TESTS OF THE EQUILIBRIUM HYPOTHESIS
IN DISEQUILIBRIUM ECONOMETRICS:
AN INTERNATIONAL COMPARISON OF CREDIT RATIONING

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ABSTRACT

The purpose of this paper is threefold: (i) to develop various tests of the equilibrium hypothesis using a partial price adjustment scheme in disequilibrium, (ii) to estimate disequilibrium models of the business loan markets in the United States and in Japan by the method proposed and (iii) to compare the adjustment speeds of the prime rate and to test the equilibrium hypothesis in each country. In the United States, the loan market may be considered to be in equilibrium with the real interest rate adjusting to market pressures. In Japan, the nominal rather than the real interest rate is believed to adjust to the market pressure of disequilibrium and the equilibrium hypothesis is rejected. Moreover, it is clear that the prime rate adjusts more slowly in Japan than in the United States. Our results support the popular view that the United States financial markets are closer to equilibrium than their Japanese counterparts. However, there is no evidence of different upward and downward adjustment speeds for either country.

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1. INTRODUCTION

Following the pioneering work by Fair and Jaffee [1972], many authors have developed elaborate methods of estimation for markets in disequilibrium.^{2/} However, tests of the equilibrium versus disequilibrium hypothesis have not been well developed. A notable exception is Quandt [1978] who proposes several ways of testing the equilibrium hypothesis. Relatively simple tests are based on the usual price adjustment mechanism generated by the law of supply and demand; that is, price changes are proportional to excess demand. In contrast, Bowden [1978a] [1978b] develops a test of the equilibrium hypothesis by rewriting the usual price adjustment equation. According to Bowden's price adjustment scheme, the current price level is a weighted average of last period's price level and the current equilibrium price level where the weight is to be estimated. Bowden's specification

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^{2/} Methods of estimation for a market in disequilibrium have been developed by Fair and Jaffee [1972], Fair and Kelejian [1974], Amemiya [1974], Maddala and Nelson [1974], Goldfeld and Quandt [1975], Laffont and Monfort [1977]. Multimarket models with disequilibrium have been proposed by Ito [1980], and Gourieroux, Laffont and Monfort [1980].

has several advantages over previous specifications. First, the estimated weight of partial adjustment is comparable across markets since it is free from units of measurement. Moreover, this weight can be interpreted as a measure of the extent to which the market is away from equilibrium. Therefore, by estimating different markets using Bowden's specification, we can compare the degree of disequilibrium across markets. Secondly, a test of the equilibrium hypothesis can be easily carried out under Bowden's specification.

It is of great interest to develop several methods of tests considering these advantages of Bowden's specification. It is also natural to apply the tests developed to an analysis of specific markets. Especially, considering the first advantage of Bowden's specification, an international comparison of the adjustment speeds of prices in the same market is a new interesting question we are able to analyze by our methods of estimation and tests.

Empirical research of disequilibrium analysis has been focused on selected markets which are usually suspected of being in disequilibrium. Fair and Jaffee [1972] estimated demand and supply of housing starts as an example of disequilibrium. Rosen and Quandt [1979] estimated the United States labor market using a disequilibrium econometric method. In addition to those markets, credit rationing in the loan market has been regarded as a representative example of disequilibrium phenomena in an economy. Laffont and Garcia [1977] and Sealey [1979] have estimated demand and supply functions of commercial bank loans. We will extend their line of research with a special emphasis on constructing new tests of the equilibrium hypothesis.

According to Jaffee's [1971] classification, our approach is regarded as an investigation of "dynamic credit rationing" by a time series analysis.

This is distinguished from an effort to explain credit rationing as an equilibrium phenomenon, or a test of credit rationing using proxy measures. Accepting the equilibrium hypothesis in our framework does not exclude the possibility of the "equilibrium credit rationing" based on asymmetric information in the market. For other types of tests for credit rationing, especially using proxy measures, Jaffee [1971] should be consulted.

It is of great interest to compare markets for the same commodity under different institutional environments. It is well summarized in Wallich and Wallich [1976] that the Japanese financial markets are regulated in many ways. Therefore a quantitative comparison of the Japanese financial market with the United States market is highly interesting. We take the adjustment speed of the prime lending rate as a common measure amenable to comparison across countries and test the equilibrium hypothesis for each country.

The purpose of this paper is threefold: (i) to develop various tests of the equilibrium hypothesis by extending Bowden's result in allowing for possible differences in upward and downward adjustment speeds; (ii) to estimate disequilibrium models of the business loan markets of Japan and of the United States; and (iii) to compare the adjustment speeds of the prime rate and to test the equilibrium hypothesis in each country. This paper, to our best knowledge, is the first attempt to use the Bowden price adjustment equation in estimating disequilibrium markets and to carry out an international comparison of markets which are suspected to be in disequilibrium.

The following empirical results are obtained. In the United States, the large estimated adjustment speed of the prime rate suggests that about 90 percent of the gap between last period's level and the current equilibrium level is adjusted within a quarter. The null hypothesis that the demand is

always equal to supply cannot be rejected. There is no significant difference between the upward and downward adjustment speeds. On the other hand, the Japanese data indicate that the prime rate adjusts very slowly with only a 10 percent adjustment of the gap between last period's level and the current equilibrium level. These findings support the popular view that the United States loan market is closer to equilibrium than its Japanese counterpart, due to tighter controls and regulations, imposed by the Japanese authorities.

In the next section, we lay out a model of a market in disequilibrium, using Bowden's price adjustment scheme with different upward and downward adjustment speeds. Section 3 is devoted to discussing several methods of testing the equilibrium hypothesis. The American and Japanese business loan markets are estimated in Sections 4 and 5, respectively; in addition, tests of the equilibrium hypothesis are carried out for each country. Comparisons of the results obtained for Japan and the United States are presented in Section 6. The last section summarizes the discussion.

2. THE MODEL

We propose the following model for a market in disequilibrium:

$$(2.1) \quad D_t = X_t' \alpha_1 + \alpha_2 p_t + u_{1t}$$

$$(2.2) \quad S_t = Z_t' \beta_1 + \beta_2 p_t + u_{2t}$$

$$(2.3) \quad Q_t = \min (D_t, S_t)$$

$$(2.4) \quad p_t = \begin{cases} \mu_1 p_{t-1} + (1 - \mu_1) p_t^*, & 0 \leq \mu_1 \leq 1 \text{ if } p_t > p_{t-1} \\ \mu_2 p_{t-1} + (1 - \mu_2) p_t^*, & 0 \leq \mu_2 \leq 1 \text{ if } p_t < p_{t-1} \end{cases}$$

where D and S are the demand for and supply of the commodity, respectively,

which are not necessarily observable; Q is the observed level of transactions; X' and Z' are vectors of predetermined variables; p and p^* are the observed and equilibrium price, respectively; the u'_t 's are i.i.d. error terms. Greek letters represent the coefficients to be estimated. Equation (2.3) implies the "short-side" rule; that is, the transaction takes place at the minimum of demand and supply when the price is not perfectly flexible within a period. The price adjusts partially toward the equilibrium level which would equate D and S from the level in the preceding period. Therefore, the current price level is a weighted average of last period's price level and the current equilibrium price, as shown in equation (2.4), where the weights are to be estimated. Finally, μ_1 and μ_2 represent the upward and downward sluggishness, respectively. It is an immediate observation that the equilibrium hypothesis, i.e., the market is always clearing, is refutable by testing the restriction $\mu_1 = \mu_2 = 0$; the hypotheses of upward (downward) price flexibility amounts to restriction $\mu_1 = 0$, ($\mu_2 = 0$, respectively).

Bowden [1978a][1978b] was the first to propose the partial adjustment equation (2.4) in the disequilibrium econometrics literature although he assumed $\mu_1 = \mu_2$. Other models are based on the price adjustment equation of the law of demand and supply:

$$(2.5) \quad \Delta p_t = \begin{cases} \lambda_1 (D_t - S_t), & \lambda_1 \geq 0 & \text{if } D_t > S_t \\ \lambda_2 (D_t - S_t), & \lambda_2 \geq 0 & \text{if } D_t < S_t \end{cases},$$

where $\Delta p_t = p_t - p_{t-1}$ or $p_{t+1} - p_t$. Bowden's formulation has two advantages over the others'. First, as Bowden noted, it is easy to test the equilibrium hypothesis, $\mu = 0$, in equation (2.4); however, a corresponding

tests using equation (2.5) runs into problems.^{3/} Secondly, the parameter μ is unit-free, lending itself to cross-market comparisons. On the other hand, λ is measured in units of the price (index) in terms of units of quantity. Thus, it is not always possible to compare estimated λ 's for different markets.

The economic importance of allowing differential upward and downward flexibilities, as in equation (2.5), has been emphasized by Laffont and Garcia [1977]. We follow their lead in this respect. Clearly Bowden's [1978a] model is a special case of our system (2.1) - (2.4) with $\mu_1 = \mu_1$.

3. TESTS OF THE EQUILIBRIUM HYPOTHESIS

3.1 Reduced Form for the Price Adjustment Equation

Bowden [1978a, equation (11)] provides a simple way to estimate the price adjustment speed for the case of equal upward and downward adjustment speeds, i.e., $\mu_1 = \mu_2$. First, solve for the p_t^* , which equates (2.1) and (2.2), in terms of exogenous variables and the error terms. Then substituting into (2.4):

$$(3.1) \quad p_t = \mu p_{t-1} + \frac{1-\mu}{\beta_2 - \alpha_2} \{X_t' \alpha_1 - Z_t' \beta_1\} + \frac{1-\mu}{\beta_2 - \alpha_2} (u_{1t} - u_{2t}) .$$

Application of OLS to (3.1) yields an unbiased estimate of μ provided that the error terms are serially uncorrelated. In the case of serially correlated error terms u_{1t} and u_{2t} with identical autocorrelation structures, we can consistently estimate μ by GLS. The equilibrium

^{3/}Quandt [1978] has pointed out that a hypothesis of $\lambda = \infty$ or $1/\lambda = 0$ is nested only in the limiting sense for the likelihood ratio test. As Laffont and Garcia [1977, p. 1197] have noted, the t-test of $1/\lambda$ is inappropriate.

hypothesis is easily tested by using the t -test for μ . If the structures of serial correlations are different, we can apply the instrumental variables method to (3.1) by using X_{t-1} and Z_{t-1} as instruments for p_{t-1} which is correlated with u_{1t} and u_{2t} . The instrumental variables (I.V.) estimation of (3.1) produces a consistent estimate of μ but fails to yield a t -test of the equilibrium hypothesis.

Note, however, that it is not always possible to recover structural parameters from the estimates of (3.1).

3.2 Structural Form by I.V.

When there are no disturbances in the price adjustment equation (2.5), Amemiya [1974] provides a simple way to estimate demand and supply functions by two-stage least squares. Charemza [1979] shows that a similar method is suitable for the partial price adjustment equation of type (2.4). To illustrate his method, (2.1) and (2.2) and solve for p_t^* to obtain

$$p_t^* = [X_t' \alpha_1 - Z_t' \beta_1 + u_{1t} - u_{2t}] / (\beta_2 - \alpha_2) .$$

Consider the case of $D_t > S_t$. Since the price is only gradually adjusted, i.e., $0 \leq \mu_1 \leq 1$, the model implies $p_{t-1} < p_t < p_t^*$. In addition, the desired supply is equal to the observed quantity, $Q_t = S_t$, and demand is equal to the sum of the observed quantity and the excess demand, $D_t = Q_t + (D_t - S_t)$. Then,

$$\begin{aligned} Q_t &= D_t - (D_t - S_t) \\ &= D_t - [X_t' \alpha_1 - Z_t' \beta_1 + u_{1t} - u_{2t}] + (\beta_2 - \beta_1) p_t \\ &= D_t + (\beta_2 - \alpha_2) (p_t - p_t^*) . \end{aligned}$$

Using the relationships, $(p_t - p_t^*) = \mu_1(p_{t-1} - p_t^*)$ and $(p_t - p_{t-1}) = (1 - \mu_1)(p_t^* - p_{t-1})$, which are obvious from equation (2.4), we can rewrite the above equation as

$$(3.2) \quad \begin{aligned} Q_t &= D_t + (\beta_2 - \alpha_2) \mu_1 (p_{t-1} - p_t^*) \\ &= D_t - \left[\mu_1 (\beta_2 - \alpha_2) / (1 - \mu_1) \right] \cdot (p_t - p_{t-1}) \end{aligned}$$

Similarly, the supply function for the case of excess supply becomes

$$(3.3) \quad Q_t = S_t + \left[\mu_2 (\beta_2 - \alpha_2) / (1 - \mu_2) \right] \cdot (p_t - p_{t-1})$$

The price change, $p_t - p_{t-1}$, appears only in either the demand function or the supply function. Let us define the following switching variables:

$$\begin{aligned} \Delta p_t^+ &= \begin{cases} p_t - p_{t-1} & , \text{ if } p_t > p_{t-1} \\ 0 & , \text{ otherwise} \end{cases} \\ \Delta p_t^- &= \begin{cases} p_t - p_{t-1} & , \text{ if } p_t < p_{t-1} \\ 0 & , \text{ otherwise.} \end{cases} \end{aligned}$$

Then the demand and supply equations to be estimated become

$$(3.4) \quad Q_t = X_t' \alpha_1 + \alpha_2 p_t + \alpha_3 \Delta p_t^+ + u_{1t}$$

$$(3.5) \quad Q_t = Z_t' \beta_1 + \beta_2 p_t + \beta_3 \Delta p_t^- + u_{2t}$$

It should be noted that the structural equations system is equivalent to the model described by (2.1) - (2.4). The price adjustment equation (2.4) is now integrated into equations (3.4) and (3.5).

In order to cope with the endogeneity of the Δp_t 's and p_t , we employ exogenous variables as instruments for Δp_t^+ , Δp_t^- and p to

find consistent estimates of the parameters.^{4/} Equations (3.4) and (3.5) are then estimated separately. Estimates of the adjustment speeds are calculated from the resulting coefficient estimates.

$$(3.6) \quad \begin{cases} \hat{\mu}_1 = -\hat{\alpha}_3/(\hat{\beta}_2 - \hat{\alpha}_2 - \hat{\alpha}_3) \\ \hat{\mu}_2 = \hat{\beta}_3/(\hat{\beta}_2 - \hat{\alpha}_2 + \hat{\beta}_3) \end{cases} .$$

Although Charemza presents the above estimation method, he does not provide a test of the equilibrium hypothesis. However, it is straightforward to estimate the asymptotic variances of $\hat{\mu}_1$ and $\hat{\mu}_2$ from the covariance matrices provided that u_1 and u_2 are contemporaneously as well as serially uncorrelated. Calculating the asymptotic variance of a fraction of estimates, e.g., Rao [1973, section 6a.2], the asymptotic variances of $\hat{\mu}_1$ and $\hat{\mu}_2$ are calculated as follows:^{5/}

$$\begin{aligned} V(\hat{\mu}_1) &= \{(\beta_2 - \alpha_2)^2 V(\hat{\alpha}_3) + (\alpha_3)^2 (V(\hat{\alpha}_2) + V(\hat{\beta}_2)) + 2\alpha_3(\beta_2 - \alpha_2) \\ &\quad \text{COV}(\hat{\alpha}_2, \hat{\alpha}_3)\}/(\beta_2 - \alpha_2 - \alpha_3)^4 \\ V(\hat{\mu}_2) &= \{(\beta_2 - \alpha_2)^2 V(\hat{\beta}_3) + (\beta_3)^2 (V(\hat{\alpha}_2) + V(\hat{\beta}_2)) - 2\beta_3(\beta_2 - \alpha_2) \\ &\quad \text{COV}(\hat{\alpha}_2, \hat{\beta}_3)\}/(\beta_2 - \alpha_2 + \beta_3)^4 \end{aligned}$$

These formulae are used to calculate the asymptotic standard errors for the I.V. estimates in Tables 1 and 2.

^{4/} Evidently, when the demand and supply equations are just identified under the equilibrium hypothesis, we do not have enough instruments to use the Amemiya-Charemza method for (3.4) and (3.5). In such a case the instruments constructed by Bowden [1978a] for the Δp terms are useful.

^{5/} Notice that $E(\mu_{1t}, \mu_{2t}) = 0$ implies $\text{Cov}(\hat{\alpha}_2, \hat{\beta}_3) = \text{Cov}(\hat{\alpha}_2, \beta_2) = \text{Cov}(\hat{\alpha}_2, \hat{\beta}_3) = 0$.

3.3 Structural Form by NL3SLS

Recognizing the cross-equation restrictions imposed on α_2 and β_2 by (3.2) and (3.3), we propose to use the nonlinear three-stage least squares (NL3SLS) method.^{6/} The equations to be estimated simultaneously are constructed from (3.2) and (3.3) with switching variables Δp 's .

$$(3.7) \quad \begin{cases} Q_t = X_t' \alpha_1 + \alpha_2 p_t - \mu_1 (\beta_2 - \alpha_2) / (1 - \mu_1) \Delta p_t^+ + u_{1t} \\ Q_t = Z_t' \beta_1 + \beta_2 p_t + \mu_2 (\beta_2 - \alpha_2) / (1 - \mu_2) \Delta p_t^- + u_{2t} \end{cases}$$

Applying the NL3SLS method to (3.6) directly yields the necessary estimates with some gain in asymptotic efficiency over the I.V. method. At this point there are various possible tests of the equilibrium hypothesis. The resulting estimates of standard errors of μ_1 and μ_2 provide us with two separate tests: upward and downward flexibility of the prime rate. The null hypothesis, $\mu_1 = 0$, is a test of upward flexibility, i.e., no excess demand. Similarly a test of $\mu_2 = 0$ is a test of no excess supply. It is also of interest to test whether upward and downward adjustment speeds are the same. This can be done by calculating the standard error of $(\mu_1 - \mu_2)$.^{7/} In a case

^{6/} The full information maximum likelihood (FIML) method is also possible. However, considering the difficulty in maximizing the likelihood function in a disequilibrium model (see Goldfeld and Quandt [1975]), and the complexity of the likelihood function in the presence of the autocorrelation (see Laffont and Monfort [1977]), we decided to employ the NL3SLS method. The NL3SLS estimator has the same asymptotic efficiency with the FIML estimator. However, when we extend our model to consider a case where the price adjustment equation has a disturbance term, the FIML method becomes necessary.

^{7/} Notice that $\text{VAR}(\mu_1 - \mu_2) = \text{VAR}(\hat{\mu}_1) + \text{VAR}(\hat{\mu}_2) - 2 \text{COV}(\hat{\mu}_1, \hat{\mu}_2)$.

where a hypothesis, $\mu_1 = \mu_2$ is accepted, it is of interest to reestimate the model by the NL3SLS method with the restriction $\mu_1 = \mu_2$.^{8/}

4. THE BUSINESS LOAN MARKET IN THE UNITED STATES

4.1 Specifications

Disequilibrium econometrics has been applied by several authors to analyze business loan markets in an attempt to prove or disprove the existence of credit rationing.^{9/} Sealey [1979] uses a maximum likelihood method to estimate the demand and supply functions of the United States business loan market. He adopts the traditional price adjustment scheme and obtains an estimate of $\lambda = 0.0640$ with a standard error of 0.0210. His result merely indicates that the adjustment speed is significantly different from zero, rejecting the hypothesis that the interest rate is completely irresponsive to excess demand for the funds. Moreover, his statement that there is "much less than complete price adjustment during each quarter" (Sealey [1979, p. 696]) is not based on any statistically precise argument.

In order to obtain an economically meaningful estimate of the adjustment speeds, we shall estimate a model of the United States business loan market using Bowden's price adjustment equation as in (2.1) - (2.4). To design our specification of the demand and supply equations we have consulted several recent works including Goldfeld [1966], Jaffee [1971], Melitz and Pardue [1973], Laffont and Garcia [1977], B. Friedman [1977] [1979], and Sealey [1979].

^{8/}This is only a simplified test of the equilibrium with a restriction of $\mu_1 = \mu_2$. The most general test would be to test $\mu_1 = \mu_2 = 0$ in estimation without the restriction of $\mu_1 = \mu_2$ which is not done in this paper.

^{9/}Baltensperger [1978] gives a concise survey of literature on credit rationing. Credit rationing in our paper is meant to be "dynamic credit rationing" as defined by Jaffee and Modigliani [1969].

The desired demand level of commercial and industrial loans, BL^d , is part of a firm's general decision making process, including production, fixed investment, new equity issues, bond issues, and borrowing behavior. Therefore, without complete theory of such a decision making process it is not clear which variables are exogenous and which are endogenous in estimating the demand for bank loans. Some previous works have included inventory and fixed investments as explanatory variables. From the viewpoint of disequilibrium analyses, however, these variables are affected by any credit rationing that may exist.^{10/} Worse still, even without rationing, the level of desired investment may be affected by the rate of interest; and therefore, it is not an exogenous variable. For these reasons, the actual level of investment is excluded from the right-hand side. Instead, we include the industrial production index, IP , and the capacity utilization rate, CUR , as exogenous variables which may be highly correlated with desired investment spending. IP is lagged by one period to take into account the delay inherent in the investment decision making. Since a higher index of production or utilization rate stimulates investment and in turn increases the firm's financial needs, coefficients for IP and CUR are expected to be positive.

Turning to the cost of loans, we note that there are various alternative sources of financing investment spending other than bank loans: firms may issue commercial paper or use internal funds. Thus, the commercial paper rate, CPR , is included in the demand equation as well as the prime rate, PR . Since CPR is the price variable for an alternative way of financing, the coefficient is expected to be positive. In order to avoid a multicollinearity problem only the difference between PR and CPR is included with a coefficient expected to be negative.

^{10/} This point is forcefully argued in Laffont and Garcia [1977], and adopted also in Sealey [1979].

The supply of business loans, BL^S , is the result of banks' portfolio decisions. It may depend on the amount and price structure of available resources. The available funds are represented here by total deposits, DP ; defined by demand deposits and time deposits including certificates of deposit. The variable DP may be correlated with the quantity of loans, but, for simplicity, we regard it as exogenous. In order to capture the net profitability of a loan the relevant price variable is the difference between the prime rate and the discount rate, $PR - DIR$.

Although the above-mentioned variables are considered to define the long-run optimal stock level of demand or supply, the short-run optimal level is different in the presence of adjustment costs. Therefore we include the observed level of business loans for the preceding period as a predetermined variable. As mentioned earlier, firms and banks make decisions regarding business loans simultaneously with other financial and portfolio decisions. This implies that a list of lagged stock variables in the demand or supply function includes not only the level of the lagged business loans but also the levels of other stock variables.^{11/} Since the government securities held by commercial banks, TB , is a major alternative item in asset management, we include TB_{t-1} in the supply function with a coefficient which is expected to be negative. We did not find any lagged stock variables other than BL_{t-1} in the demand function.

Finally, we obtain the following specification for the desired demand and supply equations:

$$(4.1) \quad BL_t^d = \alpha_0 + \alpha_1(PR_t - CPR_t) + \alpha_2 IP_{t-1} + \alpha_3 CUR_t + \alpha_4 BL_{t-1} \quad .$$

$$(4.2) \quad BL_t^s = \beta_0 + \beta_1(PR_t - DIR_t) + \beta_3 DP_t + \beta_4 BL_{t-1} + \beta_5 TB_{t-1} \quad .$$

^{11/} See Friedman [1977] [1979] for details of this argument.

All the nominal variables are normalized by the GNP deflator, and interest rates are adjusted for actual inflation as measured by the annual rate of increase in the GNP deflator.

4.2 Estimation Results

All the equations below are estimated over the period, 1965: III - 1979: II, using quarterly data.

4.2.(i) Reduced Form for the Price Adjustment Equation

Since equation (3.1) has a lagged endogenous variable on the right-hand side, it was corrected for serial correlation to yield the following results.

$$\begin{aligned} PR_t = & - 1.35 + 0.13 PR_{t-1} + 0.47 CPR_t + 0.02 IP_{t-1} - 0.01 CUR_t + 0.03 BL_{t-1} \\ & (2.07) (0.06) \quad (0.06) \quad (0.01) \quad (0.02) \quad (0.02) \\ & + 0.41 DIR_t - 0.01 DP_t + 0.01 TB_{t-1} \\ & (0.10) \quad (0.00) \quad (0.01) \end{aligned}$$

$$\rho = 0.60 \qquad R^2 = .93 \qquad SER = 0.22$$

Numbers in parentheses are estimated standard errors of coefficient estimates, $\hat{\rho}$ is the estimated first order serial correlation coefficient, and SER is the estimated standard error of the equation.

Although some of the coefficients are not statistically significant, they all have the right signs. The estimated adjustment speed is 0.126 and is barely significantly different from zero. In other words, the reduced form equation indicates that the market on average was not in equilibrium over the period of our estimation. However, the prime rate is adjusting for 87 percent of the gap between last period's level and the current equilibrium.

4.2.(ii) Structural Form for the Demand and Supply Equations

The estimation results from the I.V. and NL3SLS methods are summarized in Table 1.^{12/} The expected signs are obtained for all of the estimates except for μ_1 which is statistically insignificant from zero. All equations are estimated with adjustments for autocorrelation of a first-order Markov process in the disturbances.^{13/} Estimates of the autocorrelation ρ are about .35 and .80 for the demand and supply functions, respectively.

The high value of the estimated coefficient of BL_{t-1} implies that the desired stock of the demand for business loans adjusts slowly, by only ten percent a quarter. By a similar observation, the current desired stock of the supply of business loans is approximately half way between the long-run desired level and last period's actual level of business loans. A spillover in the vector stock adjustment process in the supply function is captured by the term of TB_{t-1} . However, its coefficient is insignificant.^{14/} The coefficients of the interest rate are significant in both equations. An increase in the spread between the prime rate and the corporate paper rate

^{12/} Computations are done by using the TROLL program in MIT IBM 370. The NL3SLS algorithm is based on Jorgenson and Laffont [1974]. The initial values are chosen from the results of preliminary two-stage least squares estimates.

^{13/} The Fair's [1970] method is employed to obtain the consistent estimator in the presence of the lagged endogenous variables and first-order autocorrelations.

^{14/} Similar attempts to capture spillovers of the stock adjustment process in the demand function were made in vain. Coefficients of the corporate bond issues (outstanding) or the total liquid assets held by nonfinancial corporations would have wrong signs in their estimated coefficients.

of one percentage point decreases the level of desired demand for business loans by 1.6 billion dollars. Similarly, a one-percentage point increase in the spread between the prime rate and the discount rate increases the level of desired supply of business loans from commercial banks by 1.9 billion dollars.

Now let us turn to our estimates of the adjustment speeds and their implications for testing the equilibrium hypothesis. Both coefficients of upward and downward speeds of adjustment are insignificant, implying that the prime rate is perfectly flexible in either direction. Therefore the equilibrium hypothesis is accepted by two different tests of $\mu_1 = 0$ and $\mu_2 = 0$. A hypothesis that μ_1 and μ_2 are the same is also tested. The estimated difference in the μ 's is -0.14 with an estimated standard error, 0.24, and the hypothesis of $\mu_1 = \mu_2$ is accepted. Finally, the model is estimated by NL3SLS with the restriction that $\mu_1 = \mu_2$. Most of the estimated coefficients are close to those obtained in the unrestricted model. The adjustment speed is estimated as 0.10 with a standard error of 0.07, and the equilibrium hypothesis is accepted.

5. THE BUSINESS LOAN MARKET IN JAPAN

5.1 Specification

Among economists who study the Japanese financial markets, there is a consensus that the markets are heavily regulated, and thus are in "disequilibrium."^{15/} In particular, the "low interest rate" policy, designed to maintain high growth rates in strategic sectors, has kept interest rates inflexible at relatively low levels. As a result, the development of the bond and equity markets has long been limited, and corporations have been forced to rely heavily on bank loans. These features of the markets led

^{15/}For detailed discussions, see Wallich and Wallich [1976] and Rimbara and Santomero [1976].

Hamada et. al. [1977] to apply disequilibrium econometrics to the Japanese business loan market. Hamada et. al. compare the results of estimates obtained under equilibrium and disequilibrium hypotheses and conclude that the disequilibrium specification makes more sense. However, they do not carry out any formal statistical tests to choose one hypothesis or another. Moreover, their estimation technique is subject to truncation biases.^{16/}

Our specifications of the demand and supply equations closely follow those of Hamada et. al. [1977] while maintaining some symmetry with the previous specification for the United States business loan market. In the demand equation, the price variable is simply assumed to be the level of the prime rate, PR, considering the unimportance of the bond or equity financing of investment spending in Japan. The index of industrial production, IP, is used as an exogenous variable which affects firms' investment decisions. The undistributed profit variable UD, is introduced to measure the impact of the availability of internal funds. Fortunately, this variable exhibits enough variability in the Japanese data to serve as an independent variable in contrast to the one in the United States.

On the supply side, Japanese "city" and "local" banks (hereafter, the banks) are a major source of business loans.^{17/} The price variable is the difference between the prime rate, PR, and the discount rate of the Bank of Japan, DIR. Since the borrowing from the central bank has been

^{16/} They separate samples into the excess demand phase and the excess supply phase by the direction of the change in the prime rate. Then they regress the demand and supply functions separately on the different groups of samples. This causes the truncation biases. See Fair and Jaffee [1972] for the warning.

^{17/} See Wallich and Wallich [1976, pp. 278 - 298] for characteristics and definitions of "city" and "local" banks and their roles in the banking system.

quite common in a phase of rapid economic growth, the latter variable is considered very important in Japan. The level of total deposits, DP , is another entry of the supply function as in the United States model.

Both the supply and the demand equations for Japan are specified in nominal terms. Moreover, the nominal prime rate is assumed to adjust to the difference between the nominal equilibrium rate and the last period's nominal rate.^{18/}

A stock adjustment scheme in the desired demand and supply in Japan is introduced in a comparable manner to the United States model. Therefore we obtain the following desired demand and supply equations for Japan:

$$(5.1) \quad BL_t^d = \alpha_1 + \alpha_2 PR_t + \alpha_3 IP_t + \alpha_4 UD_t + \alpha_5 BL_{t-1} \quad ,$$

$$(5.2) \quad BL_t^s = \beta_1 + \beta_2 (PR_t - DIR_t) + \beta_3 DP_t + \beta_4 BL_{t-1} + \beta_5 TB_{t-1} \quad .$$

5.2 Estimation Results

All the estimation results are based on quarterly data from 1968: II to 1977: I.

^{18/}We have tried the specification in real terms for Japan only to find wrong signs. One explanation is that in Japan the arbitrage between loans and equities has been so limited for various reasons that effects of inflation on the prime rate have been small. The financial system in Japan is subject to institutional controls and market segmentation. See Wallich and Wallich [1976] for detailed discussion. We conjecture that although financial institutions including banks are major stockholders of manufacturing companies, their decisions are based on considerations as a "group leader" of interlocking ownership rather than portfolio analysis. Therefore the arbitrage between loans and equities has been limited.

5.2(i) Reduced Form for the Price Adjustment Equation

First, using the above specification, equation (3.1) is estimated using GLS to correct for serial correlation.

$$\begin{aligned} PR_t = & 0.415 + 0.767 PR_{t-1} + 0.004 IP_t - 0.039 UD_t - 0.088 DIR_t - 0.595 DP_t \\ & (0.375) (0.049) \quad (0.002) \quad (0.011) \quad (0.031) \quad (0.256) \\ & + 0.603 BL_{t-1} + 0.421 TB_{t-1} \\ & (0.333) \quad (0.172) \end{aligned}$$

$$\rho = -0.51$$

$$R^2 = .99$$

$$SER = 0.097$$

All the coefficients have expected signs. The adjustment speed of the prime rate 0.77 is significantly different from zero, rejecting the equilibrium hypothesis.

5.2(ii) Structural Form for the Demand and Supply Equations

Equations (3.4) and (3.5) with specification of exogenous variables as (5.1) and (5.2) are estimated by the I.V. and NL3SLS methods.^{19/}

^{19/}We used the household deposits HD as an instrument for DP_t in the Japanese banks to avoid potential inconsistency of estimates resulting from the high correlation between bank loans and total deposits. In a country like Japan where the ratio of loans to total bank assets is quite high, the use of total deposits as an exogenous variable could hardly be justified. One way out is to use household deposits, which is considered to be original deposits in credit creation, as an instrument. Another way would be to use HD_t directly as an independent variable in place of DP_t in equation (5.5). However, the latter method would call for a complicated distributed lag formation of HD, since the credit creation process starting from an increase in HD does not end in a single period. Hence, for simplicity, we adopted the former method of using HD as an instrument.

The results are summarized in Table 2. Since the Durbin-Watson statistic is close to two, we did not assume autocorrelation among the disturbance terms.^{20/}

A coefficient of BL_{t-1} is very close to unity in the demand equation. The estimated value is higher than its American counterpart, suggesting that the Japanese borrowers experience relatively high transactions costs in making portfolio changes. A coefficient of BL_{t-1} in the supply function also has a higher value than that of the United States model. Moreover the coefficient of TB_{t-1} becomes significant in the NL3SLS estimates. Therefore the banks in Japan appear to have significant stock adjustment costs in performing operations on their portfolios. The coefficient of the prime rate in both the demand and supply equations is insignificant although with the correct sign. The point estimates of the prime rate imply that a one-percentage point increase would reduce the demand for business loans by 70 billion yen. A similar increase in the spread between the prime rate and the discount rate results in an increase of 270 billion yen in the supply of business loans.

The estimates of the adjustment speeds of the prime rate show the major differences from their American counterparts. When the market is in excess demand, the prime rate adjusts by only seven percent of the gap between the current equilibrium rate and last period's level. The downward adjustment speed is faster than upward and at about eleven percent of the gap. Estimates of both μ_1 and μ_2 are significantly different from zero, rejecting the hypotheses of perfect flexibility of the prime rate upward or downward. The estimated value of $(\mu_1 - \mu_2)$ is .05 with an estimated standard error of .07. Consequently, the hypothesis of identical adjustment

^{20/} The lagged endogenous variable, BL_{t-1} , was not included in the list of instruments. Hence coefficient estimates and the D-W statistic are consistent.

speeds in either direction is accepted for Japan, too. When the restriction of identical adjustment speeds is imposed, we find an estimated adjustment speed of 0.88 with a standard error 0.05. Finally, the Japanese data rejects the equilibrium hypothesis in all of the tests we proposed in the preceding section.

6. SOME INTERNATIONAL COMPARISONS

At this point it is of great interest to compare estimates of adjustment speeds for different countries. Note that the specification of (3.4) and (3.5) is independent of whether we use the conventional price adjustment scheme or the Bowden scheme. In other words, we can calculate the price adjustment speed of the Bowden type by (3.6) from coefficients originally estimated for a model with the conventional price adjustment mechanism. Therefore, we can obtain estimates of the Bowden adjustment speeds based on those results from previous studies of business loan markets. Table 3 summarizes our results as well as those of Laffont and Garcia, and of Sealey.

First of all, let us address the question of whether or not the market is in equilibrium. There is some evidence, although not conclusive, that the United States market is closer to equilibrium than the Japanese market. Moreover, the United States business loan market is considered to be in equilibrium if we take the structural estimates over the reduced form estimates. Thus, we confirm the conjecture that the Japanese financial market, which is subject to more regulation, is further away from equilibrium than the United States market. For the Canadian market, we are unable to make such speculations because the confidence intervals of the estimates are unavailable.

Turning to the differences between upward and downward adjustment speeds, μ_1 is greater than μ_2 in Japan; in contrast, μ_1 is smaller than μ_2 for the United States and Canada. In the Japanese case, the alleged "low interest rate policy" may be responsible for such a result. Unfortunately, no such economic explanation is readily available for the United States and Canadian cases. Remember, however, that we have already shown that the difference between upward and downward adjustment speeds is statistically insignificant for the NL3SLS estimates.

7. CONCLUDING REMARKS

Using the Bowden price adjustment scheme, we have tested the equilibrium versus disequilibrium hypothesis in the United States and Japanese business loan markets. There is some evidence that the prime rate adjusts more slowly in Japan than in the United States.

The next interesting finding is that the United States loan market is considered to be in equilibrium if the structural estimates are adopted while no such result was found for the Japanese loan market by either set of estimates. Therefore, we may conclude that our results support the popular view that the United States business loan market is closer to equilibrium than the Japanese counterpart.

Of course, our specifications are too simple to conclude anything definite. However, we believe that our results can serve as an interesting starting point for further research.

For the United States, future studies should include a more complete price structure in light of the multitude of highly developed monetary and financial markets in the country. As for Japan, improvements of the specification must start with an analysis of the effects of government

regulation, including the effect of changes in the discount rate on the prime rate. ^{21/}

Finally, we may go one step further to say that the difference in the understanding of the role of prices lies at the heart of the monetarist - Keynesian controversy: monetarists tend to believe that prices adjust to clear markets within a very short period of time, while Keynesians place a crucial importance on short-run rigidity of prices and wages. When specifications are extended to include the price and quantity expectation variables and dynamic, as opposed to static, decision making, empirical studies of the disequilibrium versus equilibrium hypotheses like the one we have presented in this paper may well become a fruitful battleground between the two schools.

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^{21/}We have started an attempt to take into account an effect of changes in the rate of borrowing from the Bank of Japan on the prime rate adjustment, in addition to the market pressure. However, the detailed results of the analysis taking into account the Japanese financial regulations will be reported in a separate paper.

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Table 1

ESTIMATION RESULTS FOR THE UNITED STATES BUSINESS LOAN MARKET
(Numbers in parentheses for the RHS variables are standard errors)

Demand Equation: LHS variable = BL_t , with mean = 124.95

<div>RHS Method (equation)</div>	Constant	$PR_t - CPR_t$	IP_{t-1}	CUR_t	BL_{t-1}	μ_1	ρ_1	R^2	SER
I.V. (3.4)	- 13.84 (8.95)	- 1.86 (0.71)	0.18 (0.05)	0.20 (0.10)	0.88 (0.05)	0.02 (0.14)	0.38	0.98	1.46
NL3SLS (3.7)	- 12.43 (6.86)	- 1.57 (0.57)	0.15 (0.04)	0.18 (0.10)	0.91 (0.04)	- 0.02 (0.16)	0.35 (0.12)	0.99	1.47

Supply Equation:

<div>RHS Method (equation)</div>	Constant	$PR_t - DIR_t$	DP_t	BL_{t-1}	TB_{t-1}	μ_2	ρ_2	R^2	SER
I.V. (3.5)	16.71 (10.88)	2.11 (0.77)	0.13 (0.03)	0.45 (0.13)	- 0.20 (0.10)	0.12 (0.10)	0.80	0.92	1.42
NL3SLS (3.7)	3.27 (5.45)	1.86 (0.88)	0.13 (0.67)	0.48 (0.23)	- 0.18 (0.11)	0.12 (0.15)	0.79 (0.25)	0.99	1.44

Table 2

ESTIMATION RESULTS FOR THE JAPANESE BUSINESS LOAN MARKET
(Numbers in parentheses for the RHS variables are standard errors)

Demand Equation:		LHS variable = BL_t , with mean = 5.94							
RHS									
Method (equation)	Constant	PR_t	IP_t	UD_t	BL_{t-1}	μ_1	R^2	DW	SER
I.V. (3.4)	- 0.260 (0.285)	- 0.062 (0.028)	0.004 (0.001)	- 0.034 (0.015)	0.992 (0.016)	.85 (.01)	.99	2.06	0.059
NL3SLS (3.7)	- 0.396 (0.435)	- 0.007 (0.035)	0.006 (0.002)	- 0.019 (0.012)	0.964 (0.025)	0.936 (0.073)	.99	1.67	0.060

Supply Equation:									
RHS									
Method (equation)	Constant	$PR_t - DIR_t$	DP_t	BL_{t-1}	TB_{t-1}	μ_2	R^2	DW	SER
I.V. (3.5)	0.026 (0.075)	0.040 (0.013)	0.169 (0.050)	0.910 (0.065)	- 0.382 (0.768)	.72 (.10)	.99	2.14	0.037
NL3SLS (3.7)	0.160 (0.140)	0.027 (0.018)	0.271 (0.089)	0.773 (0.125)	- 0.348 (0.090)	0.886 (0.110)	.99	2.01	0.036

Table 3

Equation	Estimates [§] of	U S A		JAPAN Our Result	CANADA L - G ^{**}
		Our Result	Sealey [*]		
(3.1)	μ	.13 (.06)	.366	.77 (.05)	
(3.4) IV	μ_1	.02 (.14)		.85 (.01)	.409
(3.5)	μ_2	.12 (.10)		.72 (.10)	.600
3SLS	μ_1	-.02 (.16)		.94 (.07)	
(3.7)	μ_2	.12 (.15)		.89 (.11)	

* Sealey's μ is obtained by estimates by the maximum likelihood method: calculated as $\mu = (1/\gamma) \div (\beta_2 - \alpha_2 + (1/\gamma))$.

** Laffont and Garcia's estimates are those by the two stage least squares method, with a comparable specification of the price adjustment (c.f. remarks in section 3.B).

APPENDIX

Glossary

a) UNITED STATES 1965: III to 1979: II

1. All time series except the prime and other interest rates are seasonally adjusted.
2. All time series are taken from CITIBASE, the TROLL data bank. The data name in a bracket is the code for CITIBASE. Any variable available as a monthly series in the data bank was converted into a quarterly series by taking the average of three months figures.

D : Demand for Commercial and Industrial Loans (unobservable)

S : Supply of Commercial and Industrial Loans (unobservable)

BL : Commercial and Industrial Loans outstanding (FCLICY);
in billions of dollars; deflated by the GNP deflator (GD)

PR : Prime Rate (FYPR); adjusted to the inflation rate of the
GNP deflator

CPR : Corporate Bond Rate -- average yields (FYAVG); adjusted
to the inflation rate of the GNP deflator

DP : Total Deposits (FMSDA + FMSTA) including CDs; in
billions of dollars; deflated by the GNP deflator (GD)

IP : Industrial Production Index (IP); 1967 = 100

CUR : Capacity Utilization Rate (IPXCA)

DIR : Discount Rate at the Federal Reserve Bank of New York (FYGD)

TB : U. S. Treasury Securities held by Commercial Banks; in
billions of dollars; deflated by the GNP deflator (GD)

b) JAPAN 1968:II to 1977:I

1. All time series except the prime rate are seasonally adjusted.
2. All data but IP are collected from publications by the Bank of Japan. BL is created from the Δ BL series, which is the change in industrial loans from banking accounts of the "city" and "local" banks, and the benchmark BL from the balance sheet of the banks.

D : Demand for Commercial and Industrial Loans (unobservable)

S : Supply for Commercial and Industrial Loans (unobservable)

BL : Commercial and Industrial Loans outstanding; in ten trillions of yen

PR : Prime Rate (= The Average Lending Rate from the "City" and "Local" Banks)

DP : Total Deposit to the "city" and "local" banks; in ten trillions of yen

UD : Undistributed Profits; in trillions of yen

IP : Index of Industrial Production; 1967 = 100
(IPJP in CITIBASE Data Bank)

DIR : Discount Rate of the Bank of Japan

TB : Securities held by Japanese "city" and "local" banks; in ten trillions of yen