Bank Loan Market of Japan
–A New View on the Disequilibrium Analysis*

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I. Introduction

Recent years have witnessed a growing number of researches on the postwar bank loan market of Japan. They can be categorized into those analyzing the structure and performance of the loan market as a whole and those analyzing the behaviors of participants (for example, banks and corporations) in the loan market. However, virtually all of the studies share a common objective in that they attempt to examine whether Japan's bank loan market has been in equilibrium at all. This objective seems to be underlined by a perspective to confirm recent changes in the role of the bank loan market amidst the tide of financial innovation, deregulation and internationalization.

The series of researches as classified above can in turn be reclassified into the following two groups once the specific attention is paid to the actual approaches taken:

(A) Those, with the aid of disequilibrium econometrics, trying to verify that the loan market has been in disequilibrium and thereby some form of credit rationing has existed due to insufficient market clearing adjustments in the market loan rate.

(B) Those, with a belief in the latent rationality of market participants, arguing

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that the loan market has not necessarily been in disequilibrium once factors other than the market loan rate are explicitly taken into account.

And, to whichever group a particular study might belong, it can be said to be coping with a rather old dispute on Japan's postwar bank loan market from a new perspective.[1]

This paper takes the position of (A). Before discussing, however, it would be helpful for us to make a brief explanation on the relationship between (A) and (B). This is because it is sometimes misunderstood that (A) and (B) are directly opposed to each other in a sense that one argues for disequilibrium and the other for equilibrium. But, if the notion of "equilibrium" in (B) is more carefully studied, it will be easily seen that the (B) position attempts to provide microeconomic foundations to the disequilibrium of (A). This follows because (B) is related to whether the premised Walrasian market disequilibrium can be explained as a protractedly observed phenomenon rather than a short-term transitional one. The introduction of the notion of "equilibrium of expectations" by Kuroda (1979a), applications to the loan market of the recently developed applied microeconomic theories such as the "implicit contract" and "moral hazard or adverse selection" by Wakita (1981, 1983) and Ikeo (1985), and the deviation from a simple profit maximization of banks by Takeda (1985) are such examples.

In true equilibrium, both the market equilibrium and the subjective equilibrium (or the optimization by participants) must be attained. While (A) places an emphasis on the market equilibrium and takes minimal account of the rational behaviors of the participants, (B) argues in contrast that the subjective equilibrium of and among the participants is the clue to explain the protracted market disequilibrium. Therefore, for the (B) position, the promise is to obtain a definite evidence that the loan market is in Walrasian disequilibrium. In this sense, two groups of researches should be understood as complementary rather than opposing.

The fundamental position of this paper, as stated earlier, is to analyze the postwar bank loan market with a recognition that it has basically been a disequilibrium one. We shall employ a special econometrics method to cope with estimations under market disequilibrium. Taking the (A) position also implies that we are not particularly interested in the microeconomic scrutiny of the subjective equilibrium of the market participants. Traditional studies in this area include Hamada *et al.* (1977), Furukawa (1979), Kamae (1980), and Tsutsui (1982a) which follow the methodology of Fair – Jaffee (1972). But it has been pointed out that this

1. See Royama (1984) and Takeda (1985) for compact surveys on the bank loan market of Japan. Tsutsui (1982) and Ito – Ueda (1982) make detailed surveys on (A) and Ikeo (1985) on (B). See also Suzuki (1974) and Horiuchi (1980) for comprehensive examinations on the overall postwar Japanese financial markets.

estimation technique suffers from certain econometrical problems. Ito – Ueda (1982) are free from such criticisms as their study follows the methodology of Bowden (1978).[2,3]

This paper attempts to extend the study of Ito – Ueda (1982) in the following two important aspects. First, while Ito and Ueda take it for granted that the cause of the disequilibrium in the loan market is due solely to the slow adjustment of the market loan rate to its equilibrium level, we are as much concerned with a possibility that the loan rate is directly determined by policy measures. Second, as a result of the first modification, special attention is paid to sample division between the periods of excess demand and excess supply. To be more specific, we shall develop a new econometric methodology which determines the sample division simultaneously with the estimation of the structural parameters of the model.

The structure and a brief summary of the paper is as follows. In Section II, we shall present the basic model and three null hypotheses concerning the structure of the bank loan market that are discernible from the model. These are H_1: "equilibrium market hypothesis"; H_2: "partial adjustment hypothesis"; and H_3: "policy rate hypothesis." H_1 literally considers that the loan market is always in Walrasian equilibrium. In contrast, H_2 and H_3 share a common notion that the market is in disequilibrium. However, while H_2 reasons the cause of the disequilibrium in the delayed adjustments of the market loan rate to the equilibrium rate, H_3 considers that the disequilibrium originates from the policy determined loan rate which is not necessarily set at the equilibrium level. Section III is devoted to technical explanations of the estimation methodology of the model.

Section IV, which will report the result of empirical examination, is central to the paper. In this section, the demand and supply functions of the loan market are first specified, followed by the explanation of the utilized data. Then the three null hypotheses mentioned above are tested. The empirical analysis is based on quarterly data from 1963 to 1982. Bank loans are considered on the stock base and the weighted average interest rate of the outstanding loans is used as the representative market loan rate. Also examined in this section is the related problem of the bank loan market such as a review of the transmission channels of the official discount rate policy. The major conclusion of this section is to lend support to the "policy rate hypothesis" of H_3.

2. See Maddala (1983) and Ito (1985) for the general introduction to disequilibrium econometrics.

3. The conclusions of these studies generally support the disequilibrium hypothesis, with the exception of Furukawa (1979) who supports the equilibrium hypothesis and Kamae (1980) who arrives at somewhat indefinite results. In the mean time, it cannot be overlooked that the differences in these conclusions depend in part on the differences in the specification of the model, utilized data, sample periods, and so forth.

Section V is devoted to supplementary studies to the empirical analysis of Section IV. In particular, the validity of our policy rate hypothesis is strengthened from several viewpoints. Problems and reservations or limitations on the empirical analysis that could not be incorporated into the present paper are also discussed. The identification of the policy rate, which is our theoretical product, is also attemped and the possibility of its close link with both short-term and long-term prime rates, which are regulated interest rates in the bank loan market, is discussed. Section IV concludes the paper with several remarks.

II. Explanation of the Model

1. The Basic Model

We shall consider the following four equations system as the basic model to describe the bank loan market of Japan:

$$L_t^d = \beta_0 r_t + X_t \beta + u_t, \tag{1}$$

$$L_t^s = \gamma_0 r_t + Z_t \gamma + v_t, \tag{2}$$

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

$$L_t = \min [L_t^d, L_t^s], \tag{4}$$

where L_t^d= demand for loans, L_t^s= supply of loans, L_t= realized (or ex post) loans, r_t=market loan rate r_t^*=equilibrium loan rate, $\bar{r}_t$=policy loan rate, X_t=exogenous variable vector in the demand function, and Z_t= exogenous variable vector in the supply function. The mutually independent disturbances u_t, v_t, and ε_t are white noises with means 0 and constant variances. Although a special comment is necessary in introducing a disturbance into Equation (3), it will be referred to later.[4]

Equations (1) and (2), respectively, are the loan demand and supply functions. These are formulated to depend on the market loan rate and exogenous variables. If a standard microeconomic analysis is attempted, $\beta_0<0$ and $\gamma_0>0$ can be expected. The exogenous variable vectors will be specified only later in this paper. However, the possibility of including the official discount rate, δ_t, to Z_t may be noted here. This is to help discern the transmission channel of the official discount policy rate in Japan.

4. It is possible to introduce another disturbance term in Equation (4). However, since we shall consider a rather specific disturbance in this equation later, no attempt is made to introduce a general disturbance factor here.

Equation (3) describes the adjustment process of the market loan rate in which $0 \leqq \theta_1$, $\theta_2 \leqq 1$, Namely the market loan rate generally adjusts partially toward the equilibrium rate and the policy rate. The equilibrium loan rate is the one that equates demand and supply and is given by

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

The policy loan rate, on the other hand, is in principle to be given exogenously as a matter of policy. But since no appropriate data exist in reality, it is assumed to be expressed as a simple linear function of the official discount rate,

$$\bar{r}_t = a + b\delta_t, \tag{6}$$

of which the parameters a and b can be estimated from the data. The policy loan rate is an unobservable variable. Needless to say, then, such an equation as (6) cannot be applied to an ordinary regression analysis. However, within the present framework, it is possible to identify these parameters based on the knowledge of the model as a whole as will be discussed later.[5]

When the adjustment process of the market loan rate follows Equation (3), demand and supply do not necessarily match. Equation (4) represents a rule which determines the amount of loans that is realized ex post in such cases. This is the so-called short side rule assumption and it presupposes the quantity constraint against the long side economic agents. In general, even if demand and supply do not match ex ante, the realized loans need not be determined by the short side. Instead the balance of power between the demanders and the suppliers seems to become more important in determining the ex post transactions. However, rather than getting into the depth of such disequilibrium economics here, we shall follow the traditional literature in regarding the short side rule as a plausible and appropriate rule.[6]

5. Again it is possible to introduce a disturbance term into Equation (6), but it cannot be formally discernible from ε_t of Equation (3).

6. Under the short side rule, any disequilibrium transaction is Pareto inferior because the most efficient transaction for any market loan rate is the one that is brought about under the equilibrium rate. Therefore, if some coalition, albeit insufficient, is made between the demand and supply sides, there is a high possibility that the short side rule loses its effectiveness. Results of the recent development of the applied microeconomics can be said to have persued such coalition in one way or another. However, such an arguement presents an aspect that is not necessarily compatible with the traditional disequilibrium analysis which is premised on the decentralized decision making process. See Ito (1985) for the theories of disequilibrium economics.

2. Loan Rate Adjustment Equation and the Loan Market

As mentioned earlier, the traditional empirical studies have been confined to testing simply whether or not the bank loan market is always in equilibrium or, at best as in Ito – Ueda (1982), to designating the cause of the disequilibrium in the delayed adjustment of the market loan rate to the equilibrium rate. According to our loan rate adjustment equation (3), the following three market situations can be identified:

H_1 : Equilibrium Market Hypothesis — the loan market is always in equilibrium.

H_2 : Partial Adjustment Hypothesis — the loan market is in disequilibrium and its major cause is the delayed adjustment of the market loan rate to the equilibrium rate.

H_3 : Policy Rate Hypothesis — the loan market is in disequilibrium and its major cause is the policy regulated determination of the market loan rate.

The above three situations are judged through inspecting the following three null hypotheses. First, the equilibrium market hypothesis signifies $r_t = r_t^*$ and therefore

$$H_1 : \theta_1 = 1 \text{ and } \theta_2 = 0,$$

must be established. As for the second partial adjustment hypothesis and the third policy rate hypothesis, respectively, it can be seen that the conditions

$$H_2 : 0 \leqq \theta_1 < 1 \text{ and } \theta_2 = 0,$$
$$H_2 : \theta_1 = 0 \text{ and } \theta_2 = 1,$$

become null hypotheses. However, in case of the policy rate hypothesis, less stringent joint constraints

$$H_3' : \theta_1 = 0 \text{ and } 0 < \theta_2 \leqq 1,$$

are also considered to support the hypothesis. With H_3', certain time lags exist until policy measures penetrate but yet the market loan rate is fundamentally regulated by the policy roan rate.

The loan rate adjustment equation (3) could most appropriately be interpreted as a nested model describing the three null hypotheses of the structure of the bank loan market. In other words, it is better understood as summarizing the behaviors of various economic agents rather than describing the behavior of of particular agents. Of course, for example, if H_2 is to be supported, Equation (3) can be interpreted to reflect the "law of demand and supply" through the guidance of the market auctioneer. And if H_3 is to be supported, the equation indicates the effective functioning of either institutional factor or regulations of the authority.

It may be noted that the idea of introducing the impact of the official discount rate (and thereby the policy loan rate) into the loan rate adjustment equation itself is not entirely new. Ito – Ueda (1982), for instance, propose the formulation[7]

$$r_t - r_{t-1} = \theta_1 (r_t^* - r_{t-1}) + (1 - \theta_1)\theta_2 f(\delta_t), \tag{7}$$

where $f(\delta_t)$ represents the contributions attributable to the official discount rate (including its lagged values). With the loan rate adjustment equation (7), the partial adjustment hypothesis of H_2 becomes identical with ours. However, the equilibrium market hypothesis reduces to H_1: θ_1 and the constraint on θ_2 disappears. Furthermore, although the policy rate hypothesis can in principle be tested by H_3: $\theta_1 = 0$ and $\theta_2 \neq 0$, it then reduces to

$$r_t = r_{t-1} + \theta_2 f(\delta_t), \tag{8}$$

which is not as simple as $r_t = \bar{r}_t$ as implied with our Equation (3). This is because, whereas θ_1 is constrained to be real number between 0 and 1, there is no such constraint on θ_2 and it has a deficiency of changing dimensions in accordance with the dimension of $f(\delta_t)$.

III. Estimation Method of the Model

In this section, we shall describe the estimation method of the model presented in the previous section. First the sample division for estimation is outlined, and then the simultaneous estimation method of the structural equations is discussed.

1. Sample Division

The sample periods can be classified into two categories depending on whether the market loan rate is higher or lower than the equilibrium loan rate given by (5). Namely, if $r_t \geqq r_t^*$ the period is characterized by excess supply and if $r_t < r_t^*$ by excess demand. The division of samples based on this criterion may be reasonable insofar as the demand curve is downward sloping ($\beta_0 < 0$) and the supply curve is upward sloping ($\gamma_0 > 0$). This can indeed be seen by the fact that

$$L_t^d - L_t^s = (\beta_0 - \gamma_0)(r_t - r_t^*), \tag{9}$$

7. This is equation (3.6) of Ito – Ueda (1982), modified to match with our notation. Other studies preceeding Ito and Ueda, such as Hamada *et al.* (1977), Furukawa (1979), and Tsutsui (1982a), also consider impacts of the official discount rate in categorizing samples into the excess demand and excess supply periods. These stiudies, however, do not stand on rigorous hypothesis testings.

is deduced from Equations (1) and (2) together with the definition of the equilibrium loan rate (5).

In traditional researches which presuppose $\theta_2=0$ in the loan rate adjustment equation (3), it is possible to determine the sample division without explicitly knowing the equilibrium loan rate. This is because the rewriting of (3) yields

$$r_t-r^*_t=-\frac{1-\theta_1}{\theta_1}(r_t-r_{t-1})+\frac{\theta_2}{\theta_1}(\bar{r}_t-r_{t-1})+\frac{\varepsilon_t}{\theta_1}, \tag{10}$$

and, with $\theta_2=0$ (and $\varepsilon_t=0$ as well[8]), the sign of the left-hand side of equation (10) would exclusively depend on that of the first term on the right-hand side. Thus they can claim a simple and evident relation; that is, the period when the market loan rate is increasing (or decreasing) coincides with an excess demand (or excess supply) period.

However, in our study which does not presuppose $\theta_2=0$, a direct knowledge of the equilibrium loan rate becomes necessary in dividing samples. The equilibrium loan rate is to be calculated from Equation (5), but it is a theoretical product and remains unobservable unless the equilibrium market hypothesis is established. Yet it is possible to estimate the equilibrium loan rate through the knowledge of the basic model. This raises the problem, as described below, of the need to simultaneously proceed with the division of samples itself with the estimation of the structural parameters.

2. Estimation Method of the Demand Function

In an excess supply period, the combination of the market loan rate and the realized loans is situated on the demand curve, or the short side of the market. In an excess demand period, on the other hand, it is situated on the short side supply curve and no point is observed on the demand curve. However, as shown in Figure 1, the point on the demand curve in an excess demand period can be obtained by adding the amount of excess demand to the point situated on the supply curve. These explain how the demand function can be estimated by properly taking into account the sample division between the excess demand and supply periods.

The short side rule assumption (4) implies

$$L_t=\begin{cases} L^d_t, & r_t\geqq r_t^* \\ L^d_t-(L^d_t-L^s_t), & r_t<r_t^*. \end{cases} \tag{11}$$

8. In the traditional researches, the disturbance in the loan rate adjustment equation is literally disturbing and has to be eliminated. Otherwise, for instance, a period with the increasing market loan rate may not be an excess demand period.

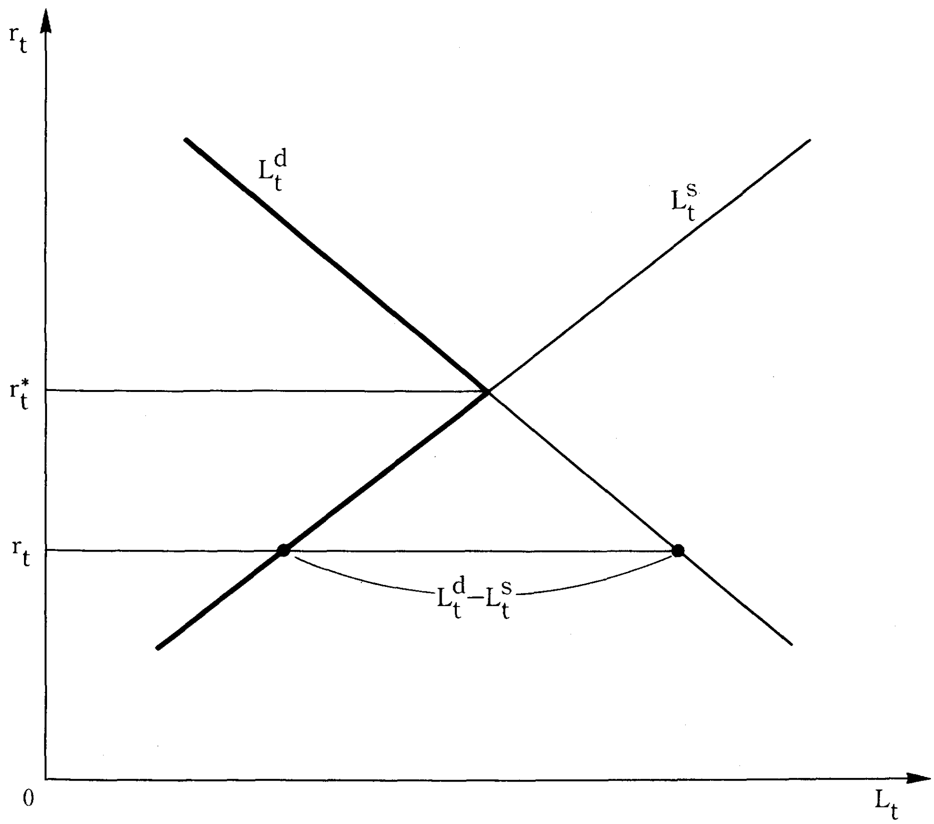
But, Equations (9) and (10) indicate that the excess demand portion of (11) can ultimately be expressed as

$$L_t = \beta_0 r_t + X_t \beta + (\beta_0 - \gamma_0)\frac{1-\theta_1}{\theta_1}(r_t - r_{t-1}) - (\beta_0 - \gamma_0)\frac{\theta_2}{\theta_1}(\bar{r}_t - r_{t-1}) + u_t - \frac{\beta_0 - \gamma_0}{\theta_1}\varepsilon_t. \tag{12}$$

Thus, we can estimate the parameters of the demand function by making use of the relation

$$L_t = \beta_0 r_t + X_t \beta + (\beta_0 - \gamma_0)\frac{1-\theta_1}{\theta_1}\nabla^d r_t - (\beta_0 - \gamma_0)\frac{\theta_2}{\theta_1}\nabla^d \bar{r}_t + u_t - \frac{\beta_0 - \gamma_0}{\theta_1}\nabla^d \varepsilon_t, \tag{13}$$

Figure 1 Market Disequilibrium



where

$$\nabla^d r_t = \begin{cases} 0 & r_t \geqq r_t^* \\ r_t - r_{t-1} & r_t < r_t, \end{cases} \tag{14}$$

$$\nabla^d \bar{r}_t = \begin{cases} 0 & r_t \geqq r_t^* \\ \bar{r}_t - r_{t-1} & r_t < r_t, \end{cases} \tag{15}$$

and

$$\nabla^d \varepsilon_t = \begin{cases} 0 & r_t \geqq r_t^* \\ \varepsilon_t & r_t < r_t. \end{cases} \tag{16}$$

It may be noted that the estimation methodology of Fair – Jaffes (1972) utilizes the data of the only excess supply periods in estimating the demand function. In estimating Equation (13), in contrast, we use all the data of all sample periods by defining artificial variables like (14) to (16). The methodology of Bowden (1978), which served as a basis to Ito – Ueda (1982), offers such a fundamental idea and Equation (13) is a further modification of the Bowden technique applied to our loan rate adjustment equation (3).

3. Estimation Method of the Supply Function

Conceptually the estimation of the supply function is carried out in parallel to that of the demand function. Namely, starting with

$$L_t = \begin{cases} L_t^s - (L_t^s - L_t^d), & r_t \geqq r_t^* \\ L_t^s, & r_t < r_t, \end{cases} \tag{17}$$

and utilizing Equations (2), (9), and (10), we obtain the estimable equation

$$\begin{aligned} L_t = \gamma_0 r_t + Z_t \gamma - (\beta_0 - \gamma_0)\frac{1-\theta_1}{\theta_1}\nabla^s r_t \\ + (\beta_0 - \gamma_0)\frac{\theta_2}{\theta_1}\nabla^s \bar{r}_t + v_t + \frac{\beta_0 - \gamma_0}{\theta_1}\nabla^s \varepsilon_t, \end{aligned} \tag{18}$$

where

$$\nabla^s r_t = \begin{cases} r_t - r_{t-1} & r_t \geqq r_t^* \\ 0 & r_t < r_t^*, \end{cases} \tag{19}$$

$$\nabla^s \bar{r}_t = \begin{cases} \bar{r}_t - r_{t-1} & r_t \geqq r_t^* \\ 0 & r_t < r_t^*, \end{cases} \tag{20}$$

and

$$\nabla^s \varepsilon_t = \begin{cases} \varepsilon_t & r_t \geqq r_t^* \\ 0 & r_t < r_t^*. \end{cases} \tag{21}$$

Note in passing that among the artificially defined variables (14) to (16) and (19) to (21),

$$\nabla^d r_t + \nabla^s r_t = r_t - r_{t-1}, \tag{22}$$

$$\nabla^d \bar{r}_t + \nabla^s \bar{r}_t = \bar{r}_t - r_{t-1}, \tag{23}$$

and

$$\nabla^d \varepsilon_t + \nabla^s \varepsilon_t = \varepsilon_t, \tag{24}$$

must always hold.

4. Simultaneous Estimation Method

So far we have pointed out the importance, in estimating the demand and supply functions, of the sample division according to whether the market loan rate, r_t, is higher or lower than the equilibrium rate, r_t^*. However, since our model requires a direct knowledge of the equilibrium loan rate itself, the division of samples has to be done simultaneously with the estimation of the structural equations system. In what follows, we shall describe this simultaneous estimation method.

To begin with, taking into account all the previous remarks, our basic model (1) to (4) can be recapitulated in the following three equations:

$$r_t = (1-\theta_1-\theta_2)r_{t-1} + \frac{\theta_1}{\beta_0-\gamma_0}(Z_t\gamma - X_t\beta) + \theta_2\bar{r}_t + \xi_t^r, \tag{25}$$

$$L_t = \beta_0 r_t + X_t\beta + (\beta_0-\gamma_0)\frac{1-\theta_1}{\theta_1}\nabla^d r_t - (\beta_0-\gamma_0)\frac{\theta_2}{\theta_1}\nabla^d \bar{r}_t + \xi_t^d, \tag{26}$$

$$L_t = \gamma_0 r_t + Z_t\gamma - (\beta_0-\gamma_0)\frac{1-\theta_1}{\theta_1}\nabla^s r_t + (\beta_0-\gamma_0)\frac{\theta_2}{\theta_1}\nabla^s \bar{r}_t + \xi_t^s, \tag{27}$$

where the disturbance terms are

$$\xi_t^r = \frac{\theta_1}{\beta_0 - \gamma_0}(v_t - u_t) + \varepsilon_t, \tag{28}$$

$$\xi_t^d = u_t - \frac{\beta_0 - \gamma_0}{\theta_1} \nabla^d \varepsilon_t, \tag{29}$$

and

$$\xi_t^s = v_t + \frac{\beta_0 - \gamma_0}{\theta_1} \nabla^s \varepsilon_t, \tag{30}$$

Equation (25) is obtained by substituting the equilibrium loan rate (5) into the loan rate adjustment equation (3). By doing this all the right-hand side variables of (25) are now observable. Equations (26) and (27), respectively, are simply the rewritings of Equations (13) and (18).

While the structural equations system now consists of three equations (25) to (27), evident endogenous variables in this system may be two: the market loan rate r_t and the realized loans L_t.[9] Thus, one of the equations appear to be redundant. However, a further reflection on the system reveals that the third endogenous variable is the equilibrium interest rate r_t^* which serves as the critical value for the sample division. Depending on this equilibrium loan rate, the variables in (14) to (16) and (19) to (21) are determined, which in turn will determine r_t and L_t. The equilibrium loan rate is theoretically given by Equation (5); but empirically it is to be computed from Equation (3) as

$$r_t^* = \frac{1}{\theta_1}[r_t - (1 - \theta_1 - \theta_2) r_{t-1} - \theta_2 \bar{r}_t - \varepsilon_t]. \tag{31}$$

In estimating the above-mentioned system, however, attention must be paid to the fact that Equations (25) to (27) are not three independent ones. In other words, any single equation of the system can be deduced from the other two equations.[10] Then, insofar as one out of the three equations does not add any new information,

9. Needless to say, $\nabla^d r_t$ and $\nabla^s r_t$ are also endogenous variables. However, counting them as endogenous variables necessitates to include Equations (14) and (19) explicitly into the present system.

10. For instance, subtract both sides of (26) from the corresponding sides of (27) and then multiply them by $\theta_1/(\beta_0 - \gamma_0)$ to obtain Equation (25).

the use of any two equations is theoretically sufficient to estimate the parameters.[11] If nonetheless three equations are used at a time to estimate the parameters, the contemporaneous variance-covariance matrix of the disturbance terms (28) to (30) becomes singular with a result of rendering the estimation theoretically impossible.

Once any set of two equations is chosen, the estimation must take account of the nonlinear constraints among the coefficient parameters. (In fact, the parameters a and b of Equation (6) become identifiable because of this constraint.) The estimated parameters give the basis to compute the equilibrium loan rate from Equation (5) or (31) and samples are divided. Therefore, the estimation process has to satisfy double constraints: that is, the nonlinear coefficient constraints and the consistency in the division of samples. As for the latter, it has to be the case that the sample division obtained on the basis of the estimated parameters with a given sample division should not be contradictory to the original sample division.

5. Estimation with Three Equations

In actually estimating the system of Equations (25) to (27), the possibility of one of the redundant equations bearing new information is not nil. If so, there occurs a gain in efficiency by simultaneously estimating the three equations. This possibility arises when some disturbances other than those of (28) to (30) exist in the model and the variance-covariance matrix of the three equations system becomes nonsingular. It is not that difficult to consider such examples and the followings are two possibilities.

First let us introduce a rather uncommon disturbance term into the short side rule (4). More specifically, it is assumed that, the asymmetric disturbance is generated in either the demand or supply function in case they are on the long side of the market. This is a kind of measurement error problem. Equations (11) and (17), respectively, are now modified as

$$L_t=\begin{cases} L_t^d, & r_t \geqq r_t^* \\ L_t^d-(L_t^d-L_t^s)+\eta_t, & r_t<r_t^*, \end{cases} \tag{32}$$

11. Although all the parameters in question are included in Equation (25), it is not possible to completely identify them by relying on this equation alone. However, if $\theta_2=0$ (or even if $\theta_2 \neq 0$ in case $\bar{r}_t$ is known), consistent estimate of θ_1 (and θ_2) can be obtained. Upon this knowledge, then, it is possible to calculate the equilibrium loan rate from Equation (31) and thereby to classify the disequilibrium situations. Ito – Ueda (1982) first determined the division of samples in this way, and then utilize Equations (26) and (27) in order to compute the parameter estimates of the demand and supply functions and that of θ_1. (They accordingly obtain two estimated values for θ_1.) However, this estimation procedure does not take full consideration of the constraints among coefficients of the structural equations. Therefore, even if the consistency of the estimators can be guaranteed, there remains a room of improving the efficiency of the estimators.

and

$$L_t = \begin{cases} L_t^s - (L_t^s - L_t^d) + \eta_t, & r_t \geqq r_t^* \\ L_t^s, & r_t < r_t^*, \end{cases} \tag{33}$$

where η_t is assumed to be a white noise with mean 0, independent of all the other disturbances included in the model. With (32) and (33), while the disturbance (28) remains intact, (29) and (30) respectively are rewritten as

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

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

where $\nabla^d \eta_t$ and $\nabla^s \eta_t$ are defined in exactly the same way as expressions (16) and (21) for ε_t.

We shall show in Appendix I that the contemporaneous variance-covariance matrix of the three disturbances (28), (34) and (35) is indeed nonsingular. Intuitively, this is because the new disturbance η_t appears in Equations (26) and (27) only and keeps Equations (25) intact, implying that it plays an asymmetrical role in the model as a whole.

The second example is the case where errors-in-variables take part in the market loan rate in the demand and supply functions. The loan rate adjustment equation (3) is based on the face loan rate. Let us consider, however, that the market participants do not regard the face loan rate as an appropriate indicator and their decisions are rather based on the effective loan rate which takes into account deposits held by borrowers. If this is the case, errors-in-variables occur to the first term (and only the first one) of the right-hand side of Equations (26) and (27). Denoting by ζ_t the white noise disturbance reflecting the errors-in-variables of the face loan rate, which is assumed independent of all the other disturbances in the model, expressions (29) and (30), respectively, now become

$$\xi_t^d = u_t - \frac{\beta_0 - \gamma_0}{\theta_1} \nabla^d \varepsilon_t + \beta_0 \zeta_t, \tag{36}$$

$$\xi_t^s = v_t + \frac{\beta_0 - \gamma_0}{\theta_1} \nabla^s \varepsilon_t + \gamma_0 \zeta_t. \tag{37}$$

Then, after an analysis similar to that for the first example, it is straightforward to demonstrate that the contemporaneous variance-covariance matrix of the three disturbances (28), (36), and (37) is again nonsingular. The proof will be briefly outlined in Appendix I.

There are other possibilities that involve the problem of errors-in-variables. For instance, there are those due to the characteristics of the employed data and those which inevitably occur when estimating the model. As will be discussed in detail later, our chosen data of bank loans and the market loan rate are, respectively, outstanding balances (that is, stocks) and the average contracted loan rate. In general, however, there is no solid guarantee that these data are most appropriate ones to examine the structure of the bank loan market of Japan. One way of reconciling this difficulty in empirical analysis may be to screen the data on the presumption that they are contaminated by errors-in-variables. The second possibility arises when we use the *estimated* data for the policy loan rate and the equilibrium loan rate. Especially, errors in the equilibrium loan rate cause errors in the sample division, which in turn generate errors-in-variables with the explanatory variables of (14), (15), (19), and (20). These errors-in-variables, however, are problems that occur uniformly in the system of Equations (25) to (27). Then, although proper attention must be paid to the estimation method of the model,[12] they do not themselves justify the simultaneous estimation with the three equations because the contemporaneous variance-covariance matrix would remain singular.

IV. Empirical Analyses

1. Specification of the Demand and Supply Functions

In proceeding with empirical analyses, it is necessary to specify the demand and supply functions. This is the question of selecting exogenous explanatory variables, X_t and Z_t, of both functions given in Equations (1) and (2). On this point, we shall follow the selections of the traditional literature and no particular attempt will be made to improve the preceeding empirical studies. In seeking to strike a contrast with the traditional studies, it is judged unwise to complicate the model unnecessarily in an eager pursuit of the mere "goodness of fit" of equations. With such awareness, we choose only two exogenous explanatory variables for both demand and supply functions (the number becomes three if the constant term is counted).

As for the demand function, Equation (1) will be

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

where the new variable y_t represents the level of production activities. An increase in the market loan rate will decrease the demand for loans and $\beta_0 < 0$ is expected. The

12. In case of errors-in-variables, the instrumental variable method must be used to obtain consistent estimators.

theoretical relation between loan demand and the level of production activities, however, is not clear. This is because there are opposing effects. On one hand, a rise in the level of production activities will prompt firms to expand their inventories and induce, by the acceleration principle, new investment in capital accumulation which in turn increases the demand for bank loans ($\beta_1>0$). With the accompanied increases in current and retained profits, on the other hand, there is a possibility that firms curtail their net demand for bank loans ($\beta_1<0$).

The third term on the right-hand side is the lagged realized loans and it predetermined at time t. It must be carefully noted here that the dependent variable is the loan demand which may not actually be effected, while the predetermined variable is the loans actually effected by the short side of the market. Therefore, ordinary theories that explain the inclusion of the lagged dependent variable as one of explanatory variables cannot necessarily be applied to the demand function (1).[13] Instead of offering its solid microfoundation, however, we anticipate $\beta_2>0$ simply because there in general is a continuity in the demand for loans.[14]

Now let us turn to the supply function (2). It is specified as

$$L_t^s = \gamma_0 r_t + \gamma_1 D_t + \gamma_2 \delta_t + v_t, \tag{2}$$

where D_t denotes bank deposits. According to the standard theory of bank behavior, we expect $\gamma_0>0$ for the market loan rate and $\gamma_1>0$ for deposits. The official discount rate is included as an exogenous explanatory variable because of the following 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 to represent ($\gamma_2<0$).[15] Second, as mentioned earlier, one of the

13. Discussions include the partial adjustment model and the introduction of an expectation variable with adaptive expectations hypothesis.

14. In case demand and supply differed in the past, there is a possibility that the current demand and supply are affected by the past unfilled transactions. It may be possible to assume $\beta_2>0$ as a special case of this carry-over effect.

15. In traditional empirical analyses, the call rate is considered to be the most appropriate opportunity cost. Certainly, in a situation where the official discount rate is lower than the call rate, it is natural to suspect that the official discount rate as cost of limited borrowings from the Bank of Japan will not have a direct impact on the supply of bank loans. See, for example, Suzuki (1974) and Horiuchi (1980). However, it is also conjectured that changes in the official discount rate exert other policy effects such as the announcement effect. In any case, therefore, it is certainly one of candidates for explanatory variables of the loan supply function. Incidentally, as a practical problem in estimation, the simultaneous inclusion of the market loan rate, the call rate, and the official discount rate into the loan supply function causes a possibility of strong multicollinearity. As we indeed observed this problem with a relatively insignificant result of the call rate in comparison to the official discount rate, we decided to exclude the call rate from Equation (2).

objectives of this paper includes the examination of the transmission channels of monetary policy. And in order to determine whether a change in the official discount rate would have a direct impact on the supply of loans or initially influence the policy loan rate of the adjustment equation (3) to eventually affect loan supply through a change in the market loan rate, it is vital to include the official discount rate in the supply function (2).

Figure 2 illustrates two transmission channels described above. Let the market loan rate be initially at r_{t-1} and the market characterized by point A which is the short side of the excess demand period. Now suppose that the official discount rate is raised. Then, if $\gamma_0<0$ is significant, the supply curve will shift toward the northwest direction and point B will be realized provided that $\theta_2=0$ in the loan rate adjustment equation (3). If, on the contrary, γ_2 is insignificant in the supply function and the policy rate hypothesis is supported, the market realization will shift from point A to C along the supply curve as a result of an increase in the market loan rate. Of course, in case both transmission channels function, the new market realization will be at point D.

2. Explanation of the Data

The sample period of the empirical analysis consists of 80 quarters from 1963III to 1982IV.[16] The data used 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),

y_t = Index of industrial production (mining and manufacturing, 1980 average = 100),

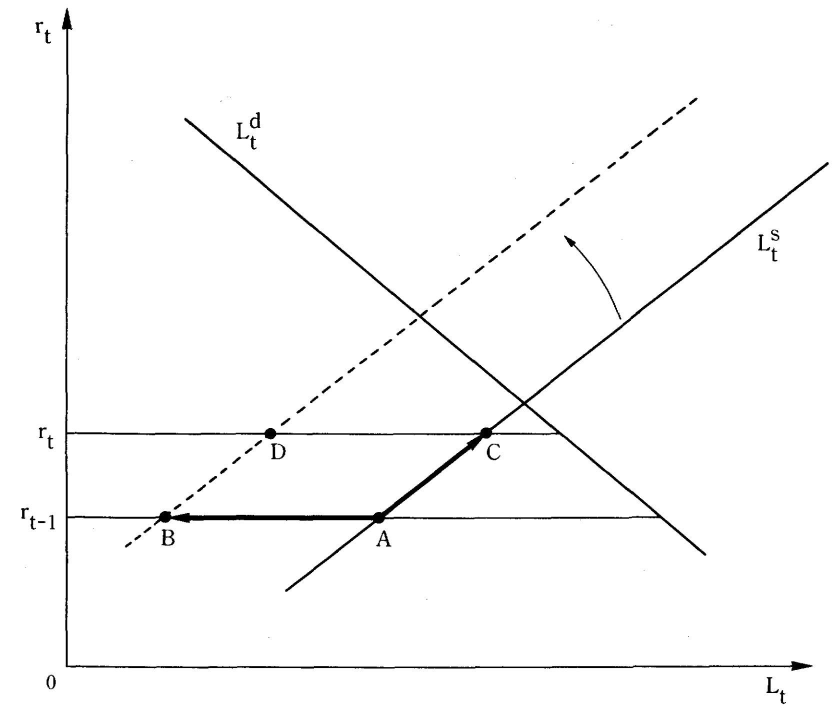
r_t = Average contracted interest rate on total bank loans and discounts (general),

δ_t = official discount rate (discount rate of commercial bills).

Of the above, r_t and δ_t are measured by the annual percentage point (period average), but because others are eventually transformed into natural logarithm, the unit itself does not matter. All the data used are not seasonally adjusted, which will be discussed later. These data are taken from the database available at the Bank of Japan.

16. Initially we attempted to make the sample period as long as possible. However, the indicated sample period had to be chosen due to various constraints on the availability of the entire data sets.

Figure 2 Transmission Channels of the Official Discount Rate Policy



3. Iterative Estimation and Convergence

As discussed earlier, parameter estimation of this paper is to be executed simultaneously with the division of samples. Namely, the sample division based on the estimated parameters with a given sample division must be in conformity with the original sample division. Moreover, among the parameters of the structural equations system, there exist nonlinear constraints. Therefore, in running regression analysis, there is a need to go through double iterative estimation processes.

For the nonlinear constraints of the parameter coefficients, we utilize the nonlinear three stage least squares method (NL3LSQ). For the consistency of the sample division, since we were restricted by the employed computer program to be able to replace the initial conditions for each run of the NL3LSQ once in every two iterations, we regarded it as converged when it resulted in the same sample division thrice consecutively.[17] A more detailed estimation procedure and the speed of the converg-

17. The employed program was the TSP (version 4.0) then available at the Bank of Japan. The convergence of the NL3LSQ is achieved under the programmed default values except that the maximum number of iterations was changed to 100.

ence in the sample division are reported in Appendix II. In summary, it is safe to conclude that in most cases the convergence is achieved at a fairly early stage and moreover the pattern of the sample division converges almost monotonously.

4. Estimation Results of the Basic Model

The main result of estimation of the structural equations system is summarized in Table 1. The result is written in terms of the original equations system (1) to (3) and (6). The SERs of these equations, however, are the standard error of regression of Equations (25) to (27), respectively. In order to avoid the instability and arbitrariness that arise from the optional selection of two equations, the estimation is based on the simultaneous use of three equations (25) to (27). Implied by this, therefore, are the setups which theoretically justify it such as those discussed in the previous section. The estimates of the constant terms of the demand and supply functions are not reported. Moreover, since the inclusion of seasonal dummy variables does not alter the basic estimation result (see Table 2, (Column (a)), we do not take explicit account of the seasonal adjustment of the data so as to simplify the estimation.[18]

The estimation result of the demand and supply functions shows that, while the market loan rate in the demand function and the official discount rate in the supply

Table 1 Estimation Results of the Basic Model

(1) $$L_t^d = -\underset{(.31)}{.005r_t} + \underset{(3.53)}{.143y_t} + \underset{(42.2)}{.908L_{t-1}} \quad SER = .066(13.32)$$

(2) $$L_t^s = \underset{(2.99)}{.067r_t} + \underset{(93.4)}{1.011D_t} - \underset{(1.56)}{.014\delta_t} \quad SER = .041(13.32)$$

(3) $$r_t - r_{t-1} = \underset{(2.68)}{.071}(r_t^* - r_{t-1}) + \underset{(12.2)}{.317}(\bar{r}_t - r_{t-1}) \quad SER = .091(7.62)$$

(6) $$\bar{r}_t = \underset{(9.15)}{3.004} + \underset{(14.2)}{.742\delta_t}$$

- Figure in parenthesis are t-statistics. Those in parenthesis after SER are the sample average value of the dependent variable of Equations (25) to (27).
- Sample period: 1963 III - 1982 IV

18. The seasonal dummy variables, however, are used throughout as instrumental variables of the NL3LSQ. Although this is done mainly to increase the list of instrumental variables, it can incidentally cope with the problem of errors-in-variables due to the possible seasonality of the data. Beside the seasonal dummy variables, the instrumental variables of the NL3LSQ include: all exogenous explanatory variables (including the predetermined variables) and the artificially defined exogenous variable of (15).

function are rather insignificant, the theoretical sign conditions are fulfilled. This indicates that the specification of both functions is reasonable. However, the SER of the demand function is .066 and is about 1.5 times as great as that of the corresponding figure of supply function, .041. Thus, there may be some room for improvement in formulating the demand function.

The result of the demand function indicates that the market loan rate is barely significant and the demand for loans depends mainly on the level of production activities and the lagged realized loans. Needless to say, however, this does not directly mean the prevalence of disequilibrium and credit rationing in the loan market. With $\beta_0=0$ the demand curve only becomes vertical in Figure 1 and it does not provide any information regarding the relative magnitudes of demand and supply. The fact that the demand for bank loans during Japan's high economic growth era was not responsive to the loan rate has been repeatedly pointed out in relation to abundant investment opportunities and "over-borrowings." The result here may lend support to such aspect.

While the elasticity of loan demand with respect to the index of industrial production is not particularly large, it is significantly positive. Thus, the positive effect due to increases in inventory and investment in capital accumulation turns out to be greater than the negative effect due to increased current and retained profits. Also, although it is naturally expected that the current demand for loans is highly correlated with the previous realized loans as bank loans are measured in terms of outstanding balances, it yet suggests that the adjustment of loan demand itself tends to be slow enough to sustain protracted market disequilibrium.

Turning to the estimation result of the supply function, we can first see that the market loan rate is significantly positive. However, one percentage point rise in the loan rate will increase the supply of loans by only .07 percent and the magnitude may not be that large. The elasticity of loan supply with respect to deposits is equal to almost unity, indicating the nonexistence of a nonneutral scale effect in the management of bank assets. As for the impact of the official discount rate, a detailed study will be made later in relation to its transmission channels.

5. The Loan Market and Three Hypotheses

Let us examine the estimation result of the loan rate adjustment equation in Table 1. First, the estimate of θ_1 equals .07 and is judged very small. The significance level to the null hypothesis $\theta_1=0$ is also not so high with the t-statistics 2.68. The estimate of θ_2, on the other hand, equals .32. Although this figure is apparently too different from unity to support the strong version of the "policy rate hypothesis," it is also significantly different from 0 (t-statistics=12.2). On the basis of the estimated standard errors, the t-statistics against a simple null hypothesis $\theta_1=1$ is calculated as 35.1 and that against $\theta_2=1$ as 26.3, thus significantly rejecting both simple null hypotheses.

Now we can examine the validity of the three hypotheses on the structure of the bank loan market in the following way. First, since the "equilibrium market hypothesis" of H_1 jointly requires $\theta_1=1$ and $\theta_2=0$, it is clearly rejected. The next question, then, is to seek the source of the disequilibrium in the loan market. The appropriate answer, by observing the estimates of insignificant $\theta_1=.07$ and highly significant $\theta_2=.32$, is to reject the "partial adjustment hypothesis" and to accept H'_3, which is a less stringent version of the "policy rate hypothesis."

The above results are not exclusive to the estimation result of Table 1. Table 2, in which two alternative estimation results are reported, reproduces the basic results and endorses the robustness of our conclusion. Column (a) shows the estimation result in the case where quarterly seasonal dummy variables are added as explana-

Table 2 Other Estimation Results

		(a)	(b)
Demand Function	β_0	−.038 (1.91)	.047 (2.03)
	β_1	.108 (2.91)	.191 (3.00)
	β_2	.926 (45.5)	.870 (28.6)
		SER = .086 (13.32)	SER = .090 (13.37)
Supply Function	γ_0	.103 (3.13)	.012 (.72)
	γ_1	1.027 (54.7)	.990 (128)
	γ_2	−.018 (1.24)	−.002 (.22)
		SER = .064 (13.32)	SER = .034 (13.37)
Loan Rate Adjustment Equation	θ_1	.099 (4.67)	−.034 (.91)
	θ_2	.287 (16.1)	.422 (13.6)
		SER = .088 (7.62)	SER =.093 (7.62)
Policy Rate Equation	a	2.423 (8.16)	3.905 (14.4)
	b	.836 (17.1)	.589 (14.4)

- Column (a) includes seasonal dummy variables as the additional explanatory variables, (1963 III - 1982 IV).
- Column (b) replaces the equilibrium loan rate by the simple moving average of the last (including the current) four quarters, (1964 II - 1982 IV).
- Figures in parentheses are t-statistics. Those in parentheses after SER are the sample average of the dependent variable of Equations (25) to (27).

tory variables to each of Equations (25) to (27).[19] Column (b) shows the estimation result with a slightly modified sample division. In this case the critical equilibrium loan rate is replaced by the simple moving average of the estimated last four quarter equilibrium loan rates (including the current one). This is expected to smooth possible errors in sample division arising from errors in the computed equilibrium loan rate. The estimates of θ_1 and θ_2 in Table 2 are seen to support the fundamental implication of Table 1; that is, although they draw slightly closer with θ_1=.10 and θ_2=.29 in Column (a), θ_1 becomes totally insignificant with θ_1=−.03 and θ_2 takes a much greater value .42 with high significance level in Column (b).

Ito – Ueda (1982), based on the formulation of (7), obtained the estimates θ_1 =.18(2.73) by the loan rate adjustment equation and θ_1=.10(1.61) by the estimation of the demand and supply functions (figures in parentheses are t-statistics against the null hypothesis θ_1=0 computed from the reported standard errors). The ratio of the contribution of the official discount rate to changes in the market loan rate (computed from the portion of $(1-\theta_1)\theta_2 f(\delta_t)$ in (7)) is calculated to be around 15 percent. As mentioned earlier, we cannot get any direct information related to θ_2 of our loan rate adjustment equation from formulation (7). However, since they obtained another estimate θ_1=.23(4.74) when the influence of the official discount rate is excluded, we believe that their conclusion to support the "partial adjustment hypothesis" of H_2 has to be altered once they consider the "policy rate hypothesis," as well as the "market equilibrium hypothesis," as another alternative to H_2.

6. Determination of the Market Loan Rate

Our empirical analysis so far has shown that the variation of the market loan rate reflects neither that of the equilibrium loan rate itself nor the adjustment toward the equilibrium rate. Instead, the market loan rate is adjusted toward the "policy loan rate" which is given by equation (6) of Table 1. Now, for simplicity, suppose that the estimates of θ_1 and θ_2 are modified to θ_1=0 and θ_2=1/3 and the disturbance ε_t is assumed away. Then, the loan adjustment equation (3) becomes

$$r_t=\frac{2}{3}r_{t-1}+\frac{1}{3}\bar{r}_t, \tag{38}$$

so that a successive backward substitution yields

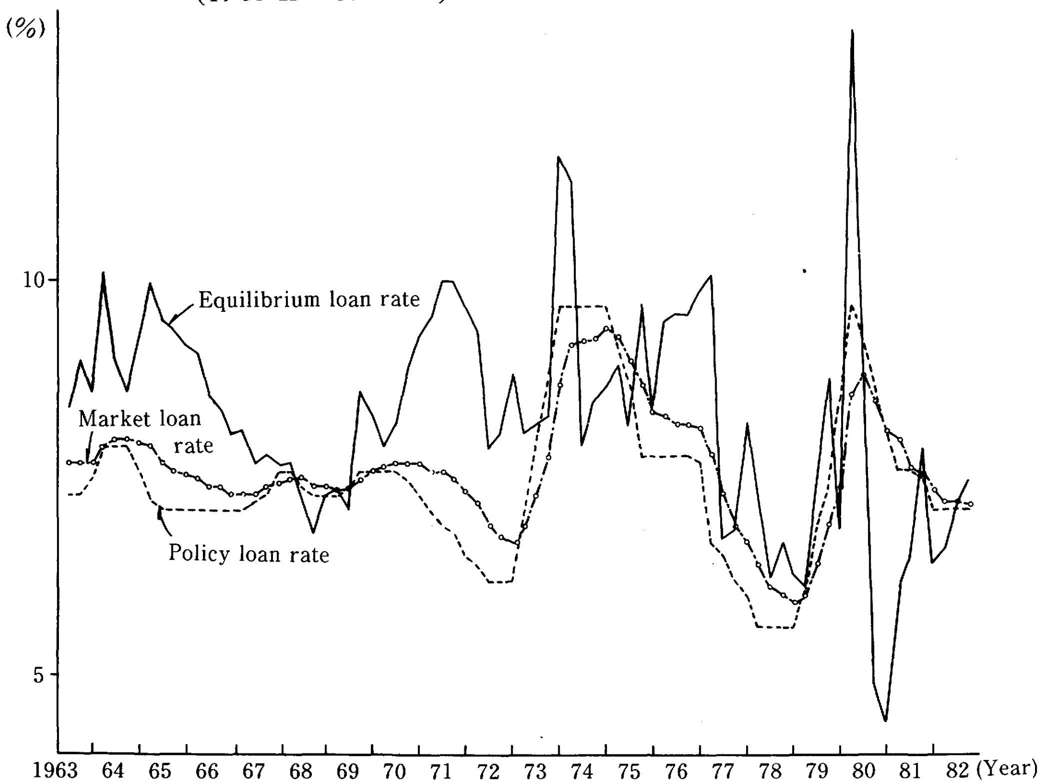
19. The estimates of seasonal dummy variables are not reported. Incidentally, if seasonal dummy variables are included as additional explanatory variables in Equations (25) to (27) in ways free from the coefficient constraints among equations and if accompanying disturbances are introduced (due, for instance, to errors-in-variables), we have the third theoretical rationale to estimate with three equations.

$$r_t=\frac{1}{3}\sum_{j=0}^{\infty}\left(\frac{2}{3}\right)^j\bar{r}_{t-j}. \tag{39}$$

In other words, the market loan rate at period t is determined as the geometrically declining weighted average of all the current and past policy loan rates. The mean log calculated from Equation (39) equals three quarters, which implies that the market loan rate varies in accordance with the policy loan rate after an average time lag of nine months. This result may be rather puzzling, since a faster adjustment of the market loan rate can be expected if the announcement effect of the official discount rate policy is taken into account. A possible reason for this will be discussed in the next section in relation to the characteristics of the employed data of the market loan rate.

Figure 3 plots the three interest rate on loans: the market loan rate, the equilibrium loan rate which is computed by the formula (31) with the parameter estimates of Table 1 (and setting $\varepsilon_t=0$ irrespective of its realization), and the estimated policy loan rate of (6). The similarity between the overall variations of the market and policy loan rates is clearly observed enough to verify the policy rate hypothesis.

Figure 3 Market Loan Rate, Equilibrium Loan Rate and Policy Loan Rate
(1963 III - 1982 IV)



Moreover, through a closer look at Figure 3, it is possible to read that the variation of the policy loan rate leads that of the market loan rate.[20]

The time series of the equilibrium loan rate of Figure 3 shows that it has been almost permanently above the market loan rate until the early 1970s except for a short period in the late 1960s, meaning that the period could be characterized by sustained excess demand. After 1973, the three interest rates show larger variation width both upward and downward. Still, however, the variation of the equilibrium loan rate is much wider than that of the two other interest rates. It can be also seen that in this period the equilibrium rate has almost no influence on the fluctuations of the market loan rate. Note that the equilibrium loan rate reflects disturbances in both demand and supply functions. Then, given that these disturbances are correlated with macroeconomic shocks, the large fluctuations of the equilibrium rate in this period can be understood easily.[21]

7. Periods of Excess Demand and Excess Supply

In order to have a closer observation of the disequilibrium during the sample period, Table 3 summarizes the results of concrete sample divisions between excess demand and excess supply periods. In this Table, eight different ways of sample division are reported, the last five of which are those adopted by the preceding empirical analyses and are included so as to provide comparisons with our results. Between the traditional researches and ours, there are differences in model specification, analytical methodology, employed data, sample period, and so on, implying that a straight comparison needs reservations. However, because the classification of disequilibria itself conveys substantial implications concerning the structure of the bank loan market, the comparison may yet be useful.

In Table 3, excess supply period are marked by ○, excess demand periods are left blank, and equilibrium periods (considered only in Column (g)) are marked by *. If the sample period is different from ours, it is adjusted by the following rule. For sample periods longer than ours, only the overlapping periods are considered and the remainder is omitted; and for those shorter than ours, only the covered periods are reported without any updating.

Column (a) is our basic sample division and is the one which obtains with the

20. This can be checked by the fact that the variation of the policy loan rate always precedes that of the market loan rate whenever there occurs a change in the order of level between the two interest rates.

21. See Takeda (1985) for the change that occurred around 1973 in the fluctuation patterns of the various interest rates as a whole including the market loan rate. Among many references which relate this change to the financial deregulation and internationalization, only Economic Planning Agency (1984) is mentioned here.

Table 3 Classification of Disequilibrium (1963 I - 1982 IV)

Period	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1963 I				○			○	
1963 II				○			*	
1963 III				○				
1963 IV				○				
1964 I								
1964 II								
1964 III								
1964 IV								
1965 I				○				
1965 II				○				
1965 III				○				
1965 IV				○			○	
1966 I				○			○	
1966 II				○			○	
1966 III				○	○		○	
1966 IV				○	○		*	
1967 I				○	○			
1967 II				○	○			
1967 III				○	○			
1967 IV					○			
1968 I					○			
1968 II					○	○		
1968 III	○	○		○	○	○		
1968 IV	○	○		○	○	○		
1969 I	○		○	○	○			
1969 II			○	○	○			
1969 III	○	○	○		○			
1969 IV								
1970 I								
1970 II					○			
1970 III					○			
1970 IV								
1971 I				○				
1971 II				○				
1971 III				○			○	○
1971 IV				○	○	○	○	○
1972 I				○	○	○	○	○
1972 II				○	○		○	○
1972 III				○	○		○	○
1972 IV				○	○		○	○
1973 I				○	○		○	○
1973 II							*	
1973 III								
1973 IV								
1974 I								
1974 II								
1974 III	○	○						
1974 IV	○	○						
1975 I	○	○	○				○	
1975 II	○	○	○	○		○	○	
1975 III	○	○	○	○		○	○	
1975 IV				○		○	*	
1976 I	○	○		○		○		
1976 II				○				
1976 III				○				○
1976 IV				○			*	○
1977 I				○			○	○
1977 II				○				
1977 III	○	○		○				
1977 IV	○			○				
1978 I				○				
1978 II				○				
1978 III				○				
1978 IV				○				
1979 I				○				
1979 II								
1979 III								
1979 IV								
1980 I	○	○	○					
1980 II								
1980 III		○						
1980 IV	○	○		○				
1981 I	○	○	○	○				
1981 II	○	○	○	○				
1981 III	○	○	○	○				
1981 IV			○	○				
1982 I	○	○	○	○				
1982 II	○	○	○	○				
1982 III			○	○				
1982 IV			○	○				

- ○ = excess supply period, blank = excess demand period, * = equilibrium period (only in (g))
- (a) : by estimation results of Table 1 (1963 III - 1982 IV)
  (b) : by estimation results of Table 2, Column (a) (1963 III - 1982 IV)
  (c) : by estimation results of Table 2, Column (b) (1964 II - 1982 IV)
  (d) : by $r_t - r_t^* \leq 0$
  (e) : by Hamada et al. (1964 III - 1973 I)
  (f) : by Ito–Ueda (1982) (1968 II - 1977 I)
  (g) : by Tsutsui (1982a) (- 1977 I)
  (h) : by *Tankan* (1968 II - 1977 I)

estimation result of Table 1. Columns (b) and (c), respectively, are due to the estimated equations of Columns (a) and (b) of Table 2. These three sample divisions share a very similar pattern, confirming again the robustness of the estimation results of Tables 1 and 2. Columns (d) to (h) are those presumed or obtained in the preceding empirical studies. Column (d) is based on the criterion that the market is in excess demand (or supply) when the market loan rate is increasing (or decreasing) over time. Column (e) is based on the criterion (ii) of Hamada *et al.* (1977), which with our notation sets *a priori* $\theta_2=.5$ in the loan rate adjustment equation (3) and specifies a=5.16 and b=.44 in the policy loan rate equation (6).[22] Column (f) is based on the estimation of demand and supply functions by NL3LSQ of Ito – Ueda (1982) and reported in Ito (1985). Column (g) represents what is qualified as a "more appropriate sample division" by Tsutsui (1982 a) and is determined not by the knowledge of the loan rate adjustment equation but by some comprehensive measures utilizing several economic indices. The last Column (h) is based on the questionnaire on the tightness of raising corporate funds conducted by the Bank of Japan and summarized in *Tankan* (or short-term economic survey of principal enterprises), which is copied here from Ito (1985).

By comparing and examining those eight ways of sample division, it is possible to outline several notable characteristics. First, by the classification based on naive criteria such as (d) and (e), excess supply periods exceed by far excess demand periods even during 1960s which ought to be an excess demand period by the traditional argument.[23] This was exactly the issue pointed out by Tsutsui (1982 a) and made him invent the "more appropriate sample division" (g). Second, although this (g) classifies 1966 as an excess supply period, excess supply periods as a whole are reduced largely and it shares a similar sample division pattern with *Tankan* (h). Third, while (f) classifies two quarters from 1971 to the next year as excess supply periods, it as a whole shows essentially a similar pattern to our division of samples for the overlapping periods. The reason for this similarity may stem from the fact that (f) is based on an econometrics technic similar to ours.

Our sample divisions (a) to (c) indicate that excess demand periods dominate except for sometime between 1968 and 1969, from 1974 to the beginning of 1976, the latter half of 1977, and a large part of the period after 1980. (Incidentally in (a), out of 73 quarters, 59 quarters are excess demand periods and only the remaining 19 are

22. The value of a and b are estimates of regression analysis of (6) where the policy loan rate $\bar{r}_t$ is replaced by the observable market loan rate r_t. Hamada *et al.* (1977) does not report any sample division; and these results are based on the follow-up research by Kamae (1980).

23. In case the "artificial low interest rate policy" or the rigidity of the market loan rate is discussed, what is naturally borne in mind is the persistence of excess demand periods. See Suzuki (1974) and Iwata – Hamada (1980). This point is discussed in more detail below in relation to the issue of credit rationing.

excess supply periods). Consequently, as previously mentioned in observation of Figure 3, our results land support to the commonly accepted view that Japan's high economic growth era of 1960s was the period of excess demand in the bank loan market. However, our sample divisions are in some discord with another commonly accepted view in that the so-called "excess liquidity period" of early 1970s is classified as the period of excess demand. Nonetheless, careful attention must be paid to the general observation that the prevalence of macroeconomic excess liquidities does not immediately mean the prevalence of excess supply in the bank loan market. Consider, for instance, that the funds for investing in lands and stocks are raised by bank loans and that banks also shift their portfolio from lendings to other more profitable assets. Then, there arises ample room to question the plausibility of the traditional view.

The fact that excess supply periods are predominant on entering 1980s may reflect the changes in the bank loan market against the background of financial deregulation and internationalization. Namely, we observe evidences that arbitration between the loan market and other open markets has become active and the role of the loan market, which is characterized by indirect financing, is gradually changing. As seen from Column (d), the observation that the market loan rate itself is declining in this period may signify the above trend. We shall again discuss this point in the next section.

8. Transmission Channels of the Discount Rate Policy and Credit Rationing

The last observation to be made from the estimation results of Table 1 is the transmission channel of the discount rate policy. In the present framework, two possible transmission channels have been considered. One channel, which is the direct impact on the supply of loans, is not particularly found. Namely, although the official discount rate exhibits a negative sign in accordance with the theory, its t-statistics 1.56 indicates that it is barely significant. Moreover, the estimation results of Table 2 are even less significant, suggesting that the first transmission channel, if any, is not so effective. In contrast, since the policy rate hypothesis was supported, we observe the effective transmission channel of the discount rate policy to the market loan rate through the loan rate adjustment equation (3). The estimation result of Equation (6) indicates that an increase in the official discount rate by a one percentage point will increase the policy loan rate by .74 percentage point. Then, the ultimate effect on the current market loan rate equals about one third of that number or .24 percent point. Because there is a mean lag of three quarters before the policy loan rate effects the market loan rate, the market loan rate is increased by .58 percent point by that time.

In terms of Figure 2, an increase in the official discount rate shifts the market realization from point A to point C and not from point A to point B. The transmission channel of the discount rate policy has been subject to debates hitherto and a dominant view is to question the direct impact on the supply of loans.[24] Our result is to confirm this view. Incidentally, the observation that the market realization moves from point A to point C during the tight monetary policy period (when the official discount rate is raised) implies that loan supply increases in the end. This feature is criticized as having a rather strange implication (Horiuchi (1980)). However, it must be a logical consequence if interpreted in the context of the relaxation of credit rationing within Walrasian disequilibrium.

Provided that the market loan rate is determined in accordance with Equation (39) and that the policy loan rate is kept at an "artificially" low level, credit rationing inevitably enters into the picture as long as the demand and supply functions (1) and (2) are premised. Empirical studies, which include Kaizuka – Onodera (1974), Rimbara – Santomero (1976), and Iwata – Hamada (1980), also support the existence of credit rationing in the bank loan market of Japan. These studies, however, rely on the theory of the dynamic credit rationing of Jaffee – Modigliani (1969) and several different criticisms, for example, Teranishi (1974) and Horiuchi (1980), have already been expressed. On this matter, we also do not think it is appropriate to accept unconditionally the story of the dynamic credit rationing as it presumes the "partial adjustment hypothesis" of H_2 which our empirical analysis has rejected. The market loan rate instead is determined by the distributed lags of the policy loan rate as in Equation (39) and is not necessarily adjusted toward the equilibrium loan rate.[25] Therefore, the credit rationing in the bank loan market of Japan should be interpreted to reflect more of the intentions of the authority (or Bank of Japan).

The short side suppliers do not adjust their quantity of loans monopolistically for given short-run rigid market loan rate as in the theory of the dynamic credit rationing; rather the quantity determination itself is thought to be guided by the quantity restrictions of the Bank of Japan (so-called "restriction of loan volume increase" or, in a broader sense, "window guidance"). As clarified by Kuroda (1979b), the window guidance itself is a policy measure that cannot be executed independently but is applied only in harmony with other measures of monetary policy such as the official discount rate operations. If so, taking into account our empirical analysis implies that, at least in theory, the Bank of Japan can literally choose point C in Figure 2

24. Suzuki (1974) and Horiuchi (1980) were already cited as examples of criticism from the theoretical analyses of the bank behavior. Ito – Ueda (1982) also obtain a negative empirical result for including the official discount rate into the loan supply equation.

25. Theoretically, however, the possibility that the policy loan rate adjusts endogenously and becomes equal to the equilibrium rate is not entirely excluded. We shall discuss this possibility in the next section.

after an increase in the official discount rate. This incidence must be stressed because, without quantity restrictions imposed by the Bank of Japan, point C may not be realized.

This possibility arises whenever either the short side rule (4) is invalidated or the supply function is unstable in the presence of credit rationing. But, since transactions under disequilibrium are not Pareto optimum and there always are Pareto improving alternative transactions, it is not difficult to imagine coalitions between the demanders and suppliers which invalidate the short side rule. Alternatively, if each monopolistically competitive bank has an incentive to shift its supply function in order, for example, to increase its own market share, the short side rule may not be effective in the loan market as a whole. Of course, if these discussions turn out to be important, it is desirable to reformulate both demand and supply functions on the basis of proper background microfoundations. However, as we stated earlier in this paper, these tasks are not our present concern and left to the future researches.

V. Supplementary Analyses

In this section, we present several additional analyses to supplement the analysis of the previous section. These will strengthen the validity of our "policy rate hypothesis."

1. Estimations with Two Equations

Without proper modifications, Equations (25) to (27) cannot theoretically be estimated with the simultaneous use of the three equations. In such a case, the correct estimation has to be based on any set of two equations, implying that there are three possible ways of estimation. Table 4 reports the result: Column (a) by the demand and supply functions; Column (b) by the supply function and the loan rate adjustment equation; and Column (c) by the demand function and the loan rate adjustment equation. It must be noted that these estimations are executed under the same sample division obtained from the estimation result of Table 1 or Column (a) of Table 3. In other words, the iterative estimation process for the consistent sample division was not individually sought.

Theoretically, any of the three sets of two equations will give consistent parameter estimators with the NL3LSQ method. Table 4 indicates that the results are in fact more or less the same in three columns; moreover, they are also in conformity with those of Tables 1 and 2. A closer examination, however, reveals that there yet are subtle differences in the estimates of parameters occurring from different combinations of equations. The selection of combination thus generates a margin of arbitrariness in the interpretation of the result. It is in order to avoid such arbitrariness that our main analysis in this paper has been developed with the simultaneous use of the three equations (25) to (27).

Table 4 Estimation Results with Two Equations

		(a)	(b)	(c)
Demand Function	β_0	.011 (1.37)	.032 (.73)	−.015 (.63)
	β_1	.068 (3.59)	−.123 (1.97)	.065 (.92)
	β_2	.958 (99.3)	1.008 (26.9)	.952 (24.7)
Supply Function	γ_0	.030 (3.17)	−.035 (1.45)	.098 (2.54)
	γ_1	.993 (245)	.977 (149)	1.023 (69.2)
	γ_2	−.006 (1.27)	.008 (.65)	−.022 (2.02)
Loan Rate Adjustment Equation	θ_1	.102 (1.42)	−.080 (1.03)	.098 (2.71)
	θ_2	.338 (5.01)	.489 (4.95)	.297 (7.17)
Policy Rate Equation	a	4.210 (5.83)	4.037 (7.66)	2.780 (5.15)
	b	.586 (5.52)	.542 (7.91)	.793 (8.77)
SER	Demand Function	.015	—	.066
	Supply Function	.025	.044	—
	Loan Rate Adjustment Equation	—	.089	.088

- (a) is demand and supply functions; (b) is supply function and loan rate adjustment equation; (c) is demand function and loan rate adjustment equation.
- Sample period: 1963 III - 1982 IV. Sample division is based on Column (a) of Table 3.
- Figures in parenthesis are t-statistics. Figures in bottom rows are SERs of estimation equations.

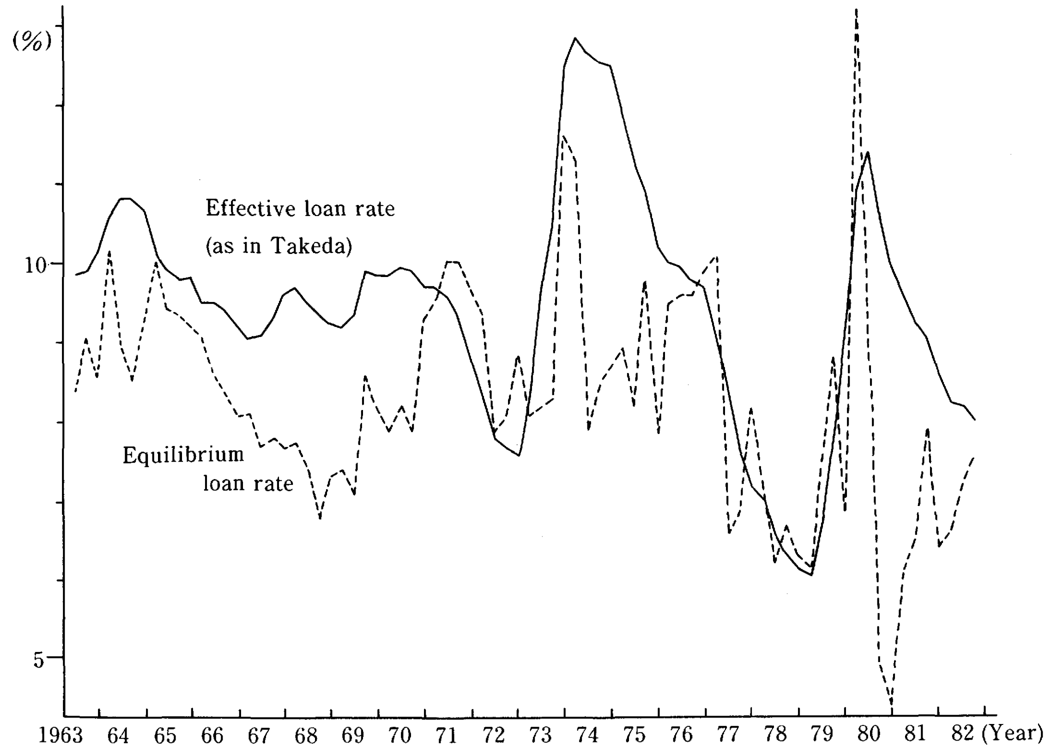
2. Case of the Effective Loan Rate

Our empirical analysis so far has taken it for granted that the loan rate adjustment equation (3) applies to the face rate. However, at the same time, we have relied on the possibility that an appropriate loan rate in the demand and supply functions is the effective rate as one of reasons to justify estimations with three equations. Extending this line of thought, it is often argued that every feature of the loan market should be discussed in terms of the effective loan rate. In particular, there is a long-standing view that the bank loan market is in equilibrium under the effective rate though it may not be the case under the face rate. Komiya (1964) is an old example; and one of the more recent empirical studies which support this view is Ito – Ueda (1982).

Our empirical examination by replacing the face loan rate by the effective loan rate in the entire system of Equations (25) to (27), however, fails to detect any notable differences in the overall implication.[26] Namely, the bank loan market is still best characterized by the "policy rate hypothesis" even with the effective loan rate.

Figure 4 plots the equilibrium loan rate computed from the estimation result of Table 1 and the effective loan rate. It is clear that these two interest rate show different fluctuation patterns. Of particular interest is that, while the effective loan rate was consistently higher than the equilibrium rate until around 1970, the rela-

Figure 4 Effective Loan Rate and Equilibrium Loan Rate
(1963 III - 1982 IV)

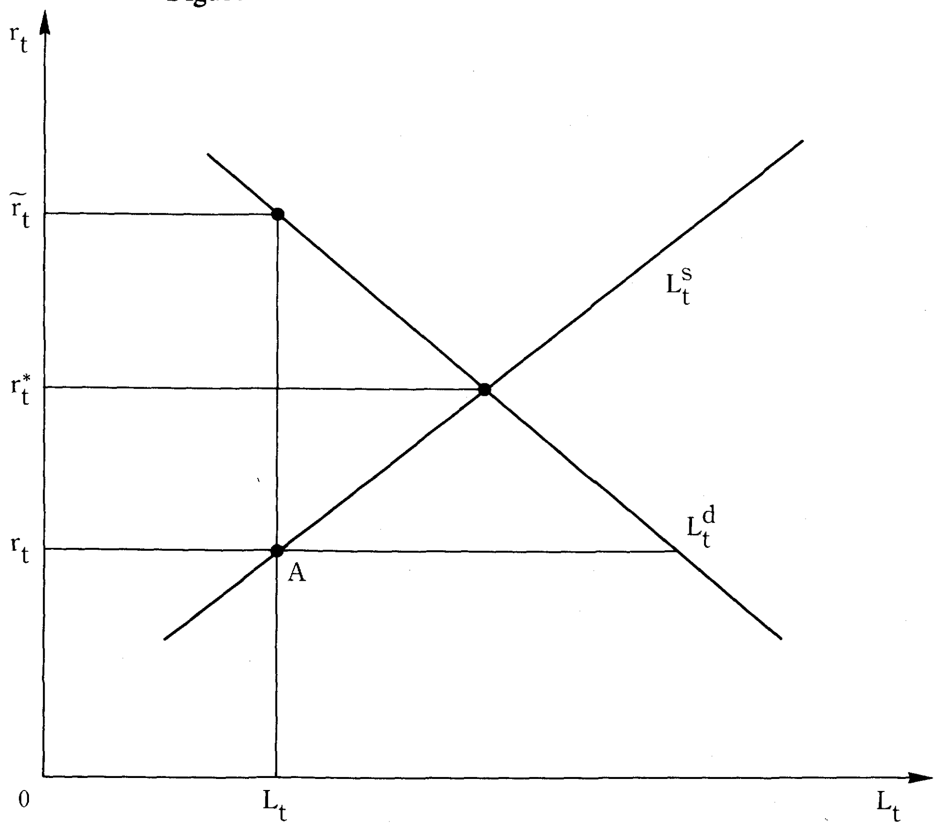


26. The data on the effective loan rate are those reported in Takeda (1985). We are thankful to Mr. Takeda for kindly providing us with his data. The estimation result is not reported. However, it is noted that the estimation with the effective loan rate is generally less satisfactory than the one with the face loan rate in that the sample division needs much more iterations for convergence and that some parameter estimates show theoretically wrong signs.

tionship seems to have been reversed thereafter. Moreover, the two interest rates nearly coincide and show a parallel movement in the period from 1971 to 1973 and in the late 1970s.[27] Needless to say, what we can infer from the observation of these time series data depends largely on the reliability of the estimated data themselves.

Nonetheless, because the relationship between the two interest rates in the 1960s is all but symbolic, let us consider whether it can be successfully explained by theory. Our estimation result indicates that the persistent excess demand was the characteristic of this period and the market realization is positioned at point A of Figure 5 for the face loan rate r_t. But for the amount of loans corresponding to point A the demand side is prepared to pay up to the interest rate level of $\tilde{r}_t$. Therefore, if banks choose to implement monopolistic pricing, the effective loan rate will rise to

Figure 5 Determination of Effective Loan Rate



27. It is interesting to see in Figure 4 that the equilibrium and effective loan rates are nearly identical in the early 1970s, that is, during the period of "excess liquidity." Earlier we classified this period as one of excess demand, in contrast to the more conventional view. The observation here suggests that the loan market was more or less equilibrated with the effective loan rate.

the level $\tilde{r}_t$, which evidently surpasses the equilibrium rate r_t^*. This is no more than a hypothesis on the determination of the effective rate. However, it at least suggests that the effective loan rate need not be lower than the equilibrium rate even during the excess demand period.

3. Average Contracted Loan Rate and Newly Contracted Loan Rate

As pointed out earlier, our selection of the data for empirical analyses are the average contracted loan rate for r_t and the loans outstanding for L_t. The latter is obviously a stock measure and the former also involves in certain rigidity because it is the average interest rate weighted by the shares of current and past contracted loans. These choices of the data are no doubt responsible, at least partially, for the delayed adjustment of the market loan rate to the policy loan rate, or for the acceptance of a weaker version of the "policy rate hypothesis" of H'_3 rather than the stronger one H_3.

Our data selection tacitly assumes that the entire stock could be instantly re-adjusted (at least ex ante) if any chage in the market loan rate occurs as would be the case where the flexible loan rate applies to all the past contracted loans as well. Needless to say, however, the bank loan market of Japan does not function in this way; and instead past contracted loan rates generally continue to apply to the outstanding balances. If the outstanding loans are subject to the past fixed loan rates, adjustments in the loan market are possible only within the confine of newly contracted loans (or flows) where the new loan rate is applicable. When these adjustments are attempted to be captured by the movement of the average contracted loan rate, we can naturally expect delayed responses of the market loan rate.

In an effort to overcome such a potential misguidance of the average contracted loan rate, a number of studies have attempted to reexamine the loan market relying on the newly contracted loan rate and thereby on flow adjustments (for example, Tsutsui (1982b), Shimizu (1984, 1985), The Sumitomo Trust Bank Company Limited (1985), and Kinoshita (1985)). Because no published data are available on the newly contracted loan rate, however, these studies have to estimate at first the time series data on the newly contracted loan rate; and different figures are reported depending on the different approaches taken. As for the study on the disequilibrium analysis of the flow loan market, Tsutsui (1982b) and Shimizu (1985) compare their studies with the past literature which utilized the average contracted loan rate.

Although the two studies follow a similar analytical approach, their conclusions are in clear contrast. On one hand, Tsutsui (1982b) arrives at the observation that the newly contracted loan rate fails to clear the market for new loans, thus supporting the disequilibrium (partial adjustment) hypothesis. Shimizu (1985), on the other hand reestimates the models of Iwata – Hamada (1980), Furukawa (1979), and Kamae

(1980) and concludes that these models now support the equilibrium market hypothesis rather than the disequilibrium one. We are unable to participate directly in this dispute as we did not conduct any empirical analysis with the newly contracted loan rate. Nonetheless, the following simple arithmetic holds the conjecture that our "policy rate hypothesis" will be more clearly underscored by the analysis of the market for new loans.

According to Shimizu (1985), the outstanding balances of all bank loans as of September 1984 are roughly divided into two broad categories: a little less than 60 percent of short-term loans of maturity less than 1 year and a little more than 40 percent of long-term loans of an average 6 to 7 years. Then an extreme simplification yields the average contracted loan period of 3 years with 1/12 of the total loans being remaned in each quarter.[28] Therefore, provided that the policy loan rate as directly reflected in the newly contracted loan rate, a one percentage point rise in the policy loan rate will result, *ceteris paribus,* in a rise of .08 percentage point in the average contracted loan rate. This figure may be smaller than expected.

Nonetheless, there are reasons to suspect that this figure is considerably underestimated and a more detailed examination would increase the figure to the level as high as .32 percentage point which equals the estimate θ_2 of Table 1. The factors which contribute to raising the figure include: nonuniform distribution of the actual loan contracts with a relatively high concentration of shorter-term loans of less than 3 months; existence of intermediate conversions and renewals as well as the partial application of the flexible loan rate to the outstanding loans; and decreasing trend in the share of short-term loans whereby during our sample period short-term loans accounted for more than 70 percent of total outstanding loans (see Table 2–1 of the Bank of Japan (1986)).

If the new figure is in fact raised considerably, it will indicate that our earlier Equation (39) derived for the average contracted loan rate is not inconsistent with the view that the loan market undergoes flow adjustments through the newly contracted loan rate. In other words, the implication of our empirical analysis remains unaltered and reinterpreting the estimated results with the aid of the above simple arithmetic will only further support the "policy rate hypothesis," moving from a potentially less pronounced H'_3 to the stronger H_3. Namely, the newly contracted loan rate continues to depend on the policy loan rate and the involved adjustment lags reduce significantly.

28. Assuming that the average maturity of short-term loans less than 1 year to be 6 months and that of long-term loans 6.5 years, the overall average contracted loan period is calculated to be $0.5\times0.6+6.5\times0.4=2.9$ years.

4. Structural Changes

In empirical researches which open over considerable time periods, the possibility of structural changes must always be borne in mind. Japan's bank loan market has shown different features over time: high economic growth era of the 1960s; period of drastic macroeconomic changes of the 1970s; and the period of financial liberalization and internationalization of the 1980s. Takenaka (1983) and The Sumitomo Trust Bank Company Limited (1985), relying on the traditional disequilibrium analysis (that is, setting $\theta_2=0$ in the loan adjustment equation (3)), have obtained that the estimated value of θ_1 shows a gradual upward trend whenever more recent data are included, concluding that the loan market has been moving toward a direction of supporting the "equilibrium market hypothesis" of H_1 over the "partial adjustment hypothesis" of H_2. Therefore, we should also review the possibility of structural changes of our model.

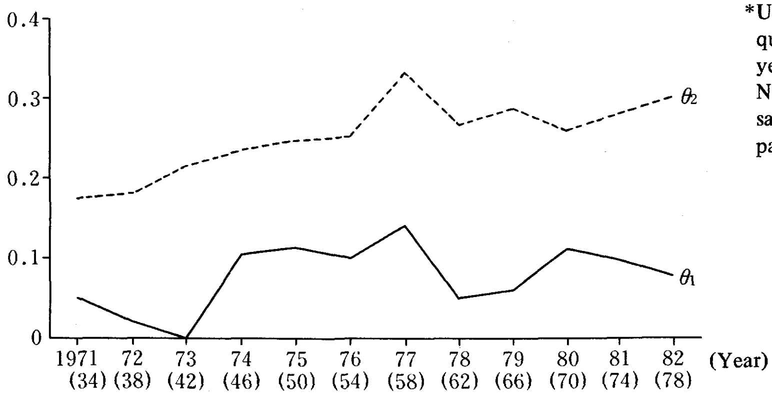
We thus ran regressions for different sample periods. Because our main concern is to test the three hypotheses on the structure of the bank loan market, we focused our examination on the possible changes in the estimates of θ_1 and θ_2 of the loan adjustment equation (3). Figure 6 summarizes the result. In this figure, the estimates are plotted for three different ways of changing sample periods. Panel (a) fixes the beginning at 1963III and updates the terminating period by every 4 quarters from 1971IV to 1982IV; panel (b) instead fixes the ending period at 1982IV and alters the beginning period by every 4 quarters from 1964I to 1975I; and panel (c) fixes the total sample period to 40 quarters and shifts the sample periods year by year from 1964I-1973IV to 1973I-1982IV. In all of these sample periods, the same sample division between the excess demand and excess supply periods is used. This is the sample division derived from the estimation result of Table 1 or Column (a) of Table 3.

From Figure 6 we observe that, while θ_2 almost monotonously increases as more recent data are included (panels (a) and (c)), no notable trend is seen for θ_1 and it almost consistently takes the value of around .1. According to panel (b), θ_2 remains almost constant even if sample periods are altered as long as the recent data are included. This stable value equals about 1/3 which in turn is equal to the estimate of Table 1. These results are more or less in disarray with the initial common sense anticipation. This is because they indicate that the "policy rate hypothesis" is more appropriate in recent time than, for example, in the 1960s and, even though based on different assumptions, the implication is entirely opposite to that of Takenaka (1983) and The Sumitomo Trust Bank Company Limited (1985).

Then, how could the above be explained? In trying to answer this, it is necessary to identify the "policy loan rate" which has so far been left open.

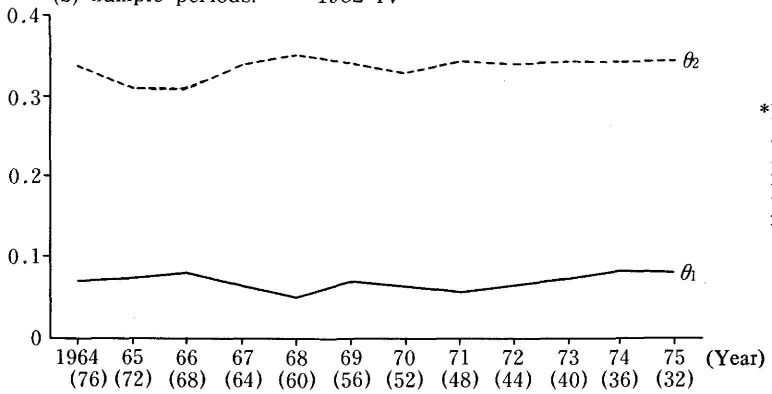
Figure 6 Patterns of the Structural Changes

(a) Sample periods: 1963 III-



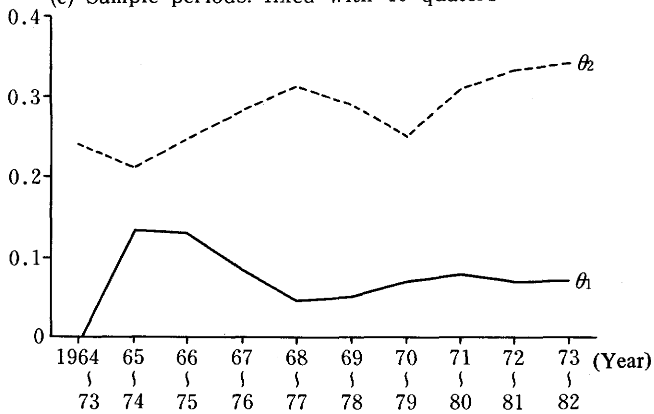
*Up to the fourth quarter of each year.
Number of samples in parenthesis.

(b) Sample periods: -1982 IV



*From the first quarter of each year.
Number of samples in parenthesis.

(c) Sample periods: fixed with 40 quaters



*Beginning period is the first quarter and the ending period is the fourth quarter of each year.

5. On "Policy Loan Rate"

The major conclusion of this paper has been that the "policy rate hypothesis" is most prominent in the bank loan market of Japan. However, we have given no consideration on the characteristics of the policy loan rate itself. The "policy loan rate" in the present framework is completely linked to the official discount rate and is, for that matter, determined by the monetary authority. But how this becomes a guideline for the market loan rate through what kinds of mechanism has been left open. It may be possible on a theoretical level to state that the market loan rate is directly regulated by the Bank of Japan as a part of the whole menu of broader "window guidance," but this of course is not realistic.

The most plausible policy loan rate in the bank loan market we can immediately think of is the prime rate. The prime rate, in reality, consists of two interest rates: the short-term prime rate applicable to short-term loan of less than one year and the long-term prime rate applicable to the longer-term loans. Both prime rates set the minimum level of loan rates and can be classified as those of the institutionally regulated interest rates in Japan. The short-term prime rate is almost completely linked to the official discount rate and thereby is very close to the policy loan rate of our image. In contrast, the long-term prime rate is linked to the yield of the interest-bearing bank debentures of the long-term credit banks and is not necessarily linked directly to the official discount rate.[29]

Taking the above observation into account, we conducted a simple regression analysis so as to obtain the specific relationships between the estimated policy loan rate and the short-term and long-term prime rates. The estimations are by ordinary least squares and the result for the short-term prime rate P_t^s, is given by

$$\bar{r}_t = \underset{(40.9)}{2.834} + \underset{(69.2)}{.741} P_t^s, \quad R^2 = .989, \tag{40}$$

and the result for the long-term prime rate P_t^l, by

$$\bar{r}_t = \underset{(5.35)}{-4.268} + \underset{(14.8)}{1.385} P_t^l, \quad R^2 = .802, \tag{41}$$

where in parentheses are t-statistics. The sample period is from 1969I to 1982IV in which the prime rate system was established and for which the entire data were available.

As for the result for the short-term prime rate, it is not at all surprising that its coefficient estimate .74 is exactly equal to the coefficient estimate b in Equation (6)

29. For more details on the prime rate system, see an introductory book to the Japanese financial institutions published by the Bank of Japan (1986).

of Table 1 because p_t^s is determined by adding a fixed premium to the official discount rate. Rather, it may at first be questioned why the coefficient of determination (R^2) of Equation (49) does not equal unity. However, this is because the added fixed premium was altered several times over the sample period rather than literally maintained constant.[30] Next, by looking at the result for the long-term prime rate, we indeed ascertain a relatively less pronounced relationship between the two interest rates as indicated by R^2.

From Equations (40) and (41), the fluctuation of our policy loan rate is generally narrower than that of the short-term prime rate (.74 fold) but wider than that of long-term prime rate (1.39 fold). Now, once the constant terms are substituted out from the two equations, we have

$$\bar{r}_t = .445P_t^s + .553P_t^l, \tag{42}$$

which indicates that the policy loan rate is expressed almost as a weighted average of both the short-term and long-term prime rates. These weights, however, do not match the historical shares of short-term and long-term loans, so that Equation (42) appears to be obtained just by chance. Nonetheless, it sufficiently suggests a close relationship between the policy loan rate and some average of the short-term and long-term prime rates.

However, we must be cautious in asserting from the above observatioin alone that our policy loan rate reflects the role of the prime rate. This is because a problem remains whether the pattern of structural changes analyzed earlier can be consistently explained. Moreover, there is a more fundamental question whether the prime rate can be genuinely controlled by the monetary authority.

In examining the first problem, a true analysis needs detailed discussions including the one from the historical perspective. But we shall attempt to explain here by focusing on only one aspect. In doing so, note to begin with that the prime rate regulates the minimum loan rate and the interest rates applied to individual loans by banks differ one from another depending on the credibility of borrower or the history of the good-customer relationships. In short, the prime rate is not applied to all loans. During Japan's high economic growth era, borrowers to whom the prime rate was applied were limited to a handful of best performing companies. However, as the Japanese economy entered the low growth era after the macroeconomic turbulent period of the 1970s, corporate reliance on bank loans gradually declined and, as its

30. The estimated equations (6) and (40) imply that the average premium over our entire sample period is .23 percentage point.

result, the portion of loans to which the prime rate is applied has increased steadily.[31] It is clear, then, that this evidence can successfully explain the trend rise of the estimate θ_2 in the loan rate adjustment equation (3) as more recent samples are included. That the period of 1980s is classified as excess supply in Table 3 also lends support to the above view.

With this interpretation, however, the second problem inevitably comes in. The recent financial deregulation and internationalization has activated the arbitrage between the loan market and the open markets (that is, short-term money markets and long-term bond market) through the increased awareness of the better portfolio management. This trend has greatly raised the link between the market loan rate and the open market free interest rates. As such is the case, rather than simply witnessing the trend rise in the applicability of the prime rate, the time has come when the effectiveness of the prime rate system itself is questioned. This is more prominently seen in the long-term prime rate which is slid to the yield of interest-bearing bank debentures of the long-term credit banks. However, in view of the expectations theory of the term structure of interest rates, it will not take long before the similar limitation shows up with the short-term prime rate.

If the prime rate ceases to function as the policy loan rate (or if the prime rate system itself is abolished as is sometimes discussed lately), and when there is arbitration between the market loan rate and free interest rates of open markets, how should the loan rate adjustment equation (3) be interpreted? Would the "policy rate hypothesis" lose its significance at once? Since no one can deny a possibility of such situation to be actually verified in case new data are added in the future, we shall make some comments on this point.

Once the policy loan rate shows a close relationship with the open market free interest rates, the policy rate hypothesis becomes least indiscernible on its surface from what may be called the "intermarket arbitration hypothesis." In this case, if we retain the linear relationship between the policy loan rate and the official discount rate as in Equation (6), the oficial discount rate no longer remains an exogenous policy variable and instead adjusts endogenously reflecting the market conditions. In such a world, however, it is also true that the authority need not confine itself to the loan market in exerting impact on the market loan rate. For example, it becomes possible for open market operations to have indirect impacts on the market loan rate. Policy interventions in the call and bills discount markets could also exert similar effects. Therefore, even in this case the "policy loan rate" hypothesis per se could remain valid in a different form. However, it is not easy to actually verify this. The

31. According to Bank of Japan (1986), while only around 30 to 40 per cent of short-term loans enjoyed the contract with the short-term prime rate during the easy monetary policy period of the latter half of 1970s, that figure rose to 70 per cent during the easy monetary policy period of the first half of 1980s.

partial disequilibrium analysis of the loan market like the present one is clearly insufficient; instead we must work with the framework where multiple market disequilibria are simultaneously taken into account.

Another interpretation may be to suspect that the policy loan rate in fact is equal to the equilibrium rate, $\bar{r}_r = r_t^*$. (The official discount rate is again endogenously adjusted.) In this case, "policy rate hypothesis" will not be identified from the "partial adjustment hypothesis" of H_2 and these two are tested against the alternative of the "equilibrium market hypothesis." The possibility that the policy loan rate identically equals the equilibrium rate has not been entirely excluded in the empirical analyses of this paper. This is because our basic model is not equipped with any null hypothesis which can formally detect it. All we could do has been to make an impressional judgement by observing the movements of these two interest rates plotted in Figure 3 — and our judgement was in the negative. In order to formally deal with this problem, we have to introduce a new adjustment equation of the policy loan rate.

For instance, let us introduce the following policy rate adjustment equation

$$\bar{r}_t = \bar{r}_{t-1} + \theta_3(r_t^* - \bar{r}_{t-1}), \quad 0 \leqq \theta_3 \leqq 1. \tag{43}$$

Then, the condition $\bar{r}_t = r_t^*$ is equivalent to the null hypothesis $\theta_3 = 1$ in the modified loan rate adjustment equation

$$r_t = (1 - \theta_1 - \theta_2) r_{t-1} + (\theta_1 + \theta_2\theta_3) r_t^* + \theta_2(1 - \theta_3)\bar{r}_{t-1} + \varepsilon_t, \tag{44}$$

which is obtained by substituting (43) into (3). This null hypothesis in principle is independent of the three null hypotheses on the structure of the loan market (of course, however, if $\theta_3 = 1$ is true, the partial adjustment hypothesis and the policy rate hypothesis cannot be distinguished). The next task, although left to the future research, then is to test the combined joint hypotheses.

VI. Concluding Remarks

In this paper, under the perspective that the postwar bank loan market of Japan is fundamentally a disequilibrium one, we tried to extend the traditional researches in this field by clarifying the market structure and by conducting empirical analyses with a new technique of disequilibrium econometrics. Our main conclusion is that the loan market is neither in Walrasian equilibrium nor is it the delayed dynamic adjustment process toward the market equilibrium. Rather, the disequilibrium is attributed to the policy regulated loan rate which is not necessarily set at the equilibrium level. Concerning what kind of mechanism actually rules to effect policy measures, no definite conclusion can be derived from our theoretical framework. However, in interpreting the result of our empirical analyses, it is suggested that the prime rate system plays a crucial role in effecting our "policy rate hypothesis." The policy loan rate, which is originally our theoretical product, is in fact closely related to both short-term and long-term prime rates.

As stated at the outset of this paper, our fundamental position was (A) or to focus on the structure of the bank loan market as whole and we took minimum account of the background microeconomic foundations which the (B) position stresses. But since we obtained an evidence that the loan market is in fact in Walrasian disequilibrium, further development of researches from the (B) position can be expected. Such researches will help further clarify the microeconomic story behind our "policy rate hypothesis."

In arriving at the above conclusion, we attempted to make as careful and detailed analyses as possible from both theoretical and empirical viewpoints. Nonetheless, our study might yet contain several shortcomings and cannot be considered as perfect. How and to what extent the remaining issues might affect our main conclusion must be kept in mind as reservations. Note also that our conclusion is obtained from an empirical analysis of the loan market until the early 1980s, implying that it does not necessarily apply to the present time or in the future. As we pointed out occasionally in this paper, the recent tide of rapid financial liberalization and internationalization is exerting large impacts on the bank loan market. Thus, there is a danger of falling into a pitfall if we adhere too much to past explanations.

Appendix I Nonsingularity of the Variance-Covariance Matrix

In this appendix, we shall demonstrate that the contemporaneous variance-covariance matrix of the three disturbances (28), (34), and (35) is nonsingular. Let Σ_t denote this matrix. Noting that Σ_t is evidently a symmetric matrix, we obtain

$$\Sigma_t = E\left[\begin{pmatrix}\xi_t^r \\ \xi_t^d \\ \xi_t^s\end{pmatrix}(\xi_t^r,\ \xi_t^d,\ \xi_t^s)\right] \tag{A-1}$$

$$= \begin{bmatrix} \phi^2(\sigma_v^2+\sigma_u^2)+\sigma_\varepsilon^2, & *, & *, \\ -\phi\,\sigma_u^2-\frac{1}{\phi}\nabla^d\sigma_\varepsilon^2, & \sigma_u^2+\frac{1}{\phi^2}\nabla^d\sigma_\varepsilon^2+\nabla^d\sigma_\eta^2, & *, \\ \phi\,\sigma_v^2+\frac{1}{\phi}\nabla^s\sigma_\varepsilon^2, & 0, & \sigma_v^2+\frac{1}{\phi^2}\nabla^2\sigma_\varepsilon^2+\nabla^s\sigma_\eta^2, \end{bmatrix},$$

where

$$\phi = \frac{\theta_1}{\beta_0-\gamma_0}, \tag{A-2}$$

and σ_x^2 represents the variance of a disturbance x_t. Let $\nabla^d\sigma_\varepsilon^2$ (or $\nabla^s\sigma_\varepsilon^2$) be equal to 0 (or σ_ε^2) in the excess supply period and σ_ε^2 (or 0) in the excess demand period, implying that we always have $\nabla^d\sigma_\varepsilon^2\nabla^s\sigma_\varepsilon^2=0$. Variables $\nabla^d\sigma_\eta^2$ and $\nabla^s\sigma_\eta^2$ are defined in a similar way so that $\nabla^d\sigma_\eta^2\nabla^s\sigma_\eta^2=0$.

After routine calculations, the determinant of matrix Σ_t is given by

$$|\Sigma_t| = (\nabla^d\sigma_\eta^2+\nabla^s\sigma_\eta^2)\left(\phi\,\sigma_u^2+\frac{1}{\phi}\nabla^d\sigma_\varepsilon^2\right)\left(\phi\sigma_v^2+\frac{1}{\phi}\nabla^s\sigma_\varepsilon^2\right), \tag{A-3}$$

so that it reduces in the excess supply period ($r_t \geqq r_t^*$) to

$$|\Sigma_t| = \sigma_\eta^2\sigma_u^2(\phi^2\sigma_v^2+\sigma_\varepsilon^2), \tag{A-4}$$

and in the excess demand period ($r_t<r_t^*$) to

$$|\Sigma_t| = \sigma_\eta^2\sigma_v^2(\phi^2\sigma_u^2+\sigma_\varepsilon^2), \tag{A-5}$$

Both (A-4) and (A-5) do not vanish, thus proving the expected result.

Next, the case of the three disturbances (28), (36), and (37) is briefly outlined. The proof follows exactly the same steps as the above. The variance-covariance matrix in this case is given by replacing the right bottom (2 × 2) elements of matrix (A-1) by

$$\begin{bmatrix} \sigma_u^2+\frac{1}{\phi^2}\nabla^d\sigma_\varepsilon^2+\beta_0^2\sigma_\xi^2, & *, \\ \beta_0\gamma_0\sigma_\xi^2, & \sigma_v^2+\frac{1}{\phi^2}\nabla^s\sigma_\varepsilon^2+\gamma_0^2\sigma_\xi^2, \end{bmatrix}, \tag{A-6}$$

Then, we obtain the determinant of the new matrix as

$$|\Sigma_t| = (\beta_0-\gamma_0)^2\sigma_\xi^2\left(\phi\sigma_u^2+\frac{1}{\phi}\nabla^d\sigma_\varepsilon^2\right)\left(\phi\sigma_v^2+\frac{1}{\phi}\nabla^s\sigma_\varepsilon^2\right), \tag{A-7}$$

which clearly does not vanish, either.

Meanwhile, Equations (A-3) and (A-7) indicate that the existence of the disturbances η_t and ζ_t are crucial. Without them, the contemporaneous variance-covariance matrix is seen to become singular.

Appendix II Estimation Procedure and Convergence

As pointed out in Section IV, our estimation goes through double iterative processes. For nonlinear constraints among parameters of the structural equations system, we employ the iterative NL3LSQ or nonlinear three stage least squares method. And for the consistency of the sample division, we regard it as converged when it resulted in the same sample division thrice consecutively because we replaced the initial conditions for each run of the NL3LSQ once in every two iterations. The very first division of samples and the initial values for the first NL3LSQ were based on the results of the standard two stage least squares (2LSQ) estimation which neglects all the coefficient constraints.[32] As for the subsequent NL3LSQ estimations, the parameter estimates of the immediately or two-runs preceding estimation were used as new initial conditions.

Table A-1 is an example of the actual convergence pattern of the sample division. This example, which was followed in obtaining the estimation result of Table 1, is shown here in order to have a sense of the required number of iterations until the convergence is achieved. According to Table A-1, the sample divisions from sixth to eighth runs of the NL3LSQ are exactly identical, indicating that the convergence is attained at the eighth iteration. (In Table A-1 two iterations are gathered in one column so as to make it sure that the initial conditions are altered once every two runs.) The numbers of required iterations in other estimations were comparable; in some cases, convergences were achieved even after five iterations.

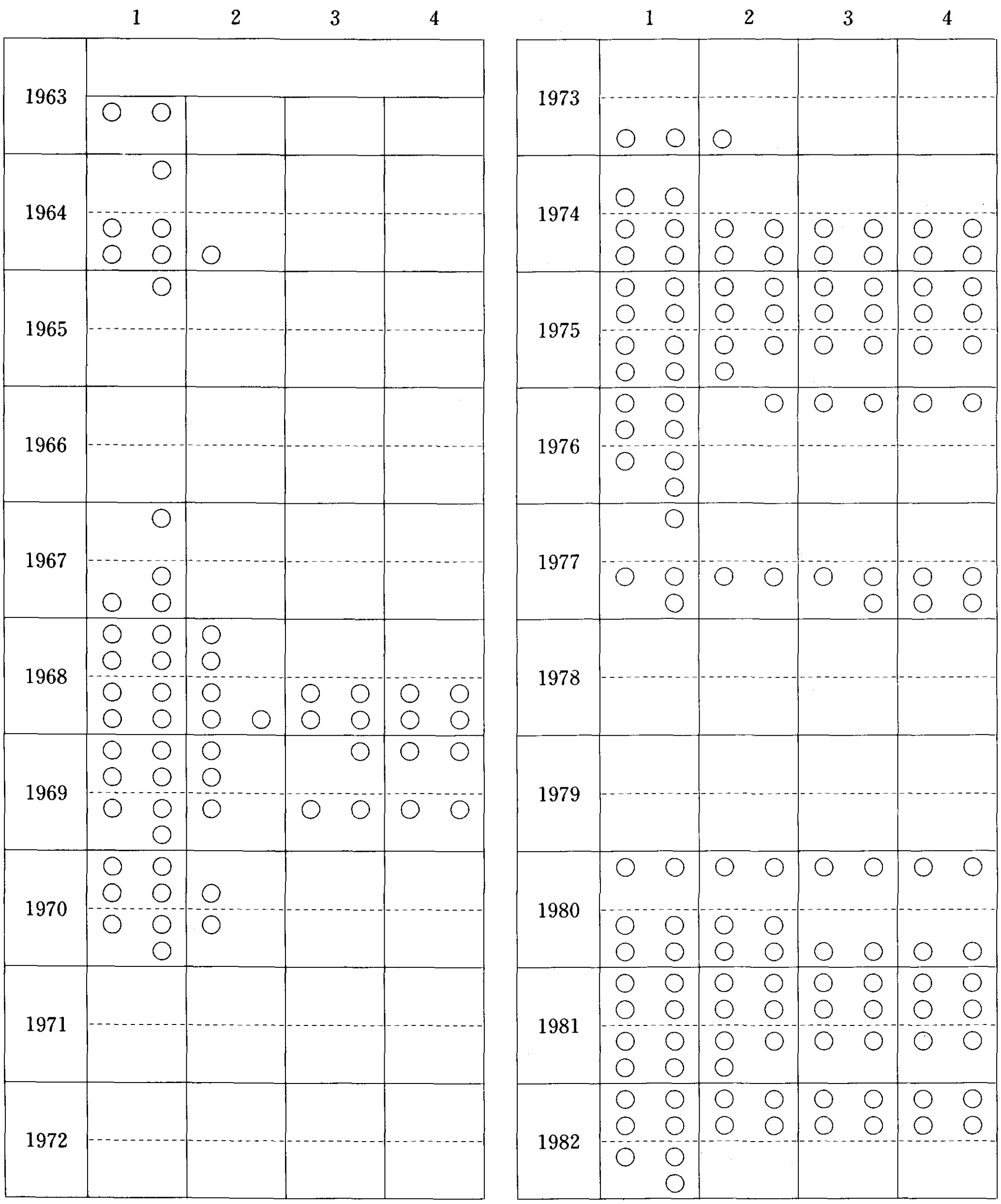
Another feature to be observed from Table A-1 is that the sample division converges almost monotonously, that is, without causing notable reversals or exhibiting whatever irregularities, implying that the convergence was not attained just by chance. This feature was almost similarly observed in other cases as well.

32. To be more specific, the initial sample division and the initial parameter estimates of the first run of the NL3LSQ were obtained by the following procedure. First, the converted loan adjustment equation (25) was estimated by the 2LSQ without any coefficient constraints to obtain the temporary estimates $\hat{\theta}_1$ and $\hat{\theta}_2$. Second, on the basis of these estimates, the initial sample division was determined by relying on the computed equilibrium loan rate which is given by

$$\hat{r}_t^* = \frac{1}{\hat{\theta}_1}[r_t - (1-\hat{\theta}_1-\hat{\theta}_2)r_{t-1} - \hat{\theta}_2\hat{\bar{r}}_t]$$

where $\hat{\bar{r}}_t$ was calculated at first by setting $\hat{a}=E(r_t)-E(\delta_t)$ and $\hat{b}=1$ in Equation (6) and $\hat{\varepsilon}_t=0$ was assumed as well. Third, based on this sample division, the results of the 2LSQ estimation of Equations (26) and (27) without any coefficient constraints yield the initial parameter values of demand and supply functions.

Table A-1 Convergence of Sample Division



- Convergence pattern of sample division until estimation results of Table 1 are attained.
- ○ = excess supply periods (1963 III - 1982 IV)

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