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Collateral value, firm borrowing, and forbearance lending: an empirical study of Taiwan

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Abstract

This paper investigates whether banks exercise forbearance lending to troubled firms by presenting a stylized model and then testing the hypotheses implied by this model, using firm-level data of Taiwan. During 1991–1996 when the economy started to show signs of weakening, banks are found to have exercised forbearance lending across all types of firms, hoping that the economy would soon recover to salvage those ailing firms. During 1997–2001 when the recession went even deeper, banks were found no longer to forbear loans. This period saw a more rapid decline in property prices, which coincided with a wave of asset liquidation during this period.

JEL Classification: E50; G20; C23

Keywords: Collateral value; Forbearance lending; Government bailout; Taiwan

1. Introduction

Previous works that emphasize anticipated government subsidies and bailouts as major sources of moral hazard find that they lead to ex-ante over-investment and asset price ‘‘bubbles’’, and ex-post regulatory forbearance. For example, Cargill et al. (1997) argue

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that Japan's government has adopted ''buy time'' policies since the burst of its real estate market and stock market boom in the early 1990s, such as relaxing bank capital requirements, allowing banks to hold accumulating nonperforming loans without special write-offs. The Japanese government has also permitted insolvent financial institutions to operate, in the hope that when the economy and the real-estate market recover, these financial institutions will be salvaged from bankruptcy.

In contrast to the popular ''regulatory forbearance'' story, we argue that financial institutions have incentives to exercise ''private forbearance'' by rolling over nonperforming loans. As observed by Okina and Shiratsuka (2002) and Mori et al. (2001), even though the amount of Japanese banks' nonperforming loans rose significantly after stock and real estate prices crashed in the early 1990s, financial institutions continued to lend to unprofitable firms in order to prevent loan losses from materializing. The reason was that the value of collateral was hardly able to cover their losses.

In this paper we investigate whether banks exercise forbearance lending to firms during economic downturns by first presenting a stylized model and then empirically test the hypotheses implied by this model, using Taiwan's firm-level data during 1991–2001. Our model is based on Chen and Chu's (2003). They investigate the foreclosure policy of collateral-based loans in which the endogenous collateral value plays a crucial role. The idea is that collateral value may drop too low when banks call in loans by auctioning off borrowers' collateral and this makes clearing up nonperforming loans less attractive. The model demonstrates that banks may only downsize loans (partial liquidation) or roll-over all of the nonperforming loans in bad times, rather than wipe out all long-term investments by seizing collateral of little market value.

Here we present a modified version of Chen and Chu's (2003) model. In our current model, we show that when forbearance lending exists the amount of bank loans may not decrease significantly or may even increase in response to declining borrowers' collateral value or deteriorating profitability and balance sheets of the borrowing firms. The model thus implies that the financial status of firms and the value of collateral may exhibit a nonpositive correlation with the amount of bank loan, when banks exercise forbearance lending. We then put this hypothesis to test, using corporate panel data on Taiwanese nonfinancial firms.

One paper that is related to this work is Sekine et al. (2003). A premise for their testing is that when forbearance lending exists the loan supply function should be nonlinear in firms' financial condition. That is, forbearance lending occurs only when firms' financial status is poor enough. We adopt this formulation as one of our empirical testings.

The other main result of Sekine et al. (2003) shows that Japanese banks exercised forbearance lending mainly to construction and real estate industries, while loans to manufacturing firms declined monotonically throughout the 1990s. Although it is conceivable that, for the construction and real estate industries, real estate prices which constitute the value of collateral and profitability are the most important factor in determining bank lending, it is a prevalent feature in Asian economies and elsewhere that all types of firms are often required to pledge collateral in order to borrow from banks. Thus, collateral value acts as a common shock to all sort of firms that not only are closely associated with real estate businesses, but also to those that rely on these assets as collateral. Therefore, it is likely that banks may exercise forbearance lending on all sorts of firms in a bank-based financial system in which loan-making is primarily determined by a collateralizable asset's value. An important difference of this paper from Sekine et al. (2003) is that our testings are mainly motivated by the change in collateral value. In the estimation we explicitly incorporate property prices as a proxy for collateral value that firms are able to pledge to their banks.

Our main empirical results show that in the first half of our sample (1991–1996), banks are found to exercise forbearance lending for all types of firms. On the other hand, during the second half of our sample period (1997–2001), when the effect of the Asian crisis set in, the recession went even deeper, and we find that forbearance lending was no longer present and the amount of loans shrunk sharply. This period also saw a more rapid decline of property prices, which coincided with substantial liquidation of forfeited properties during this period. Furthermore, since the government directly intervened in the loan market by coercing banks to extend loans to troubled firms during this period, we find that the policy was never effective as expected.

The rest of the paper is organized as follows. Section 2 provides the background for the bank loans and asset prices in the 1990s and how the government reacted. Section 3 analyzes a simple model in which we investigate how forbearance lending may arise, and then derive a testable hypothesis. Section 4 outlines the empirical model and discusses the estimation strategies. Section 5 presents the results of empirical analysis. Section 6 concludes.

2. Background

2.1. Bank loans and asset prices in the 1990s

As plotted in Fig. 1a and b, by the end of 2001 the average house price in Taiwan declined by 35 percent steadily from the peak around early 1994, and the stock price index plunged in early 1990 by more than 75 percent from its peak in just 6 months.[1] It is clear that the stock prices fluctuated more substantially than housing prices did. Even though ‘‘leveraged stock purchases’’ was widespread ever since the late 1980s, meaning that the movement of the equity market was also related to firm borrowing, reliable data are not available to assess the magnitude of using this type of financing. We concentrate here on housing prices as the major collateral for borrowing.

Fig. 1c shows the growth rates of aggregate bank credit to the private sector by domestic banks from 1992:Q3 to 2001:Q4. Two bank credit cycles are observed: the average growth rate of the first cycle was 12.46 percent and the second only 8.64 percent. The bank credit growth during the second cycle exhibited a sharper decline than the first beginning in 1998, which chronicled the impacts of the financial crisis on the local bank loan market, and then plunged into negative growth in 2001.

[1] The average real estate price is compiled by Xin-Yi Real Estate, the largest and the only publicly traded real estate company on the Taiwan Stock Exchange. Furthermore, real estate prices dropped with huge regional diversity. In particular, by the end of 2000, the real estate prices in the mid- and south-Taiwan dropped by 50 percent from their peaks around 1993.

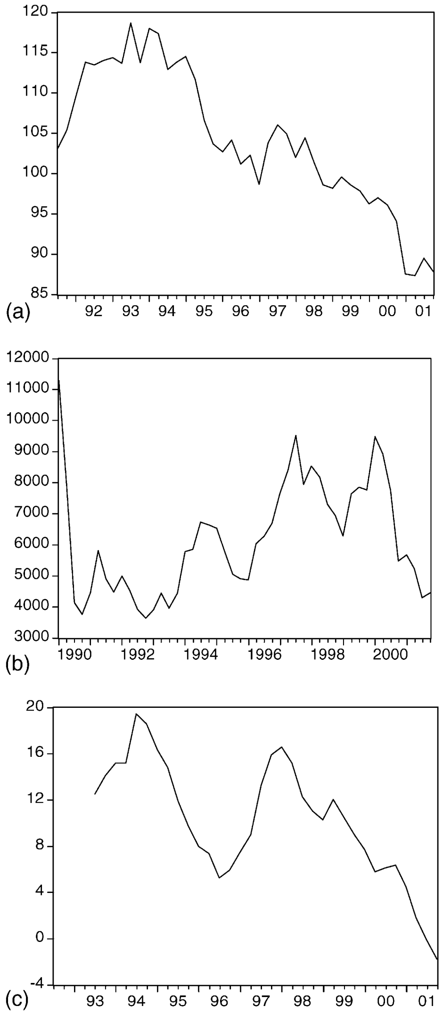

Fig. 1. (a) Average real estate price index of Taiwan. (b) Taipei stock market index. (c) Growth rates of aggregate loans to private sector by domestic banks.

Even though official statistics on examining bank statements suggest that the nonperforming loans (NPL) ratio remained at a low level, the NPLs were believed to have risen considerably in the first half of the 1990s.[2] In Fig. 2 the NPL ratio of domestic banks was extremely low before 1997, averaging 1.82 percent during 1991–1996. The NPL ratio then increased rapidly to nearly 8 percent in 2001, averaging 5.02 percent during 1997–2001.

[2] Casual reports suggest that banks tried to cover up the increase in their nonperforming loans by rearranging loan payment schedules without reporting this to the banking authorities.

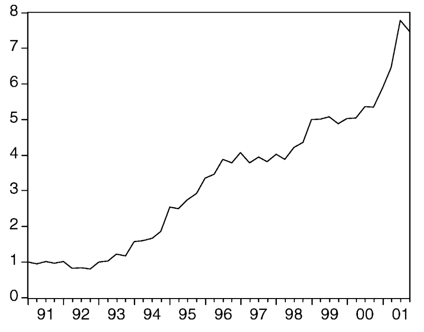

Fig. 2. Nonperforming loan ratios of domestic banks.

Note that bank loans other than mortgages are often backed by real estate or land. Thus, a decline in real estate/land prices will significantly erode the value of the collateral backing these loans and thus should affect, either positively or negatively, the incentives of banks to extend loans. Given a distorted incentive discussed above, financial institutions could have continued to channel resources to their nonprofitable borrowers to keep them from going bankrupt, because auctioning off collateral only suppresses the value of collateral to an even lower level which will not help much in recovering banks' losses.

2.2. *The reaction of the government*

Taiwan's government has been very active in directly intervening in both the stock market and the real estate market since 1996. For example, government authorities pooled the resources of public retirement funds and insurance funds and the postal savings system to establish a stock market stabilization fund. The fund directly buys and sells stocks when the market is considered to be subject to "nonfundamental factors". For the real estate market, the central bank arranged low-rate loans to first-time home buyers in order to revive the real estate market.

The authorities further took an unusual step to directly interfere in the roll-over decisions of commercial banks beginning in 1998. The central bank several times urged commercial banks to roll-over loans to those firms that had been making interest payments on schedule. As the nonperforming loans problem became more severe, in October 2000 the administration pressured banks by various means to engage in a 6-month loan roll-over scheme to troubled firms.

An interesting question is whether government intervention is effective as expected. Suppose that the government scheme was effective in curbing the decline of bank loans, and that our estimation results suggest of forbearance lending did exist after 1998. It is then difficult to tell whether the "forbearance" was due to banks' voluntary reaction or because of government intervention. On the other hand, if we find no forbearance of any kind during the period when the government intervened, then it is evident that the "public forbearance" was ineffective.

3. A simple model

The model presented here is based on a simplified variant of Chen and Chu's (2003) model. We consider a small open economy with three groups of agents: banks, entrepreneurs, and landlords. There are three periods indexed by $t = 0$, 1, and 2. All agents are assumed to be risk neutral and consume only at date-2. There are two types of goods: a consumption good and a durable asset (land). Land is initially held by entrepreneurs and landlords and its aggregate supply is assumed to be fixed at K.

Each entrepreneur is endowed with a long-term investment project which yields a stochastic return at date-2, $y_2 = \tilde{A}k_0$, where k_0 is the level of the durable asset invested at date-0 and $\tilde{A}$ is a random variable. At date-1 an additional amount of working capital ωk_1 in terms of consumption good is required if the project is continued, and $\omega > 0$ is a constant. The lenders will supply the working capital when deciding whether to liquidating the productive asset. An aggregate shock z is drawn from the set $(0, 1)$ according to the uniformly distributed probability density function $g(\bullet)$. Conditioned on z, $\tilde{A}$ is independently and identically distributed across borrowers; $\tilde{A}$ equals $A > 0$ with probability z and equals 0 with probability $(1 - z)$. The realization of $\tilde{A}$ at date-2 is publicly observable.

At date-0, an entrepreneur's budget constraint is given by

$$q_0 k_0 \leq q_0 k_{-1} + b_0, \tag{1}$$

where q_0 is the date-0 price of the durable asset, b_0 is the date-0 amount of borrowing, and k_{-1} is an entrepreneur's initial asset endowment. The gross interest rate r is normalized to be unity. The banking industry is competitive, so that borrowers have all the bargaining power when renegotiating their debt with their banks at date-1. This implies that banks earn an expected zero profit. Banks auction off the collateralized asset when a borrower defaults. Finally, landlords hold the remainder of the asset k' which is not used by entrepreneurs. The per period rental rate of the asset for alternative uses is given by $H'(k'_t)$. where $H(\bullet)$ satisfies the usual neoclassical assumptions, $H'(x) > 0$, $H''(x) < 0$ for all x. The asset market clearing condition is given by $K = k'_t + k_t$, $t = 0, 1$.

At date-1 a public signal is revealed which is perfectly correlated with the realization of probability z. We make two main assumptions. First, the investment technology is specific to each entrepreneur and the human capital of entrepreneurs is inalienable. Second, the entrepreneur can hide a fraction $(1 - \theta)$ of the date-2 project return, $0 < \theta < 1$.[3] Given these assumptions, banks will consider whether to renew loans based on the new information available at date-1. The condition whether a bank renews loans will be derived as a part of the ex-ante equilibrium contract.

Since banks have only limited enforcement ability at date-2, borrowers can negotiate with their banks over their debt repayments at date-1. Moreover, because borrowers have all the bargaining power, they are able to reduce their debt repayments to a fraction θ of

[3] The first assumption means that an entrepreneur cannot commit to his specialized investment project and that the project yields nothing if the entrepreneur walks away. See [Hart and Moore (1994, 1998)] for details. The second assumption can be justified by a bank's limited capability to track down run-away borrowers.

total project return; that is, the fraction of cash flow that can be recovered by banks.[4] Foreseeing the possibility that entrepreneurs may threaten to walk away from production at date-1, banks do not lend more than the expected value of the collateral:

$$b_0 \leq q_1 k_0, \tag{2}$$

where q_1 is the expected date-1 asset price. Condition (3) also governs the behavior of asset prices over time so that no arbitrage opportunity is allowed:

$$q_0 = H'(k_0') + q_1. \tag{3}$$

Now consider the date-1 ex-post efficient cutoff given the observation of z from the social point of view. Let $q_1(z)$ and $k_1(z)$ be the date-1 equilibrium asset price and investment, given the observation of the signal. From the social point of view, a project should be terminated if the liquidation value of the project is greater than the expected return of the project

$$q_1(z) > zA - \omega,$$

and continued if otherwise. Since $q_1(z) = H'(K - k_1(z))$, we consider $H'(\cdot)$ to be such that $H'(K - k_1(z)) = \delta k_1(z)/K$, where $\delta > 0$. Suppose the signal indicates that $q_1(z) \leq zA - \omega$; then it is ex-post efficient to continue the project and thus $k_1(z) = k_0$. Denote the threshold value $\bar{z}$ such that there will be no liquidation at all when $z \geq \bar{z}$, where $\bar{z}$ satisfies $\delta k_0/K = \bar{z}A - \omega$. We thus have $\bar{z} = (\delta k_0 + \omega K)/AK$.

On the other hand, we denote $\underline{z}$ to be such that when $z < \underline{z}$, the entire project should be liquidated, where the cutoff $\underline{z}$ satisfies $0 = \underline{z}A - \omega$, or $\underline{z} = 0$. When z is between 0 and z, an equilibrium requires that $\delta k_1(z)/K = zA - \omega$. The date-1 investment $k_1(z)$ can be solved accordingly, $k_1(z) = (zA - \omega)K/\delta$. The threshold z can be referred as the ex-post efficiency cutoff.

3.1. The equilibrium contract

The equilibrium contract consists of date-0 investment and date-1 investment given z and $\{k_0, k_1(z)\}$. The entrepreneur's problem is to maximize his expected returns $E[(1-\theta)zAk_1(z)]$, subject to the borrower's budget constraint (1) and borrowing constraint (2), and the banker's participation constraint

$$E[z\theta Ak_1(z) + (k_0 - k_1(z))q_1(z) - \omega k_1(z)] \geq b_0, \tag{4}$$

and also the constraint $0 \leq k_1(z)$ and $k_1(z) \leq k_0$. Note that in (4) lenders receive proceeds from projects $z\theta Ak_1(z)$ and from selling off the asset $(k_0 - k_1(z))q_1(z)$, while their opportunity costs include the initial lending b_0 and extra cost of working capital $\omega k_1(z)$.

Let λ be the Lagrangian multiplier of the borrowing constraint. Together with our assumption of a uniform distribution of z, the equilibrium contract has the following properties.[5] The details are in Appendix A.

[4] See Hart and Moore (1998) for more details in the analysis of renegotiation and determination of debt repayment.

[5] If $E(\pi)\theta A - \omega > q_1$, then the optimal contract features $k_1(\pi) = k_0$ for all π. There will be no asset liquidation at date-1 for any realization of π.

Proposition 1. *Suppose* $E(z)\theta A - \omega \leq q_1$, $\max_z[z\theta A - \omega] > q_1$. *The optimal contract thus features* $k_1(z) < k_0$ *for some* z. *There exist a set of thresholds* (z^{**}, z^*) *and such that* $k_1(z) = k_0$ *for* $z \geq z^*$, *and* $0 \leq k_1(z) < k_0$ *for* $z^{**} \leq z < z^*$, *where the critical values are given by*

$$z^* = \frac{\lambda\delta k_0}{[A(1-\theta) + \lambda(A\theta - \omega)]K}, \qquad z^{**} = 0.$$

This says that the equilibrium contract may specify partial or total disruption of loans, depending on the realization of z.[6] When the signal is such that $0 < z < z^*$, the date-1 asset price is

$$q_1(z) = \frac{z[A(1-\theta) + \lambda(A\theta - \omega)]}{\lambda}, \tag{5}$$

which says that in equilibrium the liquidation stops at where the land price equals the expected return of the project weighted by the multiplier λ. Since $q_1(z) = H'(K - k_1(z))$, the date-1 investment given z, $k_1(z)$, is then given by

$$k_1(z) = \frac{zK}{\lambda\delta}[A(1-\theta) + \lambda(A\theta - \omega)], \tag{6}$$

which is a continuous and increasing function of z.

We say that *forbearance lending* arises when the equilibrium contract specifies a lower level of liquidation for a given realization of the signal, compared with the foreclosure policy under ex-post efficiency, i.e., $z^* < \bar{z}$. The condition can be derived to be $\lambda < \lambda^*$, where

$$\lambda^* = \frac{A(1-\theta)(\delta k_0 + \omega K)}{A\delta k_0 - (\delta k_0 + \omega K)(A\theta - \omega)}.$$

Note that when ω is arbitrarily small, λ^* approaches 1.

Proposition 2. *Forbearance lending arises when the shadow price of the borrowing constraint* λ *is smaller; specifically, when* ω *is arbitrarily small and* $\lambda < \lambda^*$, *we have* $z^* < \bar{z}$.

Proposition 2 states the condition for the existence of forbearance lending, that is, λ cannot be too large, in which case the optimal date-1 investment is higher than the investment under ex-post efficiency criterion. In other words, the quantity of liquidation is smaller than that under ex-post efficiency. The intuition behind Proposition 2 is that λ corresponds to the shadow price of the borrowing constraint. When λ is small, the borrowing constraint is less binding and thus the corresponding shadow price is smaller. By (5) and (6), it is clear that $dq_1(z)/d\lambda < 0$ and $dk_1(z)/d\lambda < 0$ for $0 < z < z^*$, i.e., date-1 investment and asset price will be higher. This echo the fact that the optimal cutoff z^* are lower than $\bar{z}$.

[6] The condition is that banks' ex-ante expected project return per unit of investment is not larger than the expected value of the date-1 asset price, while banks' ex-post expected project return per unit of investment can be large enough for some π.

In Appendix A, we solve for the equilibrium of the model $\{k_0, q_0, q_1, \lambda\}$ and then compute the corresponding critical values $\{z^*, \lambda^*\}$, in terms of parameters $\{k_{-1}, K, A, \theta, \delta\}$. We then conduct a numerical example to illustrate the comparative statics around the neighborhood of the equilibrium. We summarize the results in the following lemma.

Lemma 1. *Given the assumptions that z is uniformly distributed and* $H'(K - k_1(z)) = \delta k_1(z)/K$

(1) λ *is increasing in* k_{-1} *and* δ, *and decreasing in* K, A, *and* θ;
(2) *both date*-0 *investment and asset price* (k_0, q_0) *are increasing in* k_{-1}, K, A, θ, *and* δ.

Given Lemma 1, when the entrepreneurs hold less land initially (lower k_{-1}), the user cost of land is lower (lower δ), the quantity of land available for development increases initially (higher K), the expected return of the project is higher (higher A), creditors can better enforce repayments (higher θ), it is ex-ante more likely that forbearance lending will occur.

We next derive a testable hypothesis for detecting ex-post forbearance lending. First, note that the total amount of loans extended at date-1 is $(1+\omega)k_1(z)$ and also recall that when $z < z^*$, productive assets are partially liquidated, and thus asset price decline. In Appendix A, we find that when

$$\frac{\Lambda k_0}{1+\omega} < z < z^* = \Lambda k_0,$$

total date-1 loans increases while asset price decline. This says that when z is realized in the range stated above, i.e., the economy is going into a downturn, then the land price $q_1(z)$ drops while the total loans $(1+\omega)k_1(z)$ may still increase. This generates a negative correlation between date-1 total loans and asset price.

Second, when the threshold value z^* is lower, meaning that forbearance lending is the likely scenario, a low realization of z will be more likely to generate the observation that the amount of bank loans is nonpositively correlated with firms' financial stance (economic fundamentals).

In sum, our hypothesis is that forbearance lending occurs if we observe that the amount of bank loans is nonpositively correlated with firms' rate of returns on investment and land value, and nonnegatively correlated to firms' debt service burden.

4. Estimating the loan supply to firms

We specify the basic loan supply function for firm j at time t as follows:

$$\ln L^s_{j,t} = a_0 + a_1 \ln L^s_{j,t-1} + a_2 r_{j,t} + a_3 \mathrm{ROA}_{j,t-1} + a_4 Q_t + a_5 \mathrm{DR}_{j,t-1} + \varepsilon_{j,t}, \quad (7)$$

where $\ln L^s_{j,t}$ is the logarithm of bank loan supplied to firm j at time t, and r_{jt} is the loan-deposit interest rate spread $(r^L_{jt} - r^D_t)$. We expect to see the coefficient of the interest rate spread to be positive, $a_2 > 0$. Term $\mathrm{ROA}_{j,t}$ is the rate of return on asset of firm j at time t, Q_t

is property price at time t, and $\mathrm{DR}_{j,t}$ is the debt-revenue ratio of firm j. The loan supply function is meant to capture the idea of forbearance lending in the above model such that the amount of bank loans is nonpositively correlated with firms' financial status and the market value of collateral.

We postulate here a stronger hypothesis, that is, we expect to observe $a_3 < 0$, $a_4 < 0$, $a_5 > 0$, which means when forbearance lending occurs, the supply of bank loans is negatively correlated with firms' investment returns and collateral value, and positively correlated with firms' debt service burden. Note that Q_t is the only term in (7) that is not firm-specific. The property price here serves as a common factor that affects the supply of bank loans to an individual firm by way of changing the value of collateral and a firm's balance sheet position. Apparently, this effect is not captured by either the firms' rate of return on asset or the debt-revenue ratio.

We next assume the loan demand to be of the following form:

$$\ln L^d_{j,t} = b_0 + b_1 \ln L^d_{j,t-1} + b_2 r^L_{j,t} + b_3(\ln K_{j,t} - \ln K_{j,t-1}) + \nu_{j,t}, \tag{8}$$

where $\ln L^d_{j,t}$ is the logarithm of the bank loan demand of firm j at time t, $r^L_{j,t}$ is the loan interest rate, and $K_{j,t}$ is the logarithm of the capital stock of firm j at time t. We expect that $b_1 > 0$, $b_2 < 0$, and $b_3 > 0$.

Given the loan market equilibrium, $\ln L^d_{j,t} = \ln L^s_{j,t} = \ln L_{j,t}$, for all j and t, we can solve for the equilibrium loan interest rate:

$$\begin{aligned} r^L_{j,t} = \frac{1}{a_2 - b_2}[& b_0 - a_0 + (b_1 - a_1)\ln L_{j,t-1} + a_2 r^D_{j,t} + b_3(\ln K_{j,t} - \ln K_{j,t-1}) \\ & - a_3 \mathrm{ROA}_{j,t-1} - a_5 Q_t - a_7 \mathrm{DR}_{j,t-1} + \eta_{j,t}], \end{aligned}$$

where $\eta_{j,t} = \nu_{j,t} - \varepsilon_{j,t}$. Given the specifications in (7) and (8), we expect to see $-a_3/(a_2 - b_2) > 0$, $-a_4/(a_2 - b_2) > 0$, and $-a_5/(a_2 - b_2) < 0$ when forbearance lending occurs.

Our main task is to estimate the loan supply curve based on model (7). When estimating (7), note that the residuals $\varepsilon_{j,t}$ can be decomposed into

$$\varepsilon_{j,t} = \theta_j + \mu_t + \omega_{jt},$$

where θ_j are the individual effects, μ_t the time-specific effects, and ω_{jt} the idiosyncratic shocks. We will estimate the model using the fixed effect model. However, it is well known that if the lagged dependent variable appears as an explanatory variable, then strict exogeneity of the regressors is violated; that is, there will be a correlation between the lagged dependent variable and individual-specific effects θ_j, and thus the fixed effect estimators are biased. Adding more exogenous variables to a first-order autoregressive process may somewhat reduce the magnitude of bias, but does not alter the direction of bias of the estimated coefficient for the lagged dependent variable (Hsiao, 2003). Furthermore, since $\mathrm{cov}(r^L_{j,t}, \varepsilon_{j,t}) \neq 0$, the estimators may not be consistent, we also estimate the model using the instrumental variable method (Greene, 1997, pp. 640–641).

5. Empirical analysis

5.1. Data

To investigate the changes of bank loans conditioned on the balance sheet positions of individual firms, we employ firm-level data taken from the Taiwan Economic Journal (TEJ) Database. The annual data set includes balance sheets and income statements for Taiwanese nonfinancial firms listed on the Taiwan Stock Exchange (TSE) or the over-the-counter (OTC) market.

Our sample period starts in 1991, which is the year right after the dramatic crash of the stock market in early 1990. The property prices peaked around late 1993 and early 1994 and then declined gradually throughout the 1990s. We divide the sample into two sub-samples: 1991–1996 and 1997–2001. The reasons to split the data at the year 1997 are two-fold. First, since the second sub-period coincides with the period in the aftermath of the Asian crisis in which nonperforming loans began to accelerate, we can compare the significance of forbearance lending before and after the 1997 Asian crisis. Second, as discussed above, since the government intervened in the loan market beginning in 1998, we can isolate the effect of government intervention on the first half sample period and thus might be able to infer the source of forbearance in the second-half sample period, i.e., private forbearance or government intervention.

5.2. The basic model

In this sub-section we first estimate the basic model (7) as a benchmark. We estimate the full sample 1991–2001 and then split the sample into two sub-periods, 1991–1996 and 1997–2001, using the fixed effect method with AR1 autocorrelation. Furthermore, we estimate this equation for all industries and for manufacturing firms, respectively.[7] The first and third columns of Table 1 present the estimation results.

The estimation results for manufacturing firms and all industries are quite similar. The coefficients on the lag term $\ln L^s_{j,t-1}$ and interest rate spread r_{jt} are both positive and significant as expected. We are actually more interested in the estimation results of $\mathrm{ROA}_{j,t-1}$, Q_t, and $\mathrm{DR}_{j,t-1}$. The coefficients on debt-revenue ratio $\mathrm{DR}_{j,t-1}$ are negative and statistically significant, suggesting a normal response of banks facing higher debt-revenue ratios. However, both coefficients on the return on asset $\mathrm{ROA}_{j,t-1}$ and property prices Q_t are negative and statistically significant, indicating a strong evidence of forbearance lending. Moreover, the magnitudes of these coefficients for either all industries or manufacturing firms are roughly the same.

Splitting the sample period into two sub-samples, 1991–1996 and 1997–2001, Table 2 presents the estimation results of the basic model. Again, the estimation results for all industries and manufacturing firms are quite similar. The coefficients on the lag term $\ln L^s_{j,t-1}$ and interest rate spread r_{jt} are both positive and statistically significant across the

[7] We have attempted to estimate the loan supply function for real estate related industries. However, the number of publicly traded real estate firms in our data set is too small, such that the efficiency of the estimation results is seriously in doubt.

Table 1
The basic model and the nonlinear model 1991–2001: fixed effect with AR1 method

Independent variables	All firms		Manufacturing firms	
	Basic model	Nonlinear model	Basic model	Nonlinear model
Constant	15.6986*** (56.425)	15.4258*** (55.143)	15.6841*** (54.271)	15.4096*** (53.027)
$\ln L^{s}_{j,t-1}$	0.0363*** (8.818)	0.0600*** (12.566)	0.0370*** (8.681)	0.0603*** (12.222)
$r_{j,t}$	0.1360E−03*** (2.830)	0.1420E−03*** (2.985)	0.1358E−03*** (2.797)	0.1417E−03*** (2.949)
$\text{ROA}_{j,t-1}$	−0.3262E−04** (−2.480)	−0.1404E−04 (−1.066)	−0.3433E−04** (−2.517)	−0.1554E−04 (−1.137)
Q_t	−0.0223*** (−9.557)	−0.0199*** (−8.556)	−0.0228*** (−9.379)	−0.0204*** (−8.412)
$\text{DR}_{j,t-1}$	−0.5461E−02*** (−3.043)	−0.0419*** (−9.957)	−0.5842E−02*** (−3.131)	−0.0417*** (−9.625)
$\text{DR}^{2}_{j,t-1}$		0.7562E−03*** (9.538)		0.7447E−03*** (9.137)
NT	5964	5964	5628	5628

Note: *t*-statistis are in parentheses.
** Significant at 5 percent.
*** Significant at 1 percent.

Table 2
The basic model and the nonlinear model: fixed effect with AR1 method

Independent variables	All firms				Manufacturing firms			
	1991–1996		1997–2001		1991–1996		1997–2001	
	Basic model	Nonlinear model	Basic model	Nonlinear model	Basic model	Nonlinear model	Basic model	Nonlinear model
Constant	14.3906*** (30.849)	14.3502*** (30.760)	0.3633** (2.150)	0.3032* (1.775)	14.3272*** (29.797)	14.2840*** (29.706)	0.3941** (2.233)	0.3373* (1.892)
$\ln L^s_{j,t-1}$	0.0079* (1.756)	0.0176*** (3.093)	0.9654*** (148.729)	0.9720*** (136.828)	0.0094** (2.028)	0.0195*** (3.347)	0.9643*** (143.470)	0.9707*** (132.405)
$r_{j,t}$	0.0048*** (4.279)	0.0042*** (3.700)	0.0002*** (4.274)	0.0002*** (4.233)	0.0046*** (4.140)	0.0040*** (3.552)	0.0002*** (4.154)	0.0002*** (4.112)
$\mathrm{ROA}_{j,t-1}$	−0.1558E−04 (−0.470)	−0.1409E−04 (−0.425)	−0.7407E−05 (−0.519)	−0.1350E−05 (−0.093)	−0.1504E−04 (−0.415)	−0.1494E−04 (−0.414)	−0.7252E−05 (−0.492)	−0.1193E−05 (−0.079)
Q_t	−0.0092** (−2.263)	−0.0088** (−2.172)	0.0018 (1.334)	0.0019 (1.379)	−0.0092** (−2.201)	−0.0088** (−2.107)	0.0016 (1.133)	0.0017 (1.169)
$\mathrm{DR}_{j,t-1}$	−0.0018 (−0.744)	−0.0187*** (−2.862)	−0.0007 (−0.909)	−0.0053** (−2.425)	−0.0028 (−1.093)	−0.0205*** (−3.062)	−0.0006 (−0.717)	−0.0050** (−2.247)
$\mathrm{DR}^2_{j,t-1}$		0.0003*** (2.785)		0.8679E−04** (2.247)		0.0004*** (2.858)		0.8470E−04** (2.135)
NT	3124	3124	2840	2840	2948	2948	2680	2680

Note: *t*-statistis are in parentheses.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

two sub-periods. The coefficients on $\mathrm{ROA}_{j,t-1}$ are negative, though insignificant, in both sub-periods. The coefficients on property prices Q_t are negative and statistically significant during 1991–1996, but not significant in the second half of the sample 1997–2001. Finally, the coefficients on $\mathrm{DR}_{j,t-1}$ are insignificant in both sub-periods.

The empirical evidence presented above in general lends strong support for the existence of forbearance lending. Among those observed variables, since land/real estate serves as the major collateral for bank loans, property prices play a significant role in detecting forbearance lending. Moreover, the evidence also suggests that forbearance lending was much more acute during 1991–1996 than during 1997–2001.

5.3. The nonlinear model

To further investigate the behavior of the coefficients on debt-revenue ratio $\mathrm{DR}_{j,t-1}$, we refine the basic model by following Sekine et al.'s (2003) assumption that if forbearance lending exists, then the loan supply function may be nonlinear in firms' debt-revenue ratio. We add the squared debt-revenue ratio $\mathrm{DR}^2_{j,t-1}$ into the basic model:

$$\ln L^s_{j,t} = a_0 + a_1 \ln L^s_{j,t-1} + a_2 r_{j,t} + a_3 \mathrm{ROA}_{j,t-1} + a_4 Q_t + a_5 \mathrm{DR}_{j,t-1} + a_6 \mathrm{DR}^2_{j,t-1} + \varepsilon_{j,t}, \tag{9}$$

where the coefficient on the squared debt-revenue ratio $\mathrm{DR}^2_{j,t-1}$ is expected to be positive, $a_6 > 0$, while the coefficient on the debt-revenue ratio $\mathrm{DR}_{j,t-1}$ is expected to be negative, $a_5 < 0$.

Using the total sample period of 1991–2001, Table 1 shows the estimation results. The coefficients on the lag term $\ln L^s_{j,t-1}$ and interest rate spread r_{jt} are both positive and statistically significant across the two sub-periods, and they are mostly the same in magnitudes to the basic model. Furthermore, the loan supply function is indeed nonlinear in corporates' debt-revenue ratio: the coefficient of $\mathrm{DR}^2_{j,t-1}$ is positive, while that of $\mathrm{DR}_{j,t-1}$ is negative, and both are statistically significant. More importantly, the coefficients on property prices Q_t and return on asset $\mathrm{ROA}_{j,t-1}$ remain negative and highly significant. The results are therefore consistent with the existence of forbearance lending.

We divide the sample as before into two sub-periods and present the estimation results in Table 2. The debt-revenue pairs $(\mathrm{DR}_{j,t-1}, \mathrm{DR}^2_{j,t-1})$ show signs of forbearance lending: the coefficients on $\mathrm{DR}_{j,t-1}$ are negative while those of $\mathrm{DR}^2_{j,t-1}$ are significantly positive across all sorts of firms and across the two sub-periods. Similar also to the basic model, the coefficients of property price Q_t are statistically significant during 1991–1996, while they are insignificant during 1997–2001, for both all industries and manufacturing firms.

A comparison of the coefficients across these two sub-periods reveals something interesting. A notable difference is that although the estimation results of $\mathrm{DR}_{j,t-1}$ and $\mathrm{DR}^2_{j,t-1}$ are significant in both sub-periods, the coefficients of the first half sub-period are much larger in absolute value than those of the second half. For example, for the case of all firms, the coefficients on $\mathrm{DR}_{j,t-1}$ and $\mathrm{DR}^2_{j,t-1}$ for 1991–1996 are −0.0187 and 0.0003, and those for 1997–2001 are −0.0053 and 0.000087, respectively. Furthermore, the estimated coefficient of property price Q_t is -0.0092 and statistically significant during 1991–1996, while it is 0.0018 and insignificant during 1997–2001.

Taken all these together, the results suggest that the first half of the sample period exhibits much stronger evidence of forbearance lending than the second half does. Our results also suggest that banks exercise forbearance lending not only to the real estate industry, but also to manufacturing firms and all other sorts of industries. This is in contrast to Sekine et al. (2003) who find that Japanese banks exercised forbearance lending only to construction and real estate industries.

To explain why banks exercised forbearance lending to their borrowers during the first half of the sample while they seemed to reverse the forbearance policy in the second half of the sample, we return to the theoretical model outlined in Section 3. Recall that forbearance lending is more likely to occur when the expected return of the project is higher, or when the user cost of land is lower, which correspond to the economic environment and outlook of the mid-1980s. Therefore, banks have an incentive to engage in forbearance lending in response to a low realization of the signal, and this was what happened during the first half of the sample period. Furthermore, the significance of nonlinearity for the estimated model also suggests that during the period 1991–1996 banks tended to forbear those firms which faced a more severe debt-overhang problem.[8]

On the other hand, after several years of a continuing slump in the real estate market starting from early 1994, the economy's outlook turned pessimistic. Therefore, banks no longer engaged in forbearance in response to the shock of the Asian crisis. Thus, during the period in the aftermath of the Asian crisis, there was no more evidence of forbearance lending. It was also evident that during this period that the negative shock prompted a wave of asset liquidation, so that collateral values declined at a faster rate than the period 1991–1996 where forbearance did not occur. Calculating the average growth rate of housing prices, we find that the annual mean was -2.36 percent during 1993–1996 and -3.05 percent during 1997–2001.

5.4. *Effectiveness of government intervention*

As discussed above, Taiwan's government was actively intervening not only in the stock market and the real estate market, but also in banks' loan roll-over decisions in the 1990s. A question then arises whether the above estimation results which support strong evidence of "forbearance" are due to the government's coercion or banks' optimizing behavior.

Note that these intervention policies were mostly implemented during the second half of our sample, 1997–2001. Since we have shown that forbearance lending was much weakened during this sub-period, this suggests that government intervention was not

[8] Sekine et al. (2003) conclude that Japanese banks exercised forbearance lending during the 1990s. This can be explained by our model in a similar way. Recall that in the second half of the 1980s, Japan's rapidly soaring land prices raised the value of corporations' collateral and rendered them to acquire more collateral and borrow more for investment. Growth rates were higher and optimism abounded. This created a fertile ground for forbearance lending.

effective as had been expected. That is, even with the government's efforts to stop banks from calling back loans, it is apparent that the economy in the aftermath of the Asian crisis had come to a point where banks preferred not to exercise forbearance lending.[9] During this period, the massive waves of asset liquidation precipitated the decline in property prices, alongside with the rapid shrinkage of bank loans during this period, as we observed in Fig. 1.

5.5. Other specifications and estimation methods

5.5.1. Instrumental variable method

In this sub-section we estimate (7) and (9) using the Instrumental Variable (IV) method. Lagged variables are used as instruments. The estimation results are presented in Table 3. As in the previous section using a fixed effect method, the estimation results for manufacturing firms are very similar to those for all industries.

For the basic model, while the coefficients on $\mathrm{ROA}_{j,t-1}$ for 1991–1996 are positive and significant, they are insignificant for the sub-period 1997–2001. The coefficients on property prices Q_t are negative and statistically significant during 1991–1996, but not significant in the second half of the sample, which is the same as using the fixed effect method. The coefficients on $\mathrm{DR}_{j,t-1}$ are statistically significant in both sub-periods, but the coefficients for the second sub-period 1997–2001 are much smaller than for the first sub-period 1991–1996. The results indicate that evidence of forbearance lending is much strong during 1991–1996.

As for the nonlinear model, the results are even closer to the results using the fixed effect in Table 2: during 1991–1996, the coefficients of Q_t are significantly negative and the coefficients on $\mathrm{DR}_{j,t-1}$ are negative while those of $\mathrm{DR}^2_{j,t-1}$ are significantly positive. However, during the second sub-period 1997–2001, they are all insignificant; finally, the coefficients on $\mathrm{ROA}_{j,t-1}$ turn out to be insignificant. For the case of all firms, the coefficients on $\mathrm{DR}_{j,t-1}$ and $\mathrm{DR}^2_{j,t-1}$ for 1991–1996 are −0.0115 and 0.0003, and those for 1997–2001 are −0.0023 and 0.00034, respectively. The coefficient of property price Q_t is −0.0047 during 1991–1996, while it is 0.0022 during 1997–2001. These results reaffirm our finding that the evidence of forbearance lending during 1991–1996 is much stronger than the period during 1997–2001.

5.5.2. Splitting data based on movements of collateral value

As shown in Fig. 1, the average real estate prices started to decline around early 1994. Therefore, an alternative way to split the data is based on the movements of this collateral value. We experiment with 1995 and 1996 as the structural break point to estimate (7) and (9). Table 4 presents the estimation results using the fixed effect with AR1 method for the sub-samples 1991–1995 and 1996–2001, respectively. As we can see, the results in Table 4 are almost identical to those in Table 2.

[9] Anecdotal reports also reveal that bank managers were complaining about government intervention and were reluctant to comply with this loan roll-over scheme during this period.

Table 3
The basic model and the nonlinear model: IV method

Independent variables	All firms				Manufacturing firms			
	1991–1996		1997–2001		1991–1996		1997-2001	
	Basic model	Nonlinear model	Basic model	Nonlinear model	Basic model	Nonlinear model	Basic model	Nonlinear model
Constant	5.4823*** (8.798)	−0.4474* (−1.905)	1.6739*** (2.683)	−0.1983 (−0.824)	5.6346*** (8.714)	−0.4763** (−1.972)	1.6128** (2.484)	−0.1740 (−0.693)
$\ln L^s_{j,t-1}$	0.6080*** (15.502)		0.8689*** (24.182)		0.6041*** (15.039)		0.8709*** (23.215)	
$r_{j,t}$	−0.1329E−05 (−0.015)	0.0100*** (8.275)	0.0076*** (5.382)	0.0004*** (5.510)	−0.2134E−05 (−0.024)	0.0100*** (8.251)	0.0076*** (5.229)	0.0004*** (5.440)
$\mathrm{ROA}_{j,t-1}$	0.0001*** (4.352)	−0.5026E−05 (−0.145)	0.3164E−04 (0.882)	−0.2317E−04 (−1.060)	0.0001*** (4.414)	−0.1014E−04 (−0.279)	0.2870E−04 (0.755)	−0.2188E−04 (−0.972)
Q_t	−0.0047* (−1.814)	−0.0047** (2.185)	−0.0004 (−0.178)	0.0022 (0.931)	−0.0059** (−2.157)	−0.0049** (2.227)	−0.0001 (−0.065)	0.0019 (0.771)
$\mathrm{DR}_{j,t-1}$	0.0291*** (9.046)	−0.0115*** (−3.495)	0.0063** (2.122)	−0.0023 (−0.785)	0.0293*** (8.944)	−0.0114*** (−3.357)	0.0062** (2.003)	−0.0020 (−0.658)
$\mathrm{DR}^2_{j,t-1}$		0.0003** (2.501)		0.3430E−04 (0.571)		0.0002** (2.407)		0.3058E−04 (0.494)
NT	3124	3124	2840	2840	2948	2948	2680	2680

Note: *t*-statistis are in parentheses.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

Table 4
The basic model and the nonlinear model: fixed effect with AR1 method

Independent variables	All firms				Manufacturing firms			
	1991–1995		1996–2001		1991–1995		1996–2001	
	Basic model	Nonlinear model	Basic model	Nonlinear model	Basic model	Nonlinear model	Basic model	Nonlinear model
Constant	14.4490*** (28.673)	14.4177*** (28.646)	0.5533*** (3.439)	0.4822*** (2.956)	14.3676*** (27.713)	14.3421*** (27.685)	0.5870*** (3.501)	0.5197*** (3.059)
$\ln L^s_{j,t-1}$	0.0074 (1.444)	0.0221*** (3.268)	0.9692*** (164.097)	0.9757*** (151.477)	0.0087 (1.644)	0.0211*** (3.049)	0.9680*** (158.527)	0.9743*** (146.631)
$r_{j,t}$	0.0099*** (7.028)	0.0091*** (6.325)	0.0002*** (4.326)	0.0002*** (4.273)	0.0097*** (6.887)	0.0090*** (6.279)	0.0002*** (4.189)	0.0002*** (4.137)
$\mathrm{ROA}_{j,t-1}$	0.1112E−04 (0.296)	0.1088E−04 (0.291)	−0.7385E−05 (−0.528)	−0.6667E−06 (−0.046)	0.2759E−04 (0.666)	0.2548E−04 (0.617)	−0.6118E−05 (−0.424)	0.4663E−06 (0.031)
Q_t	−0.0103** (−2.356)	−0.0101** (−2.309)	−0.0007 (−0.569)	−0.0005 (−0.431)	−0.0102** (−2.257)	−0.0100** (−2.220)	−0.0010 (−0.709)	−0.0008 (−0.585)
$\mathrm{DR}_{j,t-1}$	0.0013 (0.495)	−0.0217*** (−2.910)	−0.0006 (−0.787)	−0.0053*** (−2.621)	0.0004 (0.143)	−0.0193** (−2.519)	−0.0004 (−0.509)	−0.0049** (−2.366)
$\mathrm{DR}^2_{j,t-1}$		0.0005*** (3.323)		0.9241E−04** (2.515)		0.0004*** (2.767)		0.8880E−04** (2.357)
NT	2556	2556	3408	3408	2412	2412	3216	3216

Note: *t*-statistis are in parentheses.

** Significant at 5 percent.

*** Significant at 1 percent.

Table 5
Effect of uncertainty: fixed effect with AR1 method

Independent variables	1991–2001		All firms	
	All firms	Manufacturing firms	1991–1996	1997–2001
Constant	15.4618*** (55.202)	15.4504*** (53.099)	14.3802*** (30.832)	0.2770 (1.615)
$\ln L^{s}_{j,t-1}$	0.0600*** (12.562)	0.0602*** (12.214)	0.0167*** (2.931)	0.9745*** (137.383)
$r_{j,t}$	0.1416E−03*** (2.978)	0.1413E−03*** (2.940)	0.4231E−02*** (3.696)	0.2146E−03*** (4.296)
$\mathrm{ROA}_{j,t-1}$	−0.1463E−04 (−1.111)	−0.1613E−04 (−1.180)	−0.1325E−04 (−0.400)	−0.3738E−05 (−0.257)
Q_t	−0.0202*** (−8.650)	−0.0207*** (−8.515)	−0.8923E−02** (−2.180)	0.1774E−02 (1.236)
$\mathrm{DR}_{j,t-1}$	−0.0419*** (−9.971)	−0.0418*** (−9.644)	−0.0183*** (−2.803)	−0.5820E−02*** (−2.668)
$\mathrm{DR}^{2}_{j,t-1}$	0.7576E−03*** (9.556)	0.7468E−03*** (9.164)	0.3898E−03*** (2.752)	0.8783E−04** (2.286)
vol(DR)	−0.6309E−03* (−1.656)	−0.7191E−03* (−1.813)	−0.9806E−03** (−1.986)	−0.8545E−03*** (3.304)
vol(ROA)	0.1234E−07 (1.567)	0.1279E−07 (1.602)	0.3582E−07 (0.868)	0.1292E−08 (0.394)
NT	5964	5628	3124	2840

Note: *t*-statistis are in parentheses.
[*] Significant at 10 percent.
[**] Significant at 5 percent.
[***] Significant at 1 percent.

5.5.3. Effect of uncertainty

It is possible that banks may exercise forbearance lending in response to an increase in uncertainty of firms' future profitability and financial condition. Following Sekine et al. (2003), we add the volatility of the debt-revenue ratio and return on assets to the model

$$\ln L^s_{j,t} = a_0 + a_1 \ln L^s_{j,t-1} + a_2 r_{j,t} + a_3 \mathrm{ROA}_{j,t-1} + a_4 Q_t + a_5 \mathrm{DR}_{j,t-1} + a_6 \mathrm{DR}^2_{j,t-1} + a_7 \,\mathrm{vol(DR)} + a_8 \,\mathrm{vol(ROA)} + \varepsilon_{j,t}, \quad (10)$$

where $\mathrm{vol}(x) = (1/4)\sum_{\tau=t-1}^{t-4}(\Delta x_{j\tau} - 0.25\Delta_4 x_{j\tau})^2$, Δ and Δ_4 are the first- and fourth-difference operators, respectively, and $\Delta_4 x_{jt} = \sum_{\tau=t}^{t-3}\Delta x_{j\tau}$.

The estimation results are reported in Table 5. To save space, we show only the estimation results of the split sample for all firms. It is immediate to see that all the coefficients on $\mathrm{ROA}_{j,t-1}$, Q_t, $\mathrm{DR}_{j,t-1}$, and $\mathrm{DR}^2_{j,t-1}$ maintain a very similar magnitude and significance as in Table 2.

The coefficient on the volatility of DR is negative, and that of ROA is positive, but statistically insignificant, across all industries and sample periods. This says that a larger volatility will not induce banks to practice forbearance lending, i.e., uncertainty plays no role in forbearance lending.

6. Concluding remarks

In this paper we show that, as an alternative view to government's regulatory forbearance, banks tend to roll-over loans even when the returns seem not to be promising, in order not to depress the collateral value too much. This explains why at certain times banks exercise forbearance lending by rolling over a fraction or all of their nonperforming loans and delay the exposure of problem loans to the public. However, when the economic outlook is bad enough, forbearance lending is no longer an attractive option and is thus abandoned. A surge of asset liquidation then drives collateral values to sink even lower.

The empirical tests using firm-level data from Taiwan support the existence of forbearance lending across all types of firms during 1991–1996. On the other hand, as Taiwan's economy went down even deeper during 1997–2001, we no longer find evidence of forbearance lending. Since the government actively intervened in banks' loan roll-over decisions during the second half of the sample, a side-product of the result is that government intervention did not work as expected.

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Appendix A

Appendix A.1. The condition of forbearance lending

Forbearance lending exists when $z^* < \bar{z}$. The condition is following:

$$z^* - \bar{z} = \frac{\lambda \delta k_0}{[A(1-\theta) + \lambda(A\theta - \omega)]K} - \frac{\delta k_0 + \omega K}{AK} = \frac{\lambda A \delta k_0 - (\delta k_0 + \omega K)[A(1-\theta) + \lambda(A\theta - \omega)]}{AK[A(1-\theta) + \lambda(A\theta - \omega)]}.$$

Thus, $z^* < \bar{z}$ if and only if $\lambda < \lambda^*$, where

$$\lambda^* \equiv \frac{A(1-\theta)(\delta k_0 + \omega K)}{A\delta k_0 - (\delta k_0 + \omega K)(A\theta - \omega)}.$$

Note that when ω is arbitrarily small, λ^* approaches 1.

Appendix A.2. Solving for the equilibrium

Here we solve for the equilibrium of our model. Recall that the z is uniformly distributed. Furthermore, since $q_1(z) = H'(K - k_1(z))$, we consider the function $H'(\cdot)$ to be such that

$$H'(K - k_1(z)) = \frac{\delta k_1(z)}{K}.$$

By the first-order conditions, we have

$$\frac{z[A(1-\theta) + \lambda(A\theta - \omega)]}{\lambda} = q_1(z) + \frac{\mu_1(z)}{\lambda} \quad \text{for} \quad z \geq z^*, \tag{A.1}$$

$$\frac{z[A(1-\theta) + \lambda(A\theta - \omega)]}{\lambda} = q_1(z) - \frac{\mu_2(z)}{\lambda} \quad \text{for} \quad z < z^*, \tag{A.2}$$

where $\mu_1(z)$ and $\mu_2(z)$ are the multipliers of the constraints $0 \leq k_1(z)$ and $k_1(z) \leq k_0$ respectively. Note that for $z \geq z^*$, $k_1(z)$ equals k_0 and the date-1 asset price remains at $q_1(z) = H'(K - k_0)$. When $k_1(z) = 0$, i.e., for $z \leq z^{**}$, the date-1 asset price reaches its lowest level, $q_1(z) = H'(K)$. Using (A.1) and (A.2), the critical value z^* and z^{**} are given by

$$z^* = \Lambda k_0, \qquad z^{**} = 0,$$

where $\Lambda \equiv \lambda\delta/[A(1-\theta) + \lambda(A\theta - \omega)]K$. Next, when $k_1(z)$ is strictly positive but smaller than k_0, which arises when $z^* < z < z^{**}$. By (A.2), the date-1 asset price is

$$q_1(z) = \frac{z[A(1-\theta) + \lambda(A\theta - \omega)]}{\lambda} = \frac{z\delta}{\Lambda K}.$$

Finally, since $q_1(z) = H'(K - k_1(z))$, the date-1 investment $k_1(z)$ is given by

$$k_1(z) = \frac{zK}{\lambda\delta}[A(1-\theta) + \lambda(A\theta - \omega)] = \frac{z}{\Lambda}.$$

Recall that the expected date-1 price

$$q_1 = [1 - z^*]\frac{\delta k_0}{K} + \int_0^{z^*} q_1(z)\,dG.$$

After rearranging, we have

$$q_1 = \left(1 - \frac{k_0 \Lambda}{2}\right)\frac{\delta k_0}{K}.$$

Plugging in q_1, the date-0 price becomes

$$q_0 = \left(2 - \frac{k_0 \Lambda}{2}\right)\frac{\delta k_0}{K}.$$

Next, rearranging the borrowing constraint, we have

$$k_0 = \frac{q_0 k_{-1}}{q_0 - q_1} = \frac{4k_{-1}}{2 + \Lambda k_{-1}}.$$

Finally, plugging the above results into the participation constraint, after tedious computation, we can solve for

$$\Lambda = \frac{12\delta(k_0 - k_{-1}) - 6\theta AK}{4\delta k_0^2 - (3\theta AK + 3\delta k_{-1})k_0}.$$

Together with k_0, we can solve for $\Lambda = \Lambda(\theta, A, k_{-1}, K, \delta)$ and $k_0 = k_0(\theta, A, k_{-1}, K, \delta)$, and thus $q_0 = q_0(\theta, A, k_{-1}, K, \delta)$, $q_1 = q_1(\theta, A, k_{-1}, K, \delta)$, $z^* = z^*(\theta, A, k_{-1}, K, \delta)$, and $\lambda^* = \lambda^*(\theta, A, k_{-1}, K, \delta)$.

Given the assumptions that $H'(K - k_1(z)) = \delta k_1(z)/K$ and the uniform distribution of z, we conduct a numerical example as follows. Let $k_{-1} = 5, K = 10, \delta = 6, A = 10, \theta = 0.5$, $\omega = 0.1$. We can compute the endogenous variables: $\lambda = 0.54$, $k_0 = 9.05$, $q_0 = 9.82$, $q_1 = 4.39$, $z^* = 0.38$, $\lambda^* = 1.02$. This satisfies the condition for forbearance lending, because $\lambda < \lambda^*$.

Similarly, the comparative statics can be summarized as follows:

	λ	k_0	q_0	q_1	z^*	λ^*
k_{-1}	↑	↑	↑	↓	↑	↓
K	↓	↑	↑	↑	↓	↑
A	↓	↑	↑	↑	↓	↑
θ	↓	↑	↑	↑	↓	↓
δ	↑	↑	↑	↑	↓	↓

Appendix A.3. The condition when date-1 loan and asset price are negatively correlated

We look for the range of z such that when z is below z^* but not too low, such that total date-1 loans increases while asset price decline, i.e., date-1 loan and asset price are negatively correlated. First note that the date-1 loan is greater than date-0 loan when z is not too low:

$$k_0 - (1+\omega)k_1(z) < 0,$$

that is,

$$z > \frac{\Lambda k_0}{1+\omega}.$$

Together with $z < z^*$, the condition requires

$$\frac{\Lambda k_0}{1+\omega} < z < z^* = \Lambda k_0.$$

Plugging in λ and k_0

$$\frac{4\Lambda k_{-1}}{(1+\omega)(2+\Lambda k_{-1})} < z < \frac{4\Lambda k_{-1}}{2+\Lambda k_{-1}},$$

where $\Lambda = (12\delta(k_0 - k_{-1}) - 6\theta AK)/(4\delta k_0^2 - (3\theta AK + 3\delta k_{-1})k_0)$. Recall that when $z < z^*$, productive assets are partially liquidated, and thus asset price decline. This generates a negative correlation between date-1 total loans and asset price.

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