential, commercial, or industrialized district).

We run jillion of regressions for different combinations of land district type (residential, commercial, or industrialized), year, and region. As a unit for the regions, we in principle use prefecture, but in the case when the number of observations in a prefecture is not large enough to warrant trustable estimation results, we use an area including several neighboring prefectures as a unit for the region. However, this is the case only for a subset of the industrialized lands.

Second, based on the parameters obtained from the estimation of the above regressions, we projects (predicts) the current prices of the lands in our dataset. The projection is applied to the lands in our dataset, the number of which is far larger than the number of lands in the PNLP dataset. Because we have different sets of parameters depending on land district type, year, and region, when we project the price of a particular land in our dataset, we use the parameters for the same land district type, year, and region. For example, suppose land A in our dataset is in a residential district in Tokyo prefecture in year 1990. Then, its current price is obtained by projecting the parameters of the regression using observations in a residential district in Tokyo prefecture in year 1990 in PNLP.

Finally, the value of the land is obtained by multiplying its projected price and the acreage obtained from the TDB database.

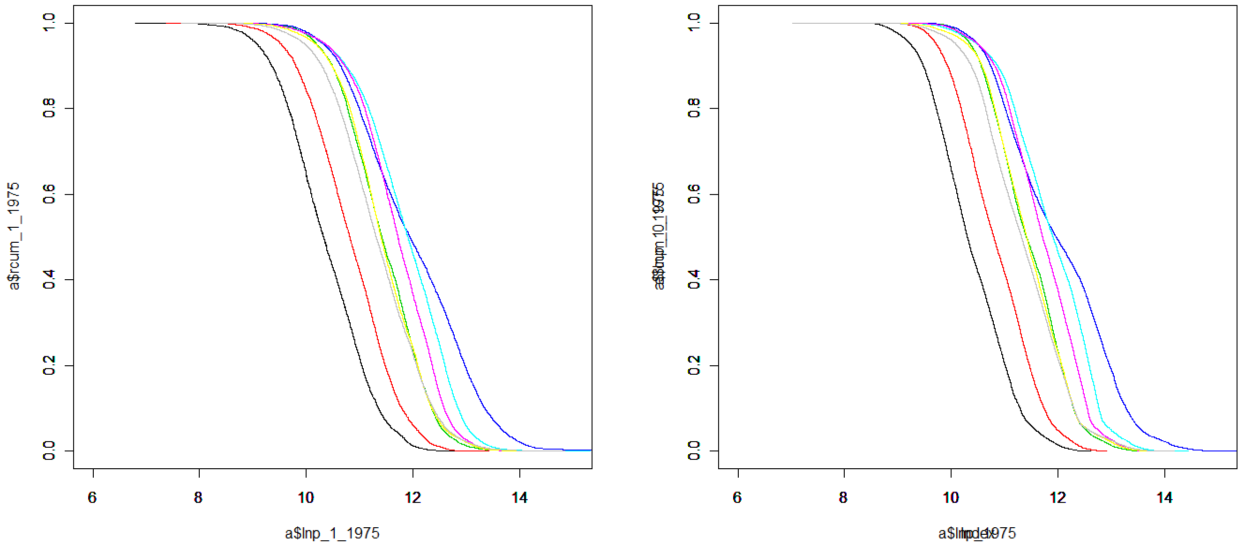
A.2 Estimation Results

As for the first stage estimation of hedonic models, the numbers of the regressions that we run for lands in residential districts and in commercial districts are both 1,738 (= 47 prefectures times 37 years, except for Okinawa in year 1975), and that for lands in industrial districts is 555 (15 regions times 37 years).

Figure A-1: In-sample comparisons between cumulative distributions of estimated and actual prices (PNLP)

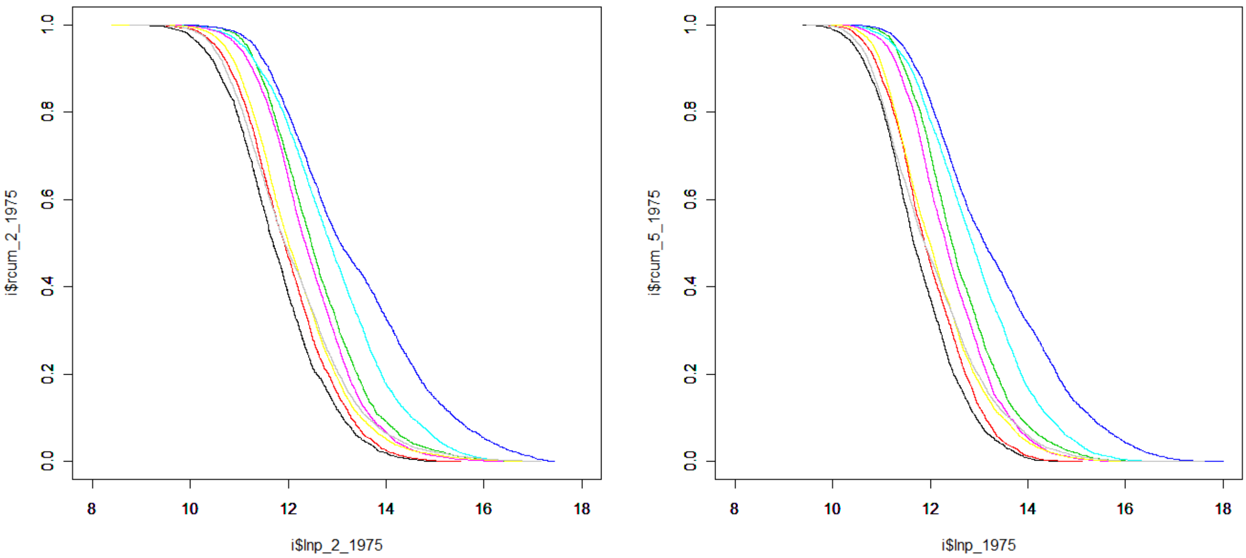
[Residential land]

[Estimation] [Actual]



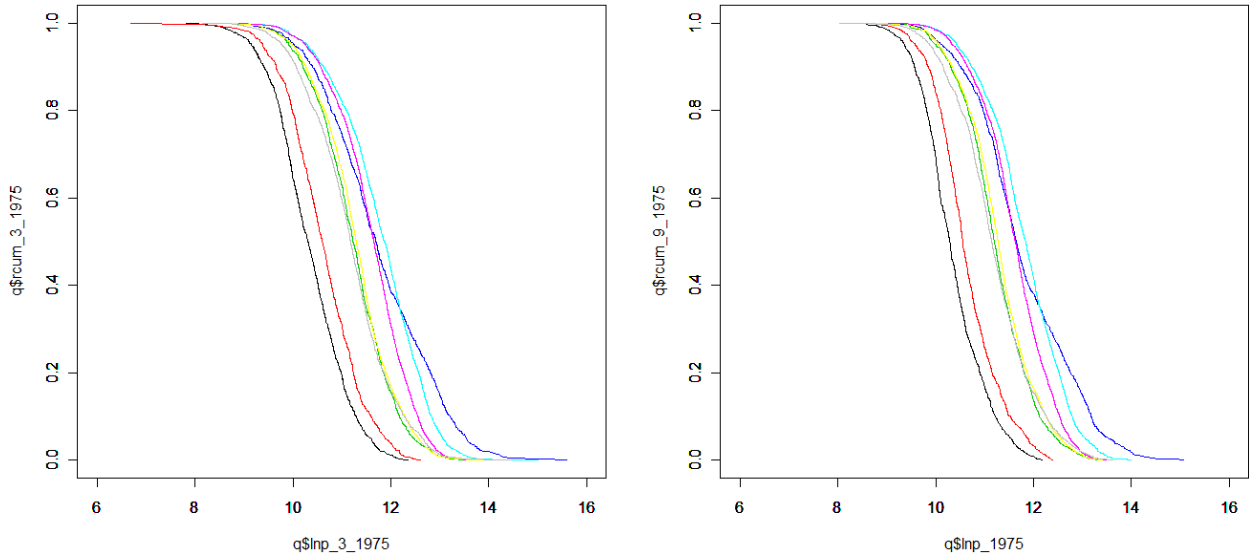
[Commercial land]

[Estimation] [Actual]



[Industrial land]

[Estimation] [Actual]



Notes: Each colored-line represents the following year: black 1975, red 1980, green 1985, blue 1990, light blue 1995, purple 2000, yellow 2005, gray 2010.

To confirm the accuracy of the prediction using the coefficients obtained from the hedonic estimation, in-sample comparisons are shown in figure A-1. In the figure, we show the cumulative distributions of the predicted prices (left panels) and the actual PNLP prices (right panels) of the lands in the PNLP dataset for each of the three types of land districts. We find that the distributions are similar in all the panels, which justifies the prediction using the estimated coefficients.

A.3 Projection Results

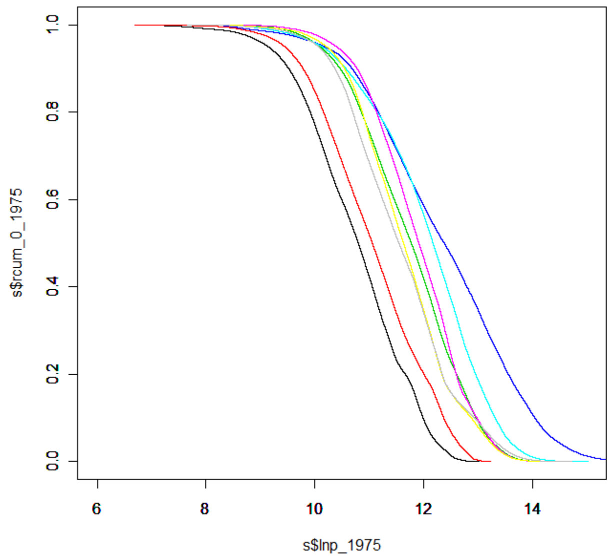
Based on the estimated coefficients obtained from the hedonic estimations using the PNLP dataset, we made projections of the prices of the lands in our dataset. We use the same parameters for lands in the same land districts, prefecture, and year. In doing so, we excluded outliers from our sample for empirical analysis in the following manner. For each combination of land district type, prefecture, and year, we dropped observations whose projected prices were higher than the highest price of lands in the corresponding combination in the PNLP dataset. We also dropped those observations whose projected prices were lower than the lowest price in the PNLP database in the relevant year.

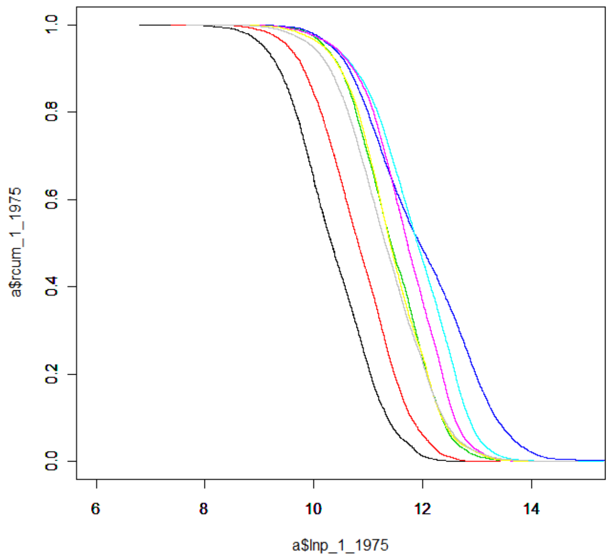
Figure A-2: Pot-of-sample comparisons between cumulative distributions of projected prices on the TDB dataset and actual prices in the PNLP dataset

[Residential land]

[Projection (TDB)]

[Actual (PNLP)]

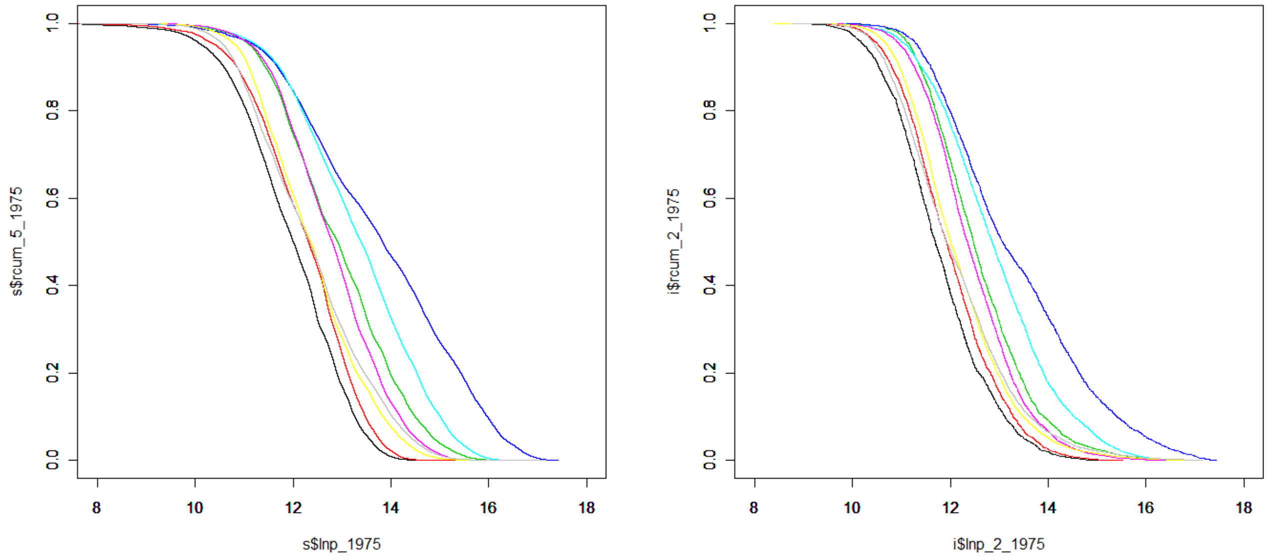




[Commercial land]

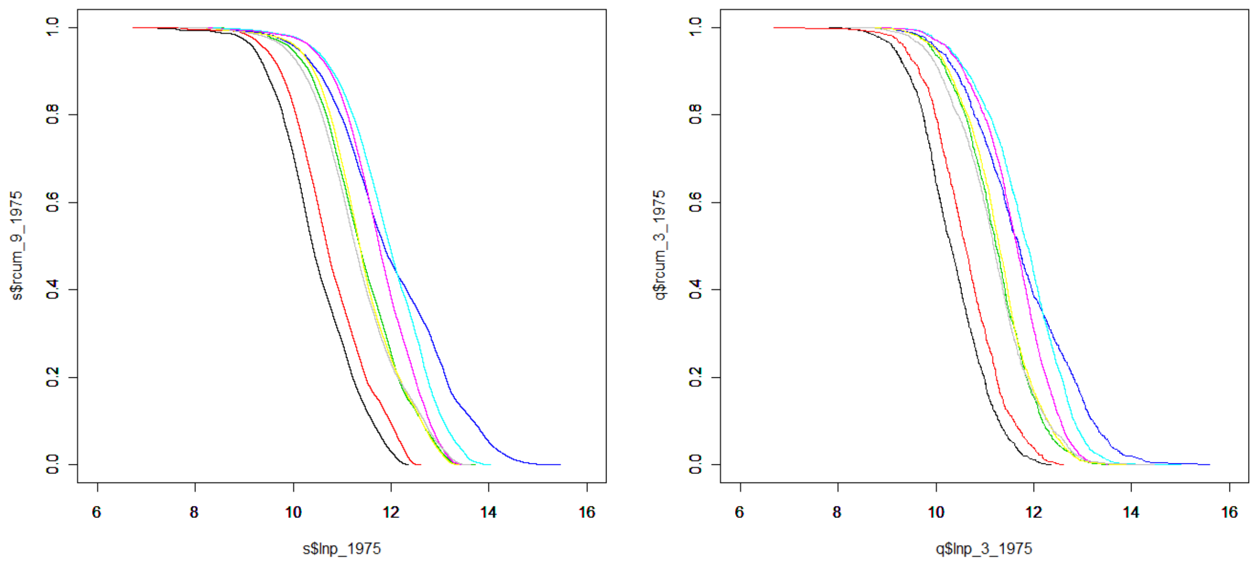
[Projection (TDB)]

[Actual (PNLP)]



[Industrial land]

[Projection (TDB)] [Actual (PNLP)]

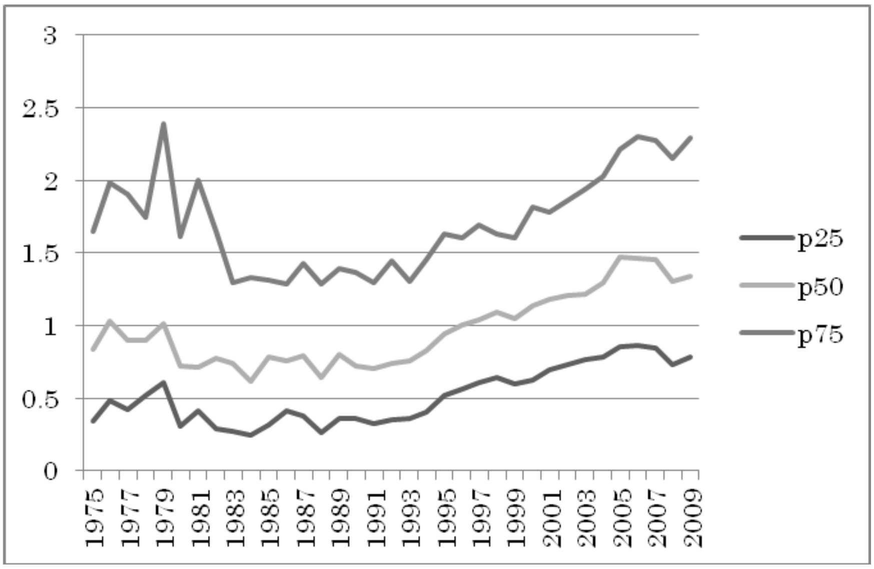


Notes: Each colored-line represents the following year: black 1975, red 1980, green 1985, blue 1990, light blue 1995, purple 2000, yellow 2005, gray 2010

Figure A-2 shows the cumulative distributions of the projected prices of lands in our TDB dataset (left panels) and the actual prices in the PNLP data (right panels) for each type of land districts. Although the projected prices are available for a larger number of lands than the actual prices in the PNLP data, their distributions are similar, which supports our use of the projected prices to calculate the LTV ratios.

Appendix B: LTV ratio for residential loans

Figure B-1: LTV for residential loans



As explained in the section 2.1, we have some data of mortgages for residential loans. Although the number of observations for residential mortgages is small (less than 10% of the business loans), we can calculate their LTV ratios as well. In this appendix, we report them here for a comparison purpose. Figure B-1 shows the 25, 50, and 75 percentiles of the LTV ratios for mortgages for residential loans. Although the figure fluctuates because of the small sample, the overall trend is similar to that of business loans (figure 4). Comparing the absolute levels, the ratio for mortgages for residential loans shown in figure B-1 is on average lower than that for business loans in figure 4. Note, however, that we also find mortgagees for residential loans being more likely to have the first lien than those for business loan, so their difference in levels might be due to the differences in priority.