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A DISEQUILIBRIUM ANALYSIS OF THE JAPANESE LOAN MARKET: WERE THE POST-BUBBLE PERIODS IN DISEQUILIBRIUM?

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Abstract

The purpose of this paper is to investigate whether demand and supply have been equilibrated in the Japanese bank loan market over the period especially after the bubble era, and if not, what the main reasons are for this state of disequilibrium. For this purpose, we have improved and extended the analysis of Asako and Uchino (1987) by taking into account notable changes in the Japanese economy. We conclude that situation of the Japanese loan market has basically been same as in the old days of Asako and Uchino (1987), although the prevailing state of disequilibrium has shifted from excess demand to excess supply. The market loan rate lacks a mechanism for rapid adjustment towards the market equilibrium rate and it is instead guided by some policy-related interest rate that does not clear the market.

Keywords: disequilibrium analysis, short-side, Japanese loan market, post-bubble periods.
JEL classifications: C34, D53, E43

I. *Introduction*

The Japanese bank loan market fulfilled very important roles on occasions of macroeconomic difficulty as well as in heydays such as the post-war recovery period, the rapid growth era with sustained low interest rates, and the stagflation period triggered by the two oil shocks of the 1970s, before it was hit by structural changes in the late 1970s and early 1980s. Since then, regulations and controls on the financial sector began to be relaxed step by step. For instance, major firms raised the financing of their investments directly by corporate bond issuance in both the domestic and foreign markets; a number of new financing instruments became available; firms were now less reliant on the bank loan market (Hoshi and Kashyap 2001); and the role of the bank loan market as the main source of capital funding became less significant.

After the bubble economy burst in the early 1990s, the Japanese economy fell into a long period of stagnation and deflation. Although fiscal policy measures were called for by each cabinet, they resulted in one failure after another. A zero-interest-rate policy was taken by the Bank of Japan in 1999 as a last desperate measure to escape from the downward spiral of deflation as well as to settle the instability of the financial system, though it was further extended after only a short period, lifting to the quantitative easing policy in 2001. Reviewing the effects of fiscal and monetary policy decisions made in this period is worthwhile not only for the Japanese economy but also for other economies in the world as is in fact evidenced by the occurrence of the Lehman shock in 2008.

In discussions of the validity of monetary policies, evaluating the state of the loan market is essential because it helps us ascertain whether capital money flows smoothly from money suppliers to capital demanders. In other words, just by having an adequate knowledge of the loan market, we are able to verify whether the increased money flows from the banking sector to the open public without being obstructed, *i. e.*, without *kashishiburi* (banks' reluctance to lend) or *kashihagashi* (banks' forcible withdrawal of money) and without any credit crunch in the manner discussed by Bernanke and Lown (1991). If there is an obstruction, which side is responsible: the banking sector or firms and households? To answer these questions, we must find an easier and better way to pin down the state of equilibrium between the supply of and the demand for loans.

Until now, there have been hundreds of theoretical and empirical papers analyzing the equilibrium or disequilibrium of the Japanese bank loan market. Each report can generally be classified into either papers on the institution and structure of the bank loan market or those on the behavior of participants in the market including banks and firms (Mori and Tsutsui 1989). However, there is a common thread in these papers in that each author attempts to clarify whether the loan market is in a state of equilibrium or in disequilibrium. Until the early 1980s, most research asserted in one way or another that the Japanese bank loan market had been continuously in disequilibrium, or in a state of chronic excess demand in particular.

As a result of the relaxation of regulations and controls in the 1980s and the bubble economy growing during the late 1980s and bursting in the early 1990s, the banking sector experienced widespread delinquent loans. As a consequence of this, on the one hand, banks became more cautious in making new loans. Comparing the risk and return from loans, many banks considered it better to keep capital money in their vaults or shift it to national bonds. For many banks, curtailing outstanding loans was also necessary for clearing the BIS capital adequacy ratio. For borrowers, on the other hand, the excess capital accumulation of firms during the bubble economy era was left unresolved, repressing demand for new investment for quite a long time. Willingness to invest became weaker as well because expectation of profit declined due to the prolonged stagnation, and the real interest rate rose as deflation worsened.

Such being the situation, there were reasons that both demand for and supply of bank loans decreased for a given nominal interest rate, implying that no quick test applies in judging whether the loan market was in equilibrium or in disequilibrium even at an exceptionally low interest rate of loans. Thus, we shall make use of the disequilibrium analysis of Asako and

Uchino (1987) in testing null hypotheses concerning the Japanese loan market. By this empirical analysis, we can answer the following two questions. How should the bank loan market function when the interest rate is suppressed to a low level by loose monetary policy for a considerably long period? And can the monetary authorities use the policy to raise the inflation rate through maintaining a low interest rate?

Asako and Uchino (1987) extended the disequilibrium analysis of the Japanese bank loan market by Ito and Ueda (1982) and other earlier research into two directions[1]. First, unlike the consideration of Ito and Ueda (1982) that the cause of the bank loan market disequilibrium was the slow speed of the market loan rate adjusting itself toward an equilibrium loan rate, Asako and Uchino (1987) took into account the *policy interest rate* besides the equilibrium loan rate as another candidate destination of the adjustment. In other words, the possibility that the market loan rate was controlled or regulated by monetary policy was studied at the same time. Second, special attention was paid to dividing the sample into an excess supply period and an excess demand period after considering that the market loan rate was going through a process of slow adjustment towards market equilibrium and/or being guided by monetary policy. A new econometric method for sample division and parameter estimation was then developed in the sense that they had to be carried out simultaneously.

The remainder of this paper is organized as follows. In Section II, we present the basic model setup and explain four hypotheses of an identifiable structural model. These are equilibrium market hypothesis H0, partial adjustment hypothesis H1, policy interest rate hypothesis H2, and concurrent adjustment hypothesis H12. Models corresponding to these four hypotheses are tested by the *t*-statistics for parameters in the loan rate adjustment equation.

H0 indicates that there is a Walrasian equilibrium in the bank loan market. In contrast, that the loan market is generally in disequilibrium is a common factor of hypotheses H1, H2, and H12. H1 shows that the reason that the loan market is in disequilibrium is the delay in market loan rate adjustment towards an equilibrium loan rate. H2 claims that disequilibrium is due to the influence of the policy interest rate on the market loan rate. H12 is a mixture of hypotheses H1 and H2, where the market loan rate concurrently adjusts itself towards both the equilibrium loan rate and the policy interest rate.

Section III explains our econometric methodologies in detail. We present and discuss our empirical results in Section IV. The basic sample period is from the third quarter of 1973 to the first quarter of 2004. To obtain robust results, we also divided the full sample into a couple of sub-samples. In addition to discussing our empirical results, the adequacy of H2 and H12 is again reviewed by taking into account other factors affecting the loan market. Section V presents additional investigation into the robustness of our results. Our conclusions are given in Section VI.

II. *Model Setting*

In this section, following Asako and Uchino (1987), we develop a theoretical framework

[1] Fair and Jaffee (1972) put forward methods of estimating markets in a state of disequilibrium, whose theoretical foundations date back to Clower (1965) and Barro and Grossman (1971) among many. Bowden (1978) complemented and summarized these methods.

for the disequilibrium analysis and present four hypotheses on the state of the loan market.

1. The Basic Model

We construct a basic model of the Japanese bank loan market by the following four equations that embody our considerations outlined in the previous introductory section.

$$\begin{aligned} \text{Demand equation:} \quad L_t^d &= \beta_0 r_t + X_t\beta + u_t, && (1)\\ \text{Supply equation:} \quad L_t^s &= \gamma_0 r_t + Z_t\gamma + v_t, && (2)\\ \text{Loan rate adjustment:} \quad r_t - r_{t-1} &= \theta_1(r_t^* - r_{t-1}) + \theta_2(\overline{r}_t - r_{t-1}) + \varepsilon_t, && (3)\\ \text{Short side rule:} \quad L_t &= \min[L_t^d, L_t^s]. && (4) \end{aligned}$$

Here, L_t^d = demand for loans, L_t^s = supply of loans, L_t = realized volume of loans, r_t = market loan rate, r_t^* = equilibrium loan rate, $\overline{r}_t$ = policy interest rate, X_t = exogenous variable vector in the demand equation, and Z_t = exogenous variable vector in the supply equation. u_t, v_t and ε_t are white noise disturbances in each equation and are independent of each other. Equations (1) and (2) are, respectively, the loan demand and supply functions of the market loan rate and other exogenous variables.

Theoretically, we expect that $\beta_0 < 0$ and $\gamma_0 > 0$. We shall specify the vectors of exogenous variables in the estimations that follow. Z_t contains the official discount rate δ_t, which can help us to identify the transmission mechanism in monetary policy. Equation (3) expresses the adjustment process of the market loan rate and requires $0 \leq \theta_1, \theta_2 \leq 1$. We envisage that the market loan rate remains at or adjusts itself toward the equilibrium loan rate and the policy interest rate at a certain speed in each period. Equilibrating demand in equation (1) and supply in equation (2), we obtain an equilibrium interest rate of

$$r_t^* = \frac{1}{\beta_0 - \gamma_0}[Z_t\gamma - X_t\beta + v_t - u_t]. \tag{5}$$

We assume that policy interest rate $\overline{r}_t$ is determined by the Bank of Japan as part of monetary policies that are directed towards the loan market. Currently, there is no appropriate data series that directly and fully captures the intentions of the monetary authorities. We create a policy interest rate series artificially by assuming that the policy interest rate is a linear function of the official discount rate δ_t:

$$\overline{r}_t = a + b\delta_t. \tag{6}$$

Since policy interest rate $\overline{r}_t$ is unobservable, we cannot directly regress equation (6). However, in the framework of simultaneous equations system parameters a and b are estimable[2].

If the market interest rate adjusts itself following equation (3), the demand for and supply of loans in the market might not then be equivalent because the market loan rate in general deviates from the equilibrium rate. Equation (4) indicates the volume to be realized in the disequilibrium loan market by whichever is smaller, and this *ex-post* transaction rule called the

[2] Although an error term can possibly be introduced into equation (6), it will not be distinguishable from ε_t in equation (3).

"short-side rule" has been approved since Clower (1965) and Barro and Grossman (1971).

2. Loan Rate Adjustment and Loan Market

As mentioned above, researchers have focused on whether the loan market is in an equilibrium state or not, and whether the reason that the loan market is in a disequilibrium state is a delay in market loan rate adjustment towards the equilibrium loan rate. We show this as a special case of our loan rate equation (3) when $\theta_2=0$. However, utilizing this equation, we are able to test the following four hypotheses:

- H0: The equilibrium market hypothesis, *i.e.*, the loan market is always in equilibrium.
- H1: The partial adjustment hypothesis, *i.e.*, the loan market is in disequilibrium because of delay in the market interest rate adjusting towards the equilibrium loan rate.
- H2: The policy interest rate hypothesis, *i.e.*, the loan market is in a state of disequilibrium and the market loan rate is regulated directly or indirectly by monetary policies.
- H12: The concurrent adjustment hypothesis, *i.e.*, the market loan rate adjusts itself towards the equilibrium loan rate and the policy interest rate concurrently.

These hypotheses can be tested together as follows by equation (3). Hypothesis H0 means $r_t = r_t^*$, which requires that $\theta_1 = 1$ and $\theta_2 = 0$ be realized at the same time. For partial adjustment hypothesis H1, it is necessary that $0 \neq \theta_1 < 1$ and that $\theta_2 = 0$. Policy interest rate hypothesis H2 needs $\theta_1=0$ and $\theta_2=1$. If $\theta_1=0$ and $0<\theta_2\neq 1$, a weaker version of hypothesis H2, denoted as H2', can be thought of as supporting policy interest rate hypothesis H2 as well. The meaning of H2' is that although there is a time lag in the transmission process of monetary policies, in the end, the market loan rate is affected. Concurrent adjustment hypothesis H12 indicates the possibility of both $0<\theta_1<1$ and $0<\theta_2<1$ being tenable at the same time. It includes the conditions of both hypotheses H1 and H2.

In this way, equation (3) appropriately describes the whole loan market. In other words, equation (3) nests the four hypotheses and sums up the consequences of various economic agents' activities although it is set up without considering their microfoundation. Of course, if H1 is right, equation (3) reflects the law of supply and demand as intermediated by an auctioneer. If H2 is supported, then equation (3) is able to show that regulations of authorities or institutional factors are effective in making changes in the market loan rate process. Finally, H12 indicates that both parts of hypotheses H1 and H2 are effective, implying that the market loan rate plays its pricing role gradually and monetary policy still duly functions.

III. *Estimation Method of the Model*

In this section, we first show how the sample is divided between excess demand and excess supply periods, and we then explain how to estimate the system of simultaneous equations.

1. Division of the Sample

Comparing the market loan rate with the equilibrium loan rate obtained from equation (5), we divide the sample into two categories: excess supply period and excess demand period. That is, when $r_t \geq r_t^*$, it is a period of excess supply; otherwise, it is a period of excess demand. This sample division is reasonable under the assumption that the demand curve slopes downward and the supply curve slopes upward. By defining equations (1), (2), and (5), we can derive

$$\mathrm{L}_t^d - \mathrm{L}_t^s = (\beta_0 - \gamma_0)\ (r_t - r_t^*). \tag{7}$$

For $\theta_2 = 0$ in earlier literature, knowledge of the equilibrium loan rate is unnecessary in dividing samples because equation (3) can be written as

$$r_t - r_t^* = -\frac{1-\theta_1}{\theta_1}(r_t - r_{t-1}) + \frac{\theta_2}{\theta_1}(\bar{r}_t - r_{t-1}) + \frac{\varepsilon_t}{\theta_1}, \tag{8}$$

implying that if $\theta_2 = 0$, the sign of $r_t - r_t^*$ is only determined by $r_t - r_{t-1}$. Then, it is a period of excess demand if the market loan rate is rising; otherwise, it is a period of excess supply.

However, $\theta_2 = 0$ is not assumed here, so knowledge of the equilibrium loan rate is necessary in the sample division. If H0 is not effective, the equilibrium loan rate obtained from equation (5) is only theoretical and unobservable. As explained later, however, with knowledge of the basic model, it is possible to estimate the equilibrium loan rate and all parameters of the structural model at the same time.

2. Estimation of Demand Function

According to the short-side rule (4), as in Figure 1, the coordinate of realized loan volume and market loan rate in the period of excess supply is on the demand curve, and the coordinate of loan volume to be supplied by the bank and the market loan rate is on the supply curve, which is unobservable. On the other hand, the coordinate of realized loan volume and market loan rate in the period of excess demand is on the supply curve, and the coordinate of loan volume to be determined and the market loan rate is on the demand curve, which is also unobservable.

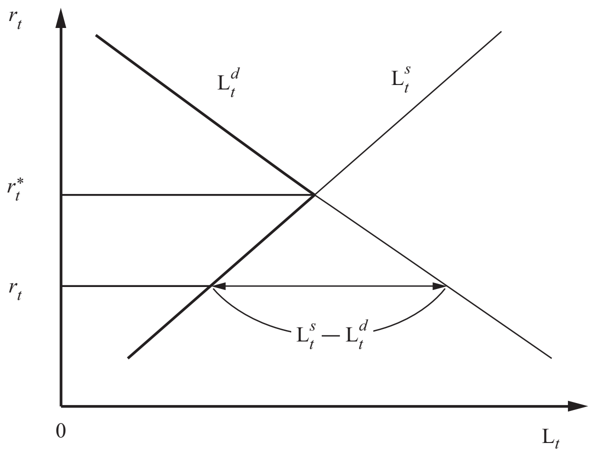
As shown in Figure 1, all the observables are on the bold lines and the unobservables equal the observables plus the gaps between supply and demand according to the short-side rule. That is, realized volume L_t can be written as

$$\mathrm{L}_t = \begin{cases} \mathrm{L}_t^d, & r_t \geq r_t^* \\ \mathrm{L}_t^d - (\mathrm{L}_t^d - \mathrm{L}_t^s), & r_t < r_t^* \end{cases} \tag{9}$$

according to the short-side rule. By equations (7) and (8), we obtain loan demand in the period of excess demand as follows:

$$\begin{aligned} \mathrm{L}_t = {} & \beta_0 r_t + \mathrm{X}_t \beta + (\beta_0 - \gamma_0)\frac{1-\theta_1}{\theta_1}(r_t - r_{t-1}) \\ & -(\beta_0 - \gamma_0)\frac{\theta_2}{\theta_1}(\bar{r}_t - r_{t-1}) + u_t - \frac{\beta_0 - \gamma_0}{\theta_1}\varepsilon_t. \end{aligned} \tag{10}$$

FIG. 1. DISEQUILIBRIUM BETWEEN SUPPLY AND DEMAND



Combining equations (1) and (10), we obtain

$$\mathrm{L}_t=\beta_0 r_t+\mathrm{X}_t\beta+(\beta_0-\gamma_0)\frac{1-\theta_1}{\theta_1}\nabla^d r_t$$
$$-(\beta_0-\gamma_0)\frac{\theta_2}{\theta_1}\nabla^d \overline{r}_t+u_t-\frac{\beta_0-\gamma_0}{\theta_1}\nabla^d \varepsilon_t, \tag{11}$$

where

$$\nabla^d r_t=\begin{cases} 0 & r_t \geq r_t^* \\ r_t-r_{t-1} & r_t<r_t^* \end{cases} \tag{12}$$

$$\nabla^d \overline{r}_t=\begin{cases} 0 & r_t \geq r_t^* \\ \overline{r}_t-r_{t-1} & r_t<r_t^* \end{cases} \tag{13}$$

$$\nabla^d \varepsilon_t=\begin{cases} 0 & r_t \geq r_t^* \\ \varepsilon_t & r_t<r_t^*. \end{cases} \tag{14}$$

Therefore, in the estimation of demand function, we utilize not only the sample on the demand curve in the period of excess supply but also the sample on the supply curve in the period of excess demand. Namely, all samples are used effectively by the newly defined variables in equations (12), (13), and (14), no matter whether in a period of excess supply or in a period of excess demand.

3. Estimation of Supply Function

To estimate the supply function, we can take the approach analogous to our estimation of the demand function. In short, we also divide the full sample into two categories: sample in the period of excess supply and sample in the period of excess demand according to the equilibrium loan rate. To be concrete, corresponding to equation (9), we set

$$L_t = \begin{cases} L_t^s - (L_t^s - L_t^d), & r_t \geq r_t^* \\ L_t^s, & r_t < r_t^* \end{cases} \tag{15}$$

for the supply function. With equations (2), (7), and (8) we can derive

$$\begin{aligned} L_t = {} & \gamma_0 r_t + Z_t \gamma - (\beta_0 - \gamma_0) \frac{1-\theta_1}{\theta_1} \nabla^s r_t \\ & + (\beta_0 - \gamma_0) \frac{\theta_2}{\theta_1} \nabla^s \bar{r}_t + v_t + \frac{\beta_0 - \gamma_0}{\theta_1} \nabla^s \varepsilon_t, \end{aligned} \tag{16}$$

where

$$\nabla^s r_t = \begin{cases} r_t - r_{t-1} & r_t \geq r_t^* \\ 0 & r_t < r_t^* \end{cases} \tag{17}$$

$$\nabla^s \bar{r}_t = \begin{cases} \bar{r}_t - r_{t-1} & r_t \geq r_t^* \\ 0 & r_t < r_t^* \end{cases} \tag{18}$$

$$\nabla^s \varepsilon_t = \begin{cases} \varepsilon_t & r_t \geq r_t^* \\ 0 & r_t < r_t^*. \end{cases} \tag{19}$$

Here, the variables in equations (12) to (14) and (17) to (19) satisfy the following equations:

$$\nabla^d r_t + \nabla^s r_t = r_t - r_{t-1}, \tag{20}$$

$$\nabla^d \bar{r}_t + \nabla^s \bar{r}_t = \bar{r}_t - r_{t-1}, \tag{21}$$

$$\nabla^d \varepsilon_t + \nabla^s \varepsilon_t = \varepsilon_t. \tag{22}$$

4. Simultaneous Estimation Method

We summarize our discussions up to this point, which allows us to integrate the basic model into the following three equations:

$$\begin{aligned} r_t = {} & (1-\theta_1-\theta_2) r_{t-1} + \frac{\theta_1}{\beta_0 - \gamma_0} (Z_t \gamma - X_t \beta) \\ & + \theta_2 \bar{r}_t + \xi_t^r, \end{aligned} \tag{23}$$

$$\begin{aligned} L_t = {} & \beta_0 r_t + X_t \beta + (\beta_0 - \gamma_0) \frac{1-\theta_1}{\theta_1} \nabla^d r_t \\ & - (\beta_0 - \gamma_0) \frac{\theta_2}{\theta_1} \nabla^d \bar{r}_t + \xi_t^d, \end{aligned} \tag{24}$$

$$\begin{aligned} L_t = {} & \gamma_0 r_t + Z_t \gamma - (\beta_0 - \gamma_0) \frac{1-\theta_1}{\theta_1} \nabla^s r_t \\ & + (\beta_0 - \gamma_0) \frac{\theta_2}{\theta_1} \nabla^s \bar{r}_t + \xi_t^s, \end{aligned} \tag{25}$$

where the disturbance terms are

$$\xi_t^r = \frac{\theta_1}{\beta_0 - \gamma_0}(v_t - u_t) + \varepsilon_t, \tag{26}$$

$$\xi_t^d = u_t - \frac{\beta_0 - \gamma_0}{\theta_1} \nabla^d \varepsilon_t, \tag{27}$$

$$\xi_t^s = v_t + \frac{\beta_0 - \gamma_0}{\theta_1} \nabla^s \varepsilon_t. \tag{28}$$

Equation (23) is derived by substituting equation (5) into equation (3). Then, the variables on the right-hand side of equation (23) are all observable. We may rewrite equations (11) and (16) as (24) and (25), respectively.

There are only two endogenous variables, r_t and L_t, in the system of equations (23) to (25). It appears that one of the three equations should become redundant. However, if we consider the system structure further, we see that equilibrium loan rate r_t^* can be taken as the third endogenous variable, which determines the newly defined variables in equations (12) to (14) and (17) to (19). These defined variables affect the parameter estimation of r_t and L_t. Although the equilibrium interest rate is defined by equation (5), it also may be derived from equation (3), the base of equation (23), *i.e.*,

$$r_t^* = \frac{1}{\theta_1}[r_t - (1 - \theta_1 - \theta_2) r_{t-1} - \theta_2 \bar{r}_t - \varepsilon_t]. \tag{29}$$

Note that these three equations in the structural system are not independent. Any one of them can be derived from the other two equations. Therefore, if an estimation is made of these three equations all together, the variance-covariance matrix of the disturbance terms as it is would be singular, and regression is theoretically impossible.

In running regressions, nonlinear restrictions must be placed on the parameters of any two equations out of the structural system comprising equations (23)-(25). We can also use these nonlinear restrictions to estimate parameters a and b in equation (6). Moreover, with these estimated parameters, the equilibrium loan rate can be calculated by equation (5) or (29), and sample division is also possible relying on the relative magnitude of the market loan rate and the equilibrium loan rate. Thus, starting from an arbitrary initial round parameter setup and the corresponding initial round sample division, nonlinear estimation must be pursued until convergence is attained in the sense that parameter estimates and sample division remain unchanged before and after a certain round of estimation.

5. Estimation with Three Equations

There may well be some further information hidden in equations (23)-(25). If so, the estimation efficiency would be enhanced by estimating these three equations simultaneously. This possibility arises when the variance-covariance matrix of the disturbance terms in equations (26)-(28) is nonsingular. As is discussed in Asako and Uchino (1987), it is not too difficult to show that such a possibility exists. We present here only the following two cases.

The first case is rather uncommon as it highlights measurement errors that occur only when supply or demand is on the long side. This can be shown by rewriting equation (9) as

$$L_t=\begin{cases} L_t^d, & r_t \geq r_t^* \\ L_t^d-(L_t^d-L_t^s)+\eta_t, & r_t < r_t^* \end{cases} \tag{30}$$

and equation (15) as

$$L_t=\begin{cases} L_t^s-(L_t^s-L_t^d)+\eta_t, & r_t \geq r_t^* \\ L_t^s, & r_t < r_t^*. \end{cases} \tag{31}$$

Disturbance term η_t is a white noise independent of the other disturbance terms. Then, equations (27) and (28) become

$$\xi_t^d=u_t-\frac{\beta_0-\gamma_0}{\theta_1}\nabla^d\varepsilon_t+\nabla^d\eta_t, \tag{32}$$

$$\xi_t^s=v_t+\frac{\beta_0-\gamma_0}{\theta_1}\nabla^s\varepsilon_t+\nabla^s\eta_t, \tag{33}$$

where $\nabla^d\eta_t$ and $\nabla^s\eta_t$ are defined in the same way as they were defined in equations (14) and (19) on ε_t. Consequently, the variance-covariance matrix of disturbance terms in equations (26), (32), and (33) turns out to be nonsingular, because η_t is only related to equations (24) and (25) and is not involved in equation (23) at all.

The second case is where there is an error term in the market interest rate process (error-in-variable) shown in the supply and demand function. Loan rate adjustment equation (3) is based on the market's face loan rate. Let us consider, however, the fact that participants in the loan market do not regard the face loan rate as an appropriate indicator, and borrower decisions are based on only the effective loan rate as the real cost measure. Thus, there are errors in the first term (and only the first one) of the right-hand side of equations (24) and (25). With ζ_t denoting white noise disturbance reflecting the errors-in-variables of the face loan rate, which is assumed to be independent of all the other disturbances in the model, we now rewrite equations (32) and (33) as

$$\xi_t^d=u_t-\frac{\beta_0-\gamma_0}{\theta_1}\nabla^d\varepsilon_t+\beta_0\zeta_t, \tag{34}$$

$$\xi_t^s=v_t+\frac{\beta_0-\gamma_0}{\theta_1}\nabla^s\varepsilon_t+\gamma_0\zeta_t. \tag{35}$$

Then, after an analysis similar to that for the first example, demonstrating that the contemporaneous variance-covariance matrix of the three disturbances (26), (34), and (35) is again nonsingular is a straightforward task.

IV. *Empirical Results*

In this section, we report the estimation and test results of the four hypotheses on the state of the Japanese loan market.

1. Specification of Demand and Supply Function

It is necessary to specify the demand and supply equations before estimation. The question is what variables should be included in explanatory variable vectors X_t and Z_t. Considering that there might be structural changes in the Japanese economy and maintaining our research associated with the earlier work of Asako and Uchino (1987), we present two models. The first one, called the basic model here, is constructed similarly to that estimated by Asako and Uchino (1987). The second one, called the expanded model, captures structural changes in the Japanese economy by introducing a time dummy variable.

1 Basic Model

First we specify the demand equation (1) as

$$L_t^d = \beta_0 r_t + \beta_1 y_t + \beta_2 L_{t-1} + u_t, \tag{36}$$

where y_t represents the level of total production. As an increase in the interest rate would reduce the need for loans, $\beta_0 < 0$ is expected. In theory, the relationship between level of total production y_t and the demand for loans is not clear because there are opposing effects. On the one hand, when the level of total production rises, firms invest more in inventory and in expanding the scale of production. Then, by the acceleration principle, capital demand for new equipment investment grows, implying that $\beta_1 > 0$ follows. On the other hand, as profits and retained earnings also increase with a rise in total production, demand for loans might decrease resulting in $\beta_1 < 0$. The third term on the right-hand side is the lagged volume of loans realized in the previous period, and $\beta_2 > 0$ is expected considering the persistence of demand for loans.

Next, we specify supply function (2) as

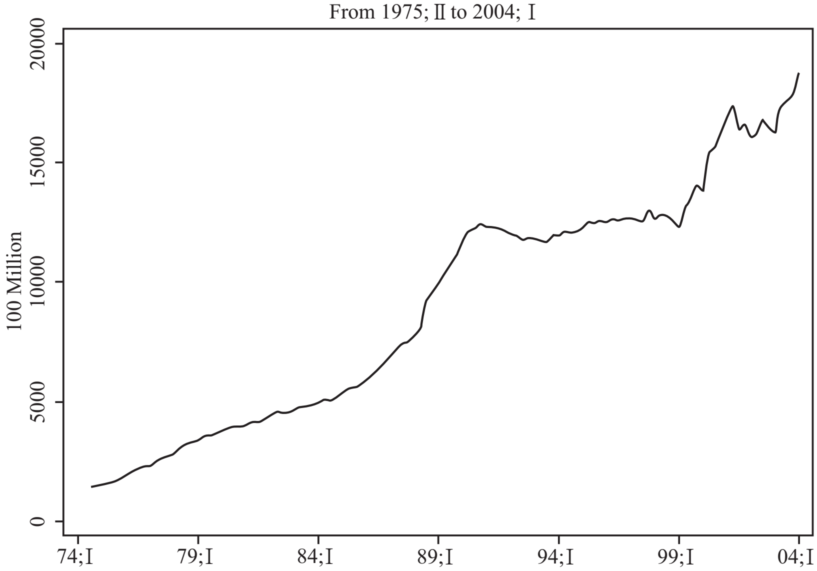
$$L_t^s = \gamma_0 r_t + \gamma_1 D_t + \gamma_2 sec_t + \gamma_3 \delta_t + v_t, \tag{37}$$

where D_t, assumed to be an exogenous variable, represents the total deposits in the banking sector. According to the standard theory of bank behavior, both $\gamma_0 > 0$ and $\gamma_1 > 0$ are expected in pursuing maximization of profits. Unlike Asako and Uchino (1987), the equation includes the amount of security holding funds of the banking sector, sec_t, as an additional explanatory variable. This is because, in describing the typical supply behavior of bank loans under the prolonged stagnant and deflationary phase of the Japanese economy, it is preferable for the basic model to include an additional variable that captures *kashishiburi* (banks' reluctance to lend) and *kashihagashi* (banks' forcible withdrawal of money) or the so-called flight-to-quality effect[3] in general, which was not considered at all among the participants of the loan market envisaged by Asako and Uchino (1987).

In periods of recession and under uncertain environments, it is reasonable for banks to allocate their capital money to safe assets such as government bonds rather than lending with increased default risk. As shown in Figure 2, the percentage of outstanding securities held by the banking sector rose steadily from the 1970s to 1993, maintained an almost constant level

[3] There are both theoretical and empirical papers on flight to quality that include Kashyap *et al*. (1993), Lang and Nakamura (1995), and Bernake *et al*. (1996).

FIG. 2. TRADING SECURITIES HELD BY THE BANKING SECTOR



for about six years after that, and finally jumped again starting in 1999. It is not surprising that this percentage ratio in general shows an increasing trend in line with, on the one hand, the massive accumulation of national bonds and, on the other hand, the disintermediation and securitization of the Japanese financial market. However, a jump in this ratio in 1999 can be best understood once we notice that the policy of zero interest rate was first introduced in this year by the Bank of Japan. At any rate, a shift of capital from lending to securities holding would reduce the loan supply. Hence, $\gamma_2 < 0$ is predicted by the flight-to-quality effect.

The official discount rate δ_t is included as an exogenous explanatory variable for two reasons. First, again according to the standard theory of bank behavior, loan supply depends negatively on the opportunity cost of lending and the official discount rate plays the role of representing it so that $\gamma_3 < 0$ is predicted. Second, as an instrument of monetary policy, the official discount rate allows us to trace the transmission mechanism. In doing so, it is necessary for us to introduce the official discount rate into equation (2) and distinguish whether changes in it affect the loan supply directly, or whether changes in the official discount rate initially influence the policy interest rate, as in equation (6), and then eventually affect the loan supply after inducing changes in the market loan rate through equation (3).

2 An Extended Model

Unlike Asako and Uchino (1987), who covered a sample period from the early 1960s to 1982, we cover a sample period from 1974 to 2004. A time span of thirty years is long enough for the Japanese economy to have experienced some structural changes. Although there are statistical ways to search from the data when structural changes occurred, we instead introduce a time dummy variable into the basic model as a simple way to capture structural changes.

In doing so, however, there remains the question of when and how many times structural changes did actually occur in the Japanese economy. We assume there was one and only one structural change that occurred in the first quarter of 1995. The extended model, therefore, adds the time dummy variable to both demand and supply equations as follows:

$$\mathrm{L}_t^d = \beta_0 r_t + \beta_1 y_t + \beta_2 \mathrm{L}_{t-1} + \beta_3 D95_t + u_t, \tag{38}$$

$$\mathrm{L}_t^s = \gamma_0 r_t + \gamma_1 \mathrm{D}_t + \gamma_2 \delta_t + \gamma_3 D95_t + v_t. \tag{39}$$

Here, $D95_t = 1$ if the time is after 1995, and it is zero otherwise.

Of course, many important events occurred during the sampling period and the choice of 1995 as the starting point of the sole structural change is a little arbitrary. The primary reason for choosing this timing is that, as will be traced *ex post* in Figure 3, the market loan rate began deviating from the policy rate and the estimated equilibrium loan rate fell below zero. After several years of post-bubble experience of stagnation and deflation, economic agents including loan suppliers and demanders learned and adapted themselves to the new economic environment. The timing of 1995 can be considered as just around the interim stage of incorporating their learning into adapted and new rational behavior.

Note that we introduce the $D95_t$ variable into both demand and supply equations at the same time. This is because, even though credit crunch stemming from the supply side in the loan market continued to be the hottest issue after 1995, excessive capital stock accumulated before the burst of the bubble economy weakened firms' willingness to make new investment over the same period, indicating that firms should also bear some responsibility for the decrease in total loans made. Such being the case, we judge the relative importance of the $D95_t$ variable in demand and supply equations by its statistical significance.

Needless to say, there could be other choices of timing. For instance, 1990 or 1991 is a candidate for representing the burst of the bubble economy and 1999 is another one for emphasizing the regime switch of the monetary policy because the zero-interest-rate policy first began in this year. However, our choice of 1995 turned out to beat the other candidates in terms of fitting the data. Note in passing that we omitted sec_t here in loan supply equation (39) in order to avoid multicollinearity caused by the coexistence of $D95_t$ and sec_t.

2. Description of the Data

We conducted empirical analyses on a quarterly data set, taken from 1974; I to 2004; I. This sample period is chosen because, on the one hand we use the Tankan (Short-term Economic Survey of Enterprises in Japan) data of the Bank of Japan in Section V, which is available only from 1974. Our main concern in this paper, on the other hand, is the state of the Japanese loan market during the post-bubble periods and the Japanese bad loans problem had to certain extent been stabilized by the end of fiscal year 2003, *i.e.*, the first quarter of 2004. Notations for the variables are as follows:

L_t = Total bank loans outstanding (all banks, include trust accounts, end of period);
D_t = Total deposits outstanding (all banks, end of period);
sec_t = Trading account securities;
y_t = Index of industrial production (mining and manufacturing, 2000 average = 100);
r_t = Averaged contracted interest rates on total bank loans and discounts (general);
δ_t = Official discount rate (discount rate of commercial bills);
tkr_t = Short-term Economic Survey of Enterprises in Japan;
$D95_t$ = 1 if the time is after the first quarter of 1995 and zero otherwise.

Of the above, r_t and δ_t are measured by the annual percentage point (period average), and L_t, D_t, sec_t, and y_t are all in natural logarithm. As in Asako and Uchino (1987), none of the data used are seasonally adjusted.

3. Iterative Estimation and Convergence

As discussed earlier, parameter estimation of this paper is to be executed simultaneously with the division of samples. Namely, sample division based on the estimated parameters with a given sample division must conform with the original sample division. Moreover, we place nonlinear restrictions on the parameters of the structural equations system. Therefore, in running regression analysis, it is necessary to go through doubly iterative estimation processes.

For the nonlinear constraints of the parameter coefficients, we used the nonlinear three-stage least squares (NL3LSQ) method. For consistency of sample division, the initial parameter values for each run of the NL3LSQ were changed once every two iterations for programming reasons, and the estimation was considered to be converged if it resulted in the same sample division thrice consecutively. In general, it is safe to conclude that in most cases, convergence is achieved at a fairly early stage and moreover the pattern of sample division converges almost monotonously.

4. Estimation Results

The estimation results of the two models of the structural equations system are presented in this subsection.

1 Estimation of the Basic Model

The main result of estimation of the basic model is summarized in Table 1. The result is written in terms of original structural equations system (1) to (3) and (6)[4]. The SERs of these equations, however, are the standard error of estimated equations (36), (37), and (3) following the methodology of structural equations system (23) to (25) . To avoid the problem of facultative choice of particular two equations from the three structural equations system, we estimate these three equations simultaneously by implicitly presuming that the variance-covariance matrix of the disturbance terms is nonsingular.

Although the basic model of this paper has an additional explanatory variable of the

[4] Equation (6) is just a definitional equation and is not counted as a structural equation in the three structural equations system.

Table 1. Estimation Results of the Basic Model

(1)	$L_t^d = 0.505 - 0.018r_t + 0.222y_t + 0.907L_{t-1},$	SER = 0.076
	(1.20) (1.28) (1.63) (15.3)	
(2)	$L_t^s = 0.189 + 0.033r_t + 1.480D_t - 0.542sec_t - 0.006\delta_t,$	SER = 0.001
	(0.22) (0.87) (6.84) (2.79) (1.68)	
(3)	$r_t - r_{t-1} = 0.046(r_t^* - r_{t-1}) + 0.251(\bar{r}_t - r_{t-1}),$	SER = 0.147
	(1.36) (10.3)	
(6)	$\bar{r}_t = 1.516 + 0.984\delta_t.$	
	(6.19) (17.5)	

1. Numbers in parentheses are *t*-statistics in absolute value
2. Sample period: From 1974;I to 2004;I

amount of security holding funds of the bank, sec_t and the sample periods are different, the overall parameter estimates are quite similar to those of Asako and Uchino (1987). This is not accidental but there is reason for us to accept the view that the disequilibrium feature of the Japanese loan market has not changed very much since the analysis of Asako and Uchino (1987), which we shall discuss in detail in Subsection IV.5.

With respect to the loan demand equation, apart from the constant term, all three explanatory variables show theoretically predicted signs, though only the coefficient of lagged loan L_{t-1} is unquestionably statistically significant. That is, the market loan rate is hardly significant and level of total production y_t as represented by the index of industrial production is on the borderline of a sufficient level of statistical significance. With respect to the loan supply equation, all four explanatory variables again show theoretically predicted signs although two interest rate variables are not statistically significant. Namely, the market loan rate is far from statistically significant and the official discount rate is on the borderline of a standard level of statistical significance.

In the loan rate adjustment equation, the estimate of θ_2 is significant. This combined with the result of the official discount rate δ_t in the supply equation appears to show that policy interest rate hypothesis H2 is very appropriate. However, as we see in Table 3 in the sequel, sample division following the results in Table 1 is not totally consistent with that in Asako and Uchino (1987) for the same period from the first quarter of 1974 to the end of 1982. As a result, we ask whether there might be certain structural changes in the Japanese economy that the basic model is not pertinent enough to describe, and question whether the basic model can accurately capture the behaviors of demanders and suppliers of loans in this period. Therefore, before we discuss in greater detail the relative appropriateness of four hypotheses H0, H1, H2, and H12 concerning the state of the loan market in Subsection IV.5, we continue with our extended model.

2 Estimation of the Extended Model

Following the same procedure as with the basic model, we regressed the system consisting of equations (3), (38), and (39). The result is presented in Table 2.

The *t*-statistics for most parameters in this system are enhanced, especially those in the loan supply equation. Compared with the result in Table 1, the SER of the loan demand equation is almost the same as that in Asako and Uchino (1986), whereas the SER of the loan

TABLE 2. ESTIMATED RESULTS BY INTRODUCING A TIME DUMMY VARIABLE

(1)	$L_t^d = 0.612 - 0.022r_t + 0.297y_t + 0.888L_{t-1} - 0.223D95_t,$ (1.14) (1.32) (1.77) (12.8) (2.96)	SER=0.107
(2)	$L_t^s = -0.709 + 0.152r_t + 1.005D_t - 0.062\delta_t + 0.998D95_t,$ (0.77) (2.37) (19.8) (1.89) (3.58)	SER=0.001
(3)	$r_t - r_{t-1} = 0.100(r_t^* - r_{t-1}) + 0.367(\bar{r}_t - r_{t-1}),$ (2.76) (19.2)	SER=0.144
(6)	$\bar{r}_t = 2.825 + 0.776\delta_t.$ (22.8) (32.6)	

1. Numbers in the parentheses are t-statistics in a absolute value.
2. Sample period: From 1974;I to 2004;I.

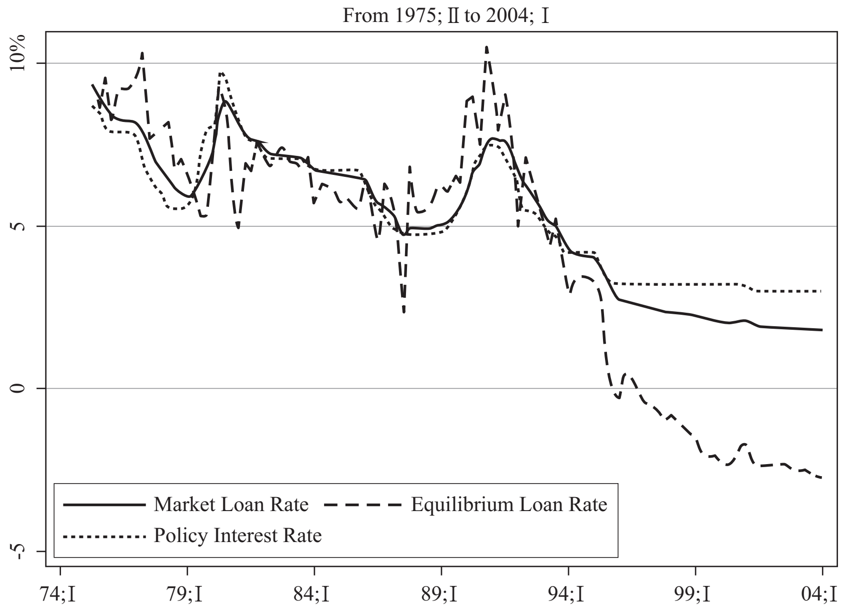
supply equation is greatly improved. We have therefore resolved one of the tasks left by Asako and Uchino (1987).

In the demand equation, loans demanded positively depend on the level of total production with an estimated coefficient of 0.297 and it is significant at the 10% level. This shows that the positive effect of inventory and equipment is larger than the negative effect of accruing profits and earnings retention. The coefficient of L_{t-1} is smaller than that in Asako and Uchino (1987), indicating that the persistency effect on outstanding total loans becomes weaker with structural changes taken into consideration. With the development of various financial markets and the liberation or relaxation of controls and regulations, many alternative ways and instruments for firms to finance funds became available, thus rendering firms' dependence on the bank loan market for financing weaker than before. For the banking sector, that blue chip companies kept away lowered the pressure on the bank loan market. The smaller value estimated for L_{t-1} reflects these changes in the conditions of the bank loan market.

By introducing time dummy variable $D95_t$, the test power for parameters in the loan supply equation is greatly enhanced in comparison to the results in Asako and Uchino (1987) and to Table 1 of the basic model. The parameter for r_t in the loan supply equation is 0.152, which is now statistically significant at the 1% level. The elasticity of loan supply with respect to total deposits is estimated to be 1.005 at a high significance level, which is consistent with the theory of credit creation. The parameter estimate for δ_t is 0.062, a value ten times larger than that in Table 1 and that is almost significant at the 5% level, which proves that loan supply is affected by the discount rate both directly and negatively. This result differs from Asako and Uchino (1987) in which δ_t is insignificant in most cases.

The estimated parameters of time dummy variable $D95_t$ in both loan demand and loan supply equations are altogether significant at the 1% level. However, the effects are opposite to each other. On the one hand, the sign of $D95_t$ in the loan demand equation is negative, which means that loans demanded by firms have declined since 1995. On the other hand, the sign of $D95_t$ in the loan supply equation is positive, which implies that loans supplied by banks have, *ceteris paribus*, increased since 1995. These results indicate, as was suggested in Subsection IV.1, that the demand side as well as the supply side should also bear some responsibility for the apparent "credit crunch" of the late 1990s. This can also be supported by the movements of the market loan rate, the equilibrium loan rate, and the policy interest rate since the late 1990s

FIG. 3. INTEREST RATES FOR MARKET, EQUILIBRIUM, AND POLICY



as demonstrated in Figure 3. We can see that since 1995, the theoretically derived equilibrium loan rate has gradually deviated from the other two interest rates and finally entered negative territory in the fourth quarter of 1996. The other two rates, the market loan rate and the policy interest rate, remain positive due to the obvious zero bound restriction.

5. The Loan Market and Four Hypotheses

We now turn to the estimation result of the loan rate adjustment equation. In judging the relative appropriateness of the four hypotheses presented in Subsection II.2, we rely mainly on the estimation result of the extended model, though we mention the estimation result of the basic model as well. The estimated parameter of θ_1 is 0.100 in the extended model, a little small but statistically significant at the 1% level. The same parameter estimate is 0.046 and is barely statistically significant in the basic model. However, what is crystal clear is that parameter θ_1 is not equal to unity, or is in other words at a significance level far below 1% for a reasonably large degree of freedom.

The estimated parameter of θ_2 in the extended model is 0.367, differing from zero at far less than the 1% significance level. In the basic model, its estimate equals 0.251 and is highly significant as well. These parameter estimates and their t-statistics are almost comparable to or a little smaller and less significant than the several parameter estimates and t-statistics reported in Asako and Uchino (1987). What is shared between the estimation of this paper and that of Asako and Uchino (1987) is that the estimate of θ_2 clearly deviates from 1, as is reported for example by the t-statistics of 33.2 for $\theta_2=1$ in the extended model.

Based on these observations, we are now able to scrutinize and judge the validity of the four hypotheses set out in Subsection II.2. First of all, the estimation result is clearly incompatible with equilibrium market hypothesis H0 as it requires $\theta_1=1$ and $\theta_2=0$ at the same time. It can be concluded that the loan market was, in general, in disequilibrium over the thirty years from 1974 to 2004. Given that equilibrium market hypothesis H0 is rejected, for the next question for θ_1 and θ_2 we can, on the one hand, definitely reject partial adjustment hypothesis H1. On the other hand, the requirement of policy interest rate hypothesis H2 is not met in its rigorous version where $\theta_1=0$ and $\theta_2=1$ are required; but an intermediate and weaker version of policy interest rate hypothesis H2' requesting $\theta_1=0$ and $0<\theta_2\neq 1$ is not untenable.

Having statistically rejected two extreme hypotheses H1 and H2, the remaining interpretation of the loan market disequilibrium is that the market loan rate adjusts itself toward the equilibrium interest rate and the policy interest rate concurrently but at different speeds. This is concurrent adjustment hypothesis H12, an amalgamation or linear combination of two extreme hypotheses H1 and H2. The influence of the policy interest rate has been larger than that of the equilibrium loan rate in the adjustment process of the market loan rate. In other words, considering the relative magnitudes of θ_1 and θ_2, it may be safe for us to assert that the market loan rate is guided mainly by the policy interest rate. This is basically the same conclusion reached by Asako and Uchino (1987).

6. Disequilibrium and Sample Division

As we have ascertained, the main message derived from our estimation results is basically the same as that of Asako and Uchino (1987). However, since the sample period used for estimation is utterly different between Asako and Uchino (1987) and this paper, it is not surprising in general even if the state of the loan market disequilibrium is of a different nature. However, contrary to this presupposition, there turns out to be little major difference. We first see the sample division in Table 3, where a circle "○" indicates the period of excess supply and a blank indicates the period of excess demand.

According to Asako and Uchino (1987), who made use of the sample period from 1963;III to 1982;IV, the Japanese loan market had been in a state of excess demand for most of the early days of the 1960s and the early 1970s except for the two years of 1968 and 1969 only. From after the first oil crisis of 1973 to the end of the sample period 1982, however, the nature of the disequilibrium showed a structural change in that excess supply occupied almost as much as a half of the sample periods as can be seen in column (a) of Table 3. Two sample divisions of this paper, based on basic model (b) and on extended model (c), exhibit almost similarly distributed disequilibrium patterns over time as they did in Asako and Uchino (1987) for the overlapping sample periods. After 1983 up to 2004, excess supply is prevalent throughout the sample periods except for the interim notorious bubble economy era from 1987 to 1992 or 1993.

Within the estimated extended model, the market loan rate in equation (3) adjusts itself within every quarter towards both the equilibrium loan rate and the policy rate, at a speed of 10% of its gap with the equilibrium loan rate and about 40% of its distance from the policy interest rate. In Figure 3, it is clear that the market loan rate was moving in concordance with changes in the policy interest rate. We also see that the policy interest rate was taking the lead

Table 3. Sample Division (1974; I-2004; I)

year	(a)	(b)	year	(b)	year	(b)
1974			1984	○	1994	○
				○		○
	○			○		○
	○			○		○
1975	○		1985	○	1995	○
	○	○		○		○
	○	○		○		○
				○		○
1976	○	○	1986	○	1996	○
				○		○
				○		○
						○
1977			1987		1997	○
				○		○
	○			○		○
	○					○
1978			1988		1998	○
						○
						○
						○
1979			1989		1999	○
						○
		○				○
		○				○
1980	○		1990		2000	○
						○
		○				○
	○	○				○
1981	○	○	1991		2001	○
	○	○				○
	○	○				○
						○
1982	○	○	1992	○	2002	○
	○	○				○
						○
						○
1983		○	1993		2003	○
		○		○		○
		○				○
				○		○
					2004	○

○ is for the excess supply period.
(a): by Asako and Uchino (1987)
(b): by estimation results of the basic model

ahead of the market loan rate.

From 1980;IV to 1986;I, the market loan rate, the equilibrium loan rate, and the policy interest rate all moved stably. Over the next six years, there were intense changes in these three rates. From 1987;IV to 1993;I, the equilibrium loan rate became estranged from the market loan rate, and the period of excess demand continued. As was touched on above, the pressure of demand for capital money was strong during this period and corresponded with increasing prices in the land and stock markets. Whereas this no doubt triggered and supported the bubble economy of the late 1980s and early 1990s, the opposite causality ran concurrently as well.

In addition, attention should be paid to the movement of these three loan rates since the second quarter of 1995. With the zero bound restriction, the market loan rate and the policy interest rate remained positive, while the equilibrium loan rate entered negative territory and stayed there. Recall that the equilibrium loan rate indicates that it is not an observable datum but a theoretical consequence of the automatic equalization of demand for and supply of loans.

In other words, because the banking sector and the monetary authorities cannot set a negative nominal loan rate, the state of disequilibrium continued. This might be a reason that it has been difficult for the Bank of Japan to abandon the nontraditional policy of zero interest rate. Recall in passing that a negative equilibrium loan rate implies that loan market disequilibrium is brought about because of excess supply of loans, *i.e.*, because, *ceteris paribus*, of either too-small demand or too-large supply.

V. *Additional Investigation*

In this section, we will continue with additional investigation into the bank loan market as a complement to the results of the previous sections.

1. Robust Estimates

It is implausible for a hypothesis to remain unchanged through the full sampling period. There should be some change in the estimation of θ_1 and θ_2. By changing the sampling period in three different ways, we obtain three sets of dynamic estimate series and plot them in Figure 5. Panel (a) shows the plots for θ_1 and θ_2 estimated on the samples fixed by twenty years. We find that while there are relatively few changes in the movements of θ_2, the trajectory of θ_1 looks like a mountain peak in 1980.

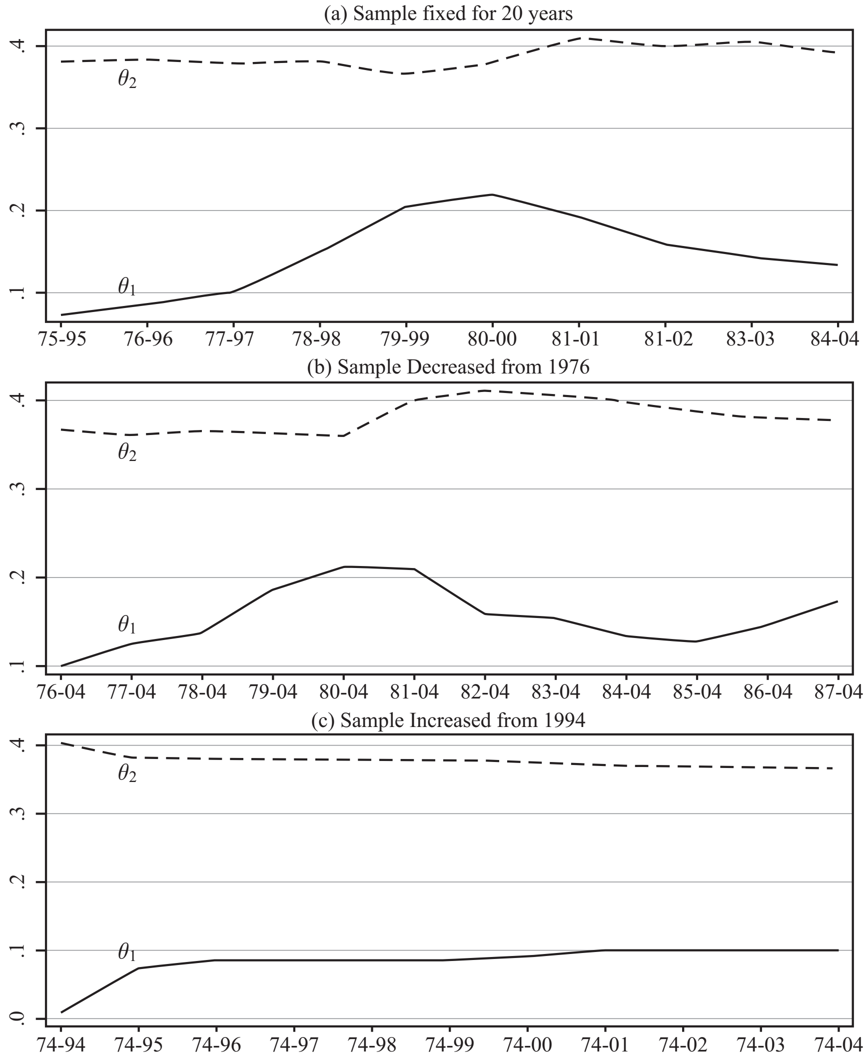
The samples for estimates of θ_1 and θ_2 plotted in panel (b) are set by fixing 2004 as the endpoint and reducing the number of samples one year at a time from 1976. The movements of θ_1 in both panels appear similar. Both peaked around 1980.

In panel (c), θ_1 and θ_2 are estimated with sub-samples divided by fixing 1974 as the base year and increasing the sample period one year at a time from 1994. Estimates of both θ_1 and θ_2 are very stable. In all three panels, no intense changes can be found in estimated θ_2. In contrast, the plot of θ_1 in panel (c) is markedly different from the other two. Changes in θ_1 are small in contrast to its fluctuations in the late 1970s and early 1980s.

2. Alternative Loan Rate Adjustment Equation

Since the bursting of the bubble economy at its climax, the Japanese economy was trapped in a depression for more than the following ten years or so. During this so-called lost decade or

FIG. 4. ROBUST ESTIMATES OF θ_1 AND θ_2



even fifteen years, all interest rates including the bank loan rate were stuck at extremely low levels. Based on this observation, we may reason that there might be something sticky and intrinsically sluggish in the interest rate adjustment process. To examine this, we make two modifications on the loan rate equation.

1 Intrinsically Sluggish Loan Rate

As the first modification, we consider whether the current market loan rate might be influenced by its lagged values because of intrinsic internal stickiness. Since the market loan rate data we use is the average contracted interest rate on total bank loans and discounts, this

Table 4. Modified Model with Intrinsically Sluggish Loan Rate

(1)	$L^d_t = 0.858 - 0.025r_t + 0.578y_t + 0.785L_{t-1}$, (1.21) (1.68) (2.24) (7.98)	SER=0.091
(2)	$L^s_t = 3.895 + 0.092r_t + 0.732D_t - 0.051\delta_t$, (2.41) (0.90) (6.96) (0.64)	SER=0.001
(3)	$r_t - r_{t-1} = 0.068(r^*_t - r_{t-1}) + 0.347(\bar{r}_t - r_{t-1}) + 0.056(r_{t-2} - r_{t-3})$, (1.17) (6.85) (0.80)	SER=0.132
(6)	$\bar{r}_t = 2.009 + 1.045\delta_t$. (9.02) (16.6)	

1. Numbers in parentheses are t-statistics in absolute value.
2. Sample period: From 1980;I to 1996;I.

loan rate increases or decreases only slowly even if new loan contracts are made with higher or lower loan rates than before. Thus, partly on account of the nature of collecting and constructing data, it is not surprising that the market loan rate is subject to certain stickiness or sluggishness at least in the short run. If the market loan rate is subject to this intrinsic stickiness, there then arises the possibility that the tests of the four hypotheses are misguided toward rejecting equilibrium market hypothesis H0 and favoring policy rate hypothesis H2 (or H2'). This bias arises because in general, the policy interest rate seldom changes and adjustment towards an unchanging target is consistent with the policy rate hypothesis.

To see whether the above conjecture is really hitting the mark, we first run third-order autoregressive AR(3) regression of the market loan rate. The sample period 1980;I to 2004;I gives the following estimation results:[5]

$$r_t = 0.014 + 1.921r_{t-1} - 1.079r_{t-2} + 0.250r_{t-3}.$$
$$(0.46) \quad (20.2) \qquad (7.31) \qquad (3.14)$$

Here, the numbers in parentheses are t-statistics in absolute value, and SER=0.010. Obviously, all the AR(3) terms are statistically highly significant, indicating that the market loan rate is heavily influenced by its own lagged values.

We now modify loan rate adjustment equation (3) as follows:

$$r_t - r_{t-1} = \theta_1(r^*_t - r_{t-1}) + \theta_2(\bar{r}_t - r_{t-1}) + \theta_3(r_{t-2} - r_{t-3}) + \varepsilon_t.$$

The meaning of the first two terms and coefficients θ_1 and θ_2 are the same as before. We add as the third term the two-quarters lagged difference in the loan rate. The simultaneous estimation result is reported in Table 4.

The coefficient of the market loan rate in the demand equation becomes significant this time, but not in the supply equation. The parameters of y_t and L_t are robust. We see from our results in the loan rate adjustment equation that both hypotheses H0 and H1 are rejected and that H2' is accepted. However, the estimated coefficient of θ_3 is not significant, though its sign is positive.

[5] We also attempted the same analyses over different sample periods 1980;I−1991;IV and 1982;I−2004;I. All results including those in Table 4 were robust and almost the same.

TABLE 5. MODIFIED MODEL WITH BUSINESS CONDITION

(1)	$L_t^d = 0.541 - 0.005 r_t + 0.139 y_t + 0.924 L_{t-1}$, (1.06) (0.57) (0.69) (13.2)	SER=0.079
(2)	$L_t^s = 0.932 + 0.141 r_t + 0.932 D_t - 0.172 \delta_t$, (0.45) (1.41) (9.34) (1.87)	SER=0.001
(3)	$r_t - r_{t-1} = -0.079(r_t^* - r_{t-1}) + 0.337(\overline{r}_t - r_{t-1}) + 0.120 tkr_t$ (1.51) (8.82) (6.42)	SER=0.106
(6)	$\overline{r}_t = 2.409 + 0.969 \delta_t$. (27.8) (35.4)	

1. Numbers in parentheses are t-statistics in absolute value.
2. Sample period: From 1980;I to 1997; II.

2 Business Condition and Loan Rate Adjustment

Another factor that possibly influences the short-run process of loan rate adjustment is the business condition. In a period of expansion or boom, besides the standard excess demand pressure pushing up the market loan rate, there may be an additional accelerating impact on loan rate adjustment through the expectations mechanism envisaged and shared by both demanders and suppliers in the loan market. Of course, the opposite decelerating impact may work in a period of contraction or recession.

There may be several ways to model this acceleration or deceleration of loan rate adjustment. One is to make speed coefficients θ_1 and θ_2 dependent on the business condition. However, as we have already investigated the trend changes of these parameters from a long-run perspective in Subsection V.1, we instead choose to add an additional explanatory variable directly to the loan rate adjustment equation. We select the realized prediction index by the Bank of Japan as the proxy variable of economic conditions (Tankan), denoted as tkr_t. Thus, the loan rate adjustment equation is modified by the introduction of tkr_t to

$$r_t - r_{t-1} = \theta_1(r_t^* - r_{t-1}) + \theta_2(\overline{r}_t - r_{t-1}) + \theta_3 tkr_t + \varepsilon_t.$$

The explanation of θ_1 and θ_2 is again the same as before. If the parameter estimated of θ_3 is positive and significant, then our conjecture of accelerating or decelerating effect of business condition will be affirmed. Our results are contained in Table 5.

Since 1995, the interest rate was controlled so as to be kept at extremely low levels. Its changes were limited to a very narrow range in comparison to earlier sample periods. As we have investigated in relation to the extended model, dummy variable $D95_t$ was significant, indicating that there occurred some structural change around 1995. Therefore, we took our sample from 1980;I to 1997;II. The estimation result for tkr_t is 0.120 and is significant at the 1% critical level. This result is consistent with our conjecture of the dependence of loan rate adjustment on the additional factor of business condition. The other coefficients estimates are almost the same as those in the basic model reported in Table 1 except that adjustment towards equilibrium θ_1 now has the wrong sign.

VI. *Conclusion*

In this paper, we conducted a rather intensive investigation into the Japanese bank loan market from 1974 to 2004 using the methodology developed by Asako and Uchino (1987). The state of disequilibrium between those who demand loans and those who supply them has continued until now, although the state of disequilibrium shifted from excess demand to excess supply. We demonstrated that the reason for this disequilibrium was that the market loan rate had been mainly affected by the prevailing policy interest rate rather than the equilibrium interest rate. Understanding the transmission mechanism of monetary policies is not only helpful in assisting loan demanders and suppliers in making their decisions, but is also useful for the monetary authorities in predicting the effect of their policies on the loan market.

The introduction of variables reflecting changes in the conditions of the Japanese economy into the structural system enhanced the model's explanatory power. In an era of low interest rate, it is important for the monetary authorities to encourage banks to lend actively. However, the movements of the market loan rate and the equilibrium loan rate since 1995 demonstrated that firms should also be responsible for the apparent credit crunch of these days, as the theoretically obtainable equilibrium loan rate was negative and the market disequilibrium stemmed from excess supply of, rather than excess demand for, loans.

There remains much to be done in understanding in greater depth the Japanese loan market. For instance, not only do *kashishiburi* and *kashihagashi* or the credit crunch and the flight-to-quality effect need to be investigated further for their own sake because of their prevalence in the late 1990s and early 2000s, seemingly contradictory *oigashi* (additional or rolling-over lending to highly indebted firms, or so-called zombie lending) and relief loans by main banks and the like await scrutiny from the viewpoint of questioning their rationality as well as from the efficiency criterion of resource allocation. However, what should be investigated above all is the detailed mechanism by which the market loan rate does not rapidly adjust to the equilibrium loan rate but is guided by the policy interest rate.

References

Asako, K. and Y. Uchino (1987), "Bank Loan Market of Japan — A New View on the Disequilibrium Analysis," *Bank of Japan Monetary and Economic Studies* 5 (1), pp.169-216.

Barro, R. J. and H. I. Grossman (1971), "A General Disequilibrium Model of Income and Employment, *American Economic Review* 61, pp.82-93.

Bernanke, B. S. and C. S. Lown (1991), "The Credit Crunch," *Brookings Papers on Economic Activity* No. 2, pp.205-239.

Bernanke, B. S., M. Gertler and S. Gilchrist (1996), "The Financial Accelerator and the Flight to Quality," *The Review of Economics and Statistics* 78 (1), pp.1-15.

Bowden, R. J. (1978), *The Econometrics of Disequilibrium*, Amsterdam: North-Holland.

Clower, R. W. (1965), "The Keynesian Counter-Revolution: A Theoretical Appraisal," in F. H. Hahn and F. P. R. Brechling, eds., *The Theory of Interest Rates*, Macmillan, pp.103-125.

Fair, R. C. and D. M. Jaffee (1972), "Methods of Estimation for Markets in Disequilibrium," *Econometrica* 40, pp.497-514.

Gertler, M. and S. Gilchrist (1994), “Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms,” *Quarterly Journal of Economics* 109 (2), pp.309-340.

Ito, T. and K. Ueda (1982), “Tests of the Equilibrium Hypothesis in the Japanese Business Loan Market,” *Economic Studies Quarterly* 33 (1), pp.25-36.

Kashyap, A. K., J. C. Stein and D. W. Wilcox (1993), “Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance,” *American Economic Review* 83(1), pp.78-98.

Lang. W. W. and L. I. Nakamura (1995), “Flight to Quality in Banking and Economic Activity,” *Journal of Monetary Economics* 36 (1), pp.145-164.

Mori, N. and Y. Tsutsui (1989), “Bank Market Structure and Performance: Evidence from Japan,” *Economic Studies Quarterly* 40 (4), pp.296-316.

Ramey, G. and V. A. Ramey (1995), “Cross-Country Evidence on the Link between Volatility and Growth,” *American Economic Review* 85 (5), pp.1385-1396.

Hoshi, T. and A. Kashyap (2001), *Corporate Financing and Governance in Japan: The Road to the Future*, MIT Press.