Hitotsubashi Journal of Commerce and Management 21 (1986) pp. 19-44.

DETERMINATION OF THE YIELDS OF THE JAPANESE GOVERNMENT BONDS*

HIROSHI KAMAE

I. *Introduction*

Recently, the secondary markets of long-term government bonds have rapidly grown. After the sale of them by underwriting syndicate was allowed in 1977, the financial institutions who participated in the syndicate began to buy and sell the bonds actively in terms of their yields. In this paper, holding of the bonds is analysed using structural equations, and these equations will determine their yields.

In section 2, an institutional outline of the secondary markets of Japanese government bonds is given. In the third section, a theoretical model is presented. In section four, whether or not the three markets (those of government bonds, loan and call and bills bought and sold) are in equilibrium is examined. In section five, asset holding functions are specified taking into account the spill-over effects of a disequilibrium of the loan markets.[1] In the sixth section, these functions are empirically estimated. A pooling method which uses cross-sectional data as well as time series data is tried. Simultaneous equations which consist of asset holding functions and market clearing equations are used to determine the bonds' yields and call and bills' rates. The final section gives concluding comments.

II. *An Institutional Outline of the Secondary Markets of the Government Bonds*

Most of the government bonds are underwritten by a syndicate which consists of almost all financial institutions. Before 1976, bonds except for those underwritten by the life insurance companies were not allowed to be sold by the Ministry of Finance (MOF). In 1977, these financial institutions including the life insurance companies began to sell bonds which were issued more than a year before. The bonds were allowed to be sold after the listing period (that is, after about seven to nine months of the issue) in 1980. In 1981 these were allowed to be sold after only about 100 days since issue. With these changes, the bonds' demand and supply have begun to move their prices, in particular, their over-the-counter (OTC) market prices.

* This is an abridged version of my paper in Japanese, "Kokusai Ryūtsū Shijō ni okeru Juyō to Rimawari no Kettei," *Shōgaku Kenkyū* (Hitotsubashi University), forthcoming. Much thanks are due to Mr. S. Good for his editing the English.

[1] See, Smith and Brainard [8].

TABLE 1. GOVERNMENT BONDS HOLDING BY SECTORS

(%)

Financial Institutions	End of Fiscal Year 1978	1979	1980	1981	1982	1983	1984
City Banks	18.4	18.6	12.6	9.2	7.5	6.5	5.7
Regional Banks Trust Banks Long-Term Credit Banks	16.5	17.8	16.9	16.6	16.5	17.0	17.5
Mutual Loan & Savings Banks Credit Associations	5.0	5.4	4.4	4.6	4.4	5.1	5.2
Financial Institutions for Agricultures, Forestry & Fishery	2.8	3.9	5.6	5.7	5.7	6.2	6.9
Insurance Institutions	1.8	2.1	1.6	1.5	1.8	1.8	2.5
Total	44.5	47.8	41.1	37.6	35.9	36.6	37.8

Source: BOJ's *Flow of Funds Accounts.*

TABLE 2. BOND TRADING SHARES BY TYPES OF INVESTORS

(%)

Institutions Year	Sales 1978	1979	1980	1981	1982	1983	1984	Purchases 1978	1979	1980	1981	1982	1983	1984
City Banks	6.3	9.1	12.3	12.4	9.9	9.1	6.4	0.9	2.4	5.8	6.9	5.4	7.0	5.9
Regional Banks	5.8	7.2	7.3	8.0	8.7	6.3	4.0	4.1	4.8	4.4	7.1	6.3	5.0	3.7
Trust Banks Long-Term Credit Banks	5.1	6.0	4.6	7.6	8.6	11.1	9.4	5.3	6.7	6.2	7.5	11.2	11.9	10.4
Mutual Loan & Savings Banks Credit Associations	8.8	9.6	7.7	7.3	6.6	5.0	4.5	8.4	8.6	6.8	8.9	6.5	4.1	4.2
Financial Institutions for Agricultures & Forestry	10.0	11.7	14.0	9.7	6.3	6.6	3.5	14.6	16.2	15.5	10.8	7.8	7.4	4.0
Insurance Institutions	2.3	2.8	3.1	2.9	2.6	1.9	0.9	2.7	3.0	2.7	2.7	2.7	1.8	0.8
Total	38.3	46.4	49.0	47.9	42.7	40.0	28.7	36.0	41.7	41.4	43.9	39.9	37.2	29.0

Source: Tokyo Stock Exchange's *Annual Statistics Report.*

Table 1 shows each sector's holding of government bonds, and Table 2 shows each sector's public and corporate bonds trading shares in the OTC market. According to these tables, shares of financial institutions and life insurance companies, of which behavior this paper will analyse, are about 30 or 40% respectively.

III. *A Theoretical Model*

In this paper, the Brainard and Tobin [1] type demand functions are used.[2] The financial institutions' desired holding of financial assets are presented in equation (1). Am^*_{jt} is mth institution group's desired holding of jth asset at tth period. Am_{1t} represents the holding of government bonds (Bm_t). Am_{2t} represents the holding of net call loans and bills bought (NCm_t), that is, call loans − call money + bills bought − bills sold. Am_{3t} represents the holding of loans (Lm_t). Six financial institution groups are analysed. The first group consists of city banks, the second consists of regional banks, and the third consists of long-term credit banks and trust banks, including trust accounts of all banks. Mutual loan and savings banks ("sōgo" banks) and credit associations ("shinkin" banks) including the National Federation of Credit Associations ("Zenshinren" bank) constitute the fourth group. The fifth group consists of financial institutions for agriculture, forestry and fisheries, that is, the Central Cooperative Bank for Agriculture and Forestry ("Norin-chukin" Bank), credit federations of agricultural cooperatives and agricultural cooperatives. The last consists of life insurance companies. Wm_t is mth groups' holding of total assets at tth period, rb_t represents the yields of government bonds, rc_t is call and discount rates, while rlm_t represents mth group's loan rates.

Equation (2) shows how an institution adjusts to the difference between an asset's desired holding and actual holding according to the partial adjustment mechanism. Am_{jt} represents mth group's actual holding of jth asset at tth period. Am^e_{jt} represents mth group's demand (or supply, if the asset is a loan) for jth asset after the partial adjustment; it is called effective demand (or supply). The adding-up constraint (equation (4)) is assumed. From this constraint, condition (5) and (6) are imposed.

Effective demand for (or supply of) asset functions, equation (7), are derived from equations (1) and (2). If the three assets being analysed are substitutes, the expected signs of the interest rates' coefficients in equation (1) are as shown in equation (8).

(1) $Am_{jt}^* = \alpha_j^m Wm_t + \beta_j^m rb_t + \gamma_j^m rc_t + \delta_j^m rlm_t + c_j^m, \qquad m=1, \ldots, 6, \; j=1, 2, 3$

(2) $Am_{it}^e = Am_{i,t-1} + \sum_{j=1}^{3} \theta_{ij}^m (Am_{jt}^* - Am_{j,t-1}), \qquad i=1, 2, 3$

(3) $\Delta Am_{jt} \equiv Am_{jt} - Am_{j,t-1}$

(4) $\sum_j Am_{jt}^e = \sum_j Am_{jt}^* = \sum_j Am_{jt} = Wm_t$

(5) $\begin{cases} \sum_j \alpha_j^m = 1, \; \sum_j \beta_j^m = 0 \\ \sum_j \gamma_j^m = 0, \; \sum_j \delta_j^m = 0 \end{cases}$

(6) $\sum_j \theta_{jk}^m = 1$

[2] See, Saitō and Ōshika [7].

$$(7)\quad Am_{it}^{e}=(1-\theta_{ii}{}^{m})Am_{i,t-1}-\sum_{j\neq i}\theta_{ij}{}^{m}Am_{j,t-1}$$

$$+\sum_{j}\theta_{ij}{}^{m}(\alpha_j{}^{m}Wm_t+\beta_j{}^{m}rb_t+\gamma_j{}^{m}rc_t+\delta_j{}^{m}rlm_t+c_j{}^{m}),\ i=1,\ 2,\ 3$$

$$(8)\quad \beta_1{}^{m}>0,\ \beta_2{}^{m}<0,\ \beta_3{}^{m}<0,\ \gamma_1{}^{m}<0,\ \gamma_2{}^{m}>0,\ \gamma_3{}^{m}<0,$$

$$\delta_1{}^{m}<0,\ \delta_2{}^{m}<0,\ \delta_3{}^{m}>0$$

IV. *Tests of Disequilibrium*

Here, whether or not the government bonds market, the call and discount market and the loan market are in equilibrium is examined. The loan market is assumed to be divided into six submarkets where the six institution groups exclusively supply loans. Each of the other two markets is assumed to constitute a single market, because the loan submarkets seem to have different circumstances and the loan interest rates data of each submarket are available.

Next, the models which test this equilibrium are presented.[3]

(i) the government bond market

In this market, equilibrium means that the sum of the six groups' effective demand and the other sectors' holding (BEX_t) equals outstanding amounts (BTL_t). See equation (9). Let $rb_t{}^*$ be a yield which equates demand and supply in this market. A partial adjustment mechanism, equation (10), is assumed to adjust the yield in case of disequilibrium. η_1 is the speed of adjustment, and if η_1 is equal to 1, then equation (10) becomes $rb_t=rb_t{}^*$ implying equilibrium. If η_1 is smaller than 1, then disequilibrium remains. From equation (9), equation (11) is gained. From equations (7), (10) and (11), equation (13) is obtained. When the estimate of coefficient $(1-\eta_1)$ is not significantly different from 0, the market is taken to be in equilibrium.

$$(9)\quad \sum_{m=1}^{6}Bm_t{}^{e}+BEX_t=BTL_t$$

$$(10)\quad rb_t=(1-\eta_1)rb_{t-1}+\eta_1 rb_t{}^*$$

$$(11)\quad \sum_{m=1}^{6}Bm_t{}^{e}=BEND_t$$

$$(12)\quad BEND_t\equiv BTL_t-BEX_t$$

$$(13)\quad rb_t=(1-\eta_1)rb_{t-1}+\eta_1\Bigg[-\frac{\omega_1}{\omega_3}-\sum_{m=1}^{6}\frac{1-\theta_{11}{}^{m}}{\omega_3}Bm_{t-1}+\sum_{m}\frac{\theta_{12}{}^{m}}{\omega_3}NCm_{t-1}$$

$$+\sum_{m}\frac{\theta_{13}{}^{m}}{\omega_3}Lm_{t-1}-\sum_{m}\frac{\omega_{2m}}{\omega_3}Wm_t-\sum_{m}\frac{\omega_{4m}}{\omega_3}rlm_t-\frac{\omega_5}{\omega_3}rc_t$$

$$+\frac{1}{\omega_3}BEND_t\Bigg],$$

[3] See, Itō [3] and Kamae [4].

$$
(14)\quad \begin{cases}
\omega_1=\sum_{j=1}^{3}\sum_{m=1}^{6}\theta_{1j}{}^{m}c_j{}^{m}, & \\
\omega_{2m}=\sum_{j}\theta_{1j}{}^{m}\alpha_j{}^{m}, & m=1,\ldots,6 \\
\omega_3=\sum_{j}\sum_{m}\theta_{1j}{}^{m}\beta_j{}^{m} & \\
\omega_{4m}=\sum_{j}\theta_{1j}{}^{m}\delta_j{}^{m}, & m=1,\ldots,6 \\
\omega_5=\sum_{j}\sum_{m}\theta_{1j}{}^{m}\gamma_j{}^{m} &
\end{cases}
$$

(ii) the call and discount market

In this market, equilibrium means that the sum of the six groups' holding of the net call and bills is equal to zero (see equation (15)). $NCEX_t$ displays the exogenous sectors' holding of the net call and bills at tth period. Equation (17) is assumed to adjust the call and discount rate when the market is in disequilibrium. From equations (7), (16) and (17), equation (18) is gained. $rc_t{}^*$ is an equilibrium call and discount rate.

$$(15)\quad \sum_{m=1}^{6}NCm_t{}^e+NCEX_t=0$$

$$(16)\quad \sum_{m}NCm_t{}^e=-NCEX_t$$

$$(17)\quad rc_t=(1-\eta_2)rc_{t-1}+\eta_2 rc_t{}^*$$

$$
\begin{aligned}
(18)\quad rc_t=(1-\eta_2)rc_t+\eta_2\Big[&-\frac{\phi_1}{\phi_5}+\sum_{m}\frac{\theta_{21}{}^{m}}{\phi_5}Bm_{t-1}-\sum_{m}\frac{1-\theta_{22}{}^{m}}{\phi_5}NCm_{t-1}\\
&+\sum_{m}\frac{\theta_{23}{}^{m}}{\phi_5}Lm_{t-1}-\sum_{m}\frac{\phi_{2m}}{\phi_5}Wm_t-\frac{\phi_3}{\phi_5}rb_t-\sum_{m}\frac{\phi_{4m}}{\phi_5}rlm_t\\
&-\frac{1}{\phi_5}NCEX_t\Big]
\end{aligned}
$$

$$
(19)\quad \begin{cases}
\phi_1=\sum_{j}\sum_{m}\theta_{2j}{}^{m}c_j{}^{m} & \\
\phi_{2m}=\sum_{j}\theta_{2j}{}^{m}\alpha_j{}^{m}, & m=1,\ldots,6 \\
\phi_3=\sum_{j}\sum_{m}\theta_{2j}{}^{m}\beta_j{}^{m} & \\
\phi_{4m}=\sum_{j}\theta_{2j}{}^{m}\delta_j{}^{m}, & m=1,\ldots,6 \\
\phi_5=\sum_{j}\sum_{m}\theta_{2j}{}^{m}\gamma_j{}^{m} &
\end{cases}
$$

(iii) the loan market

Whether the six submarkets are in equilibrium or not is investigated. Equilibrium in the mth submarket means that demand for loans is equal to its effective supply (equation (20)). The effective demand for loans is assumed to be equal to the desired holding. Equation (21) denotes the demand function for loans. S_t gives the sales of the corporate sector, rcd_t gives the interest rates on the certificate of deposit. Equation (23) is gained from equation (7), (20) and (22).

From estimating equations (13), (18) and (23) and testing whether η_i is equal to one, we can examines whether equilibrium is obtained or not. In order to take account of compensatory deposit's equilibrating effect, effective loan rates are used for estimation as well as nominal ones.

(20) $Lm_t^e = LDm_t^e, \qquad m=1, \ldots, 6$

(21) $LDm_t^e = LDm_t^* = b_0^m + b_1^m S_t + b_2^m rb_t + b_3^m rlm_t + b_4^m rcd_t$

(22) $rlm_t = (1-\eta_3^m) rlm_{t-1} + \eta_3^m rlm_t^*$

(23) $$rlm_t = (1-\eta_3^m) rlm_{t-1} + \eta_3^m \left(\frac{x_{2m}}{x_{1m}} + \frac{\theta_3^m}{x_{1m}} Bm_{t-1} + \frac{\theta_{32}^m}{x_{1m}} NCm_{t-1} - \frac{1-\theta_{33}^m}{x_{1m}} Lm_{t-1} + \frac{x_{3m}}{x_{1m}} Wm_t + \frac{b_1^m}{x_{1m}} S_t + \frac{x_{4m}}{x_{1m}} rb_t + \frac{x_{5m}}{x_{1m}} rc_t + \frac{b_4^m}{x_{1m}} rcd_t \right)$$

(24) $$\begin{cases} x_{1m} = \sum_j \theta_{3j}^m \delta_j^m - b_3^m \\ x_{2m} = -\sum_j \theta_{3j}^m c_j^m + b_0^m \\ x_{3m} = -\sum_j \theta_{3j}^m \alpha_j^m \\ x_{4m} = -\sum_j \theta_{3j}^m \beta_j^m + b_2^m \\ x_{5m} = -\sum_j \theta_{3j}^m \gamma_j^m \end{cases}$$

The estimation period is from the second quarter of 1978 to the first quarter of 1984. This period is chosen because (a) among the data of the government bonds' yields, the over-the-counter index quotations which move according to demand and supply of the government bonds have been available from February 1978, and (b) the dealing activity of the public bonds by banks began in June 1984 and the structure of the government bonds markets may change.

Balance data of the all institutions' government bonds, loans, call money, call loans and bills bought and sold are collected from the BOJ's *Economic Statistics Annual.* These are the end of period amounts. This government bond data includes long-term bonds which were underwritten by the financial institutions and were not allowed to be sold by the MOF. When government bonds are traded with a repurchase agreement, the bonds' balance changes, but these changes move according to the yields of bonds traded with a repurchase agreement, not to the yields of bond (ordinary) trading. In order to obtain the bond balance that depends on this yield, the balance changes due to repurchase agreement trading and those which were not allowed to be sold are taken into account. After these adjustments, the bonds balance data which is, so to speak, the tradable bond balance is gained. It is denoted as *Bm*. *BET* denotes the balance of the salable brands held by the exogenous sectors. *BTL* denotes the balance of the salable brands among the outstanding amounts. *BEND* is the difference between the two, however it is not observable. Instead the total of the six institution groups' actual holdings is used as an approximation through reference to equation (11).

NCEX is also unobservable. Therefore from equation (16), the total of the six institution groups' actual holding of the net call and bills is used as an approximation. Sales data of the firm sector (S) are picked from the MOF's *Financial Statements of Incorporated Business*.

The compound yields of government bonds (rb) are calculated using the over-the-counter index quotations of the longest remaining life bonds of 8% coupon rate.[4] The call and discount rate (rc) is calculated as a weighted average of the rates of the overnight (or the seven-days) call, the unconditional call and the two-month-period bills.

All the institutions' average contracted interest rates on loans and discounts gathered from the BOJ's *Economic Statistics Annual* are used as the loan rates. Among these rates, the "general" rates are used for the city banks, the regional banks, the mutual loan and savings banks and the credit associations. The "long-term" loans rates are used for the trust banks and the long-term credit banks.

The data for financial institutions of agriculture, forestry and fishery, except for yearly data of the credit federations of agricultural cooperatives' loan yields is not available. Because the yields of these federations move similarly with the "long-term" loans rates of the mutual loan and savings banks, the federations' loan rates are estimated as follows and are used as a proxy of the loan rates of the financial institutions for agriculture, forestry and fishery.

$$\left(\begin{array}{l}\text{quarterly loan rates of the}\\ \text{mutual loan and savings bank}\end{array}\right) \times \frac{\left(\begin{array}{l}\text{yearly loan yields of the credit}\\ \text{federations of}\\ \text{agricultural cooperatives}\end{array}\right)}{\left(\begin{array}{l}\text{yearly average loan rates of the}\\ \text{mutual loan}\\ \text{and savings bank}\end{array}\right)}$$

The loan rates data of the life insurance companies are collected from the *Life Insurance Statistics Quarterly*.

The effective loan rates of the city banks, the regional banks, the trust banks, the long-term credit banks, the mutual loan and savings banks and the credit associations are estimated as follows. That of mth institution group $rlem$ is

$$rlem = \frac{rlm - \Omega \cdot rdm}{1 - \Omega},$$

where Ω is the deposit yield rate and rdm is the interest rate of a three-month time deposit. The data of Ω are picked from the MOF's *Survey of Compensatory Deposits* and the Fair Trade Commission's *Actual State of Compensatory Deposits*.

The empirical estimation results of equations (13), (18) and (22) are (25)-(38). These results show that $(1-\eta_i)$'s of the government bond market and the call and bills market are not significantly different from zero, but those of the loan markets are significantly different from zero and of a positive nature. Therefore, the government bonds market and

[4] The yields data used in this paper are the actual values. The expected values are not used but should be investigated. About the relationship between the two value, see Masson [6], p. 367.

the call and bills market are judged to be in equilibrium while the loan markets of all institution groups are not in equilibrium.

(25) $$\begin{aligned} rb = {} & \underset{(1.02)}{4.686} + \underset{(0.02)}{0.005633}\, rb_{-1} + \underset{(0.23)}{0.002432}\, BEND \\ & + \underset{(0.20)}{0.08061}\, rl1 + \underset{(1.51)}{0.2077}\, rc - \underset{(-0.88)}{0.007604}\, W1 \\ & + \underset{(3.72)}{0.07857}\, B1_{-1} + \underset{(0.52)}{0.005086}\, NC1_{-1} + \underset{(0.34)}{0.003441}\, L1_{-1} \\ & \bar{R}^2 = 0.7685,\ SSR = 1.798,\ SE = 0.3462,\ DW = 2.21 \end{aligned}$$

(26) $$\begin{aligned} rb = {} & \underset{(0.12)}{0.5797} - \underset{(-0.26)}{0.05736}\, rb_{-1} - \underset{(-0.45)}{0.004391}\, BEND \\ & + \underset{(1.20)}{0.2988}\, rle1 + \underset{(1.35)}{0.1392}\, rc - \underset{(-1.11)}{0.009338}\, W1 \\ & + \underset{(4.28)}{0.09012}\, B1_{-1} + \underset{(0.17)}{0.001731}\, NC1_{-1} + \underset{(0.98)}{0.01010}\, L1_{-1} \\ & \bar{R}^2 = 0.7882,\ SSR = 1.644,\ SE = 0.3311,\ DW = 2.14 \end{aligned}$$

(27) $$\begin{aligned} rc = {} & -\underset{(-5.41)}{17.78} - \underset{(-1.67)}{0.4600}\, rc_{-1} + \underset{(1.88)}{0.8668}\, rb + \underset{(1.49)}{0.02989}\, NCEX \\ & + \underset{(3.89)}{2.590}\, rl1 - \underset{(-0.40)}{0.008383}\, W1 - \underset{(-1.39)}{0.06917}\, B1_{-1} \\ & - \underset{(-1.73)}{0.02992}\, NC1_{-1} + \underset{(0.69)}{0.01461}\, L1_{-1} \\ & \bar{R}^2 = 0.9174,\ SSR = 6.231,\ SE = 0.6445,\ DW = 1.07 \end{aligned}$$

(28) $$\begin{aligned} rc = {} & -\underset{(-2.91)}{16.32} + \underset{(0.55)}{0.1689}\, rc_{-1} + \underset{(2.02)}{1.277}\, rb + \underset{(0.56)}{0.01509}\, NCEX \\ & + \underset{(1.25)}{0.8139}\, rle1 - \underset{(-0.44)}{0.01278}\, W1 - \underset{(-0.92)}{0.06561}\, B1_{-1} \\ & - \underset{(-1.61)}{0.03845}\, NC1_{-1} + \underset{(0.67)}{p.02001}\, L1_{-1} \\ & \bar{R}^2 = 0.8499,\ SSR = 11.32,\ SE = 0.8688,\ DW = 1.38 \end{aligned}$$

(29) $$\begin{aligned} rl1 = {} & \underset{(2.86)}{3.652} + \underset{(7.76)}{0.4835}\, rl1_{-1} + \underset{(1.76)}{0.007006}\, W1 - \underset{(-0.49)}{0.0004132}\, S \\ & + \underset{(1.43)}{0.06348}\, rcd - \underset{(-1.27)}{0.1424}\, rb + \underset{(4.21)}{0.2228}\, rc \\ & + \underset{(0.62)}{0.008003}\, B1_{-1} + \underset{(0.32)}{0.001251}\, NC1_{-1} - \underset{(-2.12)}{0.007836}\, L1_{-1} \\ & \bar{R}^2 = 0.9822,\ SSR = 0.2355,\ SE = 0.1297,\ DW = 1.90 \end{aligned}$$

(30) $$\begin{aligned} rle1 = {} & \underset{(1.80)}{4.383} + \underset{(5.16)}{0.5353}\, rle1_{-1} + \underset{(0.96)}{0.007273}\, W1 + \underset{(0.42)}{0.0006693}\, S \\ & + \underset{(0.69)}{0.05847}\, rcd + \underset{(0.18)}{0.04013}\, rb + \underset{(1.52)}{0.1526}\, rc \\ & - \underset{(-0.97)}{0.02397}\, B1_{-1} + \underset{(0.41)}{0.003113}\, NC1_{-1} - \underset{(-1.31)}{0.009362}\, L1_{-1} \\ & \bar{R}^2 = 0.9516,\ SSR = 0.8521,\ SE = 0.2467,\ DW = 2.57 \end{aligned}$$

$$(31)\quad rl2=\underset{(1.25)}{1.986}+\underset{(8.88)}{0.6009}\, rl2_{-1}-\underset{(-0.75)}{0.002489}\, W2+\underset{(0.64)}{0.0005467}\, S$$
$$+\underset{(0.18)}{0.007368}\, rcd-\underset{(-0.46)}{0.05624}\, rb+\underset{(3.56)}{0.1580}\, rc$$
$$+\underset{(0.13)}{0.002217}\, B2_{-1}+\underset{(0.68)}{0.004858}\, NC2_{-1}+\underset{(0.27)}{0.0008107}\, L2_{-1}$$
$\bar{R}^2=0.9733$, $SSR=0.2169$, $SE=0.1245$, $DW=2.19$

$$(32)\quad rle2=\underset{(0.09)}{0.2483}+\underset{(7.13)}{0.7656}\, rle2_{-1}-\underset{(-1.02)}{0.005874}\, W2+\underset{(1.13)}{0.001677}\, S$$
$$-\underset{(-0.20)}{0.01408}\, rcd-\underset{(-0.01)}{0.001586}\, rb+\underset{(1.44)}{0.1102}\, rc$$
$$-\underset{(-0.70)}{0.02038}\, B2_{-1}+\underset{(0.77)}{0.009465}\, NC2_{-1}+\underset{(0.94)}{0.004866}\, L2_{-1}$$
$\bar{R}^2=0.9296$, $SSR=0.6402$, $SE=0.2138$, $DW=2.80$

$$(33)\quad rl3=\underset{(2.58)}{4.666}+\underset{(5.33)}{0.5157}\, rl3_{-1}+\underset{(3.74)}{0.008600}\, W3+\underset{(2.49)}{0.0005100}\, S$$
$$-\underset{(-0.31)}{0.005516}\, rcd-\underset{(-1.18)}{0.04683}\, rb+\underset{(3.77)}{0.06953}\, rc$$
$$-\underset{(-0.12)}{0.0006241}\, B3_{-1}+\underset{(0.44)}{0.002647}\, NC3_{-1}-\underset{(-3.12)}{0.01423}\, L3_{-1}$$
$\bar{R}^2=0.9593$, $SSR=0.04330$, $SE=0.05562$, $DW=2.14$

$$(34)\quad rle3=\underset{(0.72)}{1.855}+\underset{(5.05)}{0.7164}\, rle3_{-1}+\underset{(2.05)}{0.007230}\, W3+\underset{(2.90)}{0.007632}\, S$$
$$-\underset{(-1.21)}{0.03246}\, rcd+\underset{(0.12)}{0.006634}\, rb+\underset{(-1.73)}{0.04744}\, rc$$
$$-\underset{(-1.01)}{0.006992}\, B3_{-1}+\underset{(0.26)}{0.002078}\, NC3_{-1}-\underset{(-1.41)}{0.009305}\, L3_{-1}$$
$\bar{R}^2=0.8056$, $SSR=0.09468$, $SE=0.08224$, $DW=2.56$

$$(35)\quad rl4=\underset{(2.19)}{1.648}+\underset{(12.09)}{0.7450}\, rl4_{-1}-\underset{(-0.52)}{0.002720}\, W4+\underset{(0.52)}{0.0005254}\, S$$
$$+\underset{(0.25)}{0.007339}\, rcd-\underset{(-1.21)}{0.08702}\, rb+\underset{(2.74)}{0.1118}\, rc$$
$$-\underset{(-0.09)}{0.001232}\, B4_{-1}+\underset{(0.47)}{0.004294}\, NC4_{-1}+\underset{(0.45)}{0.001566}\, L4_{-1}$$
$\bar{R}^2=0.9753$, $SSR=0.1234$, $SE=0.09389$, $DW=2.58$

$$(36)\quad rle4=\underset{(0.06)}{0.1069}+\underset{(6.61)}{0.8301}\, rle4_{-1}-\underset{(-1.05)}{0.01211}\, W4+\underset{(1.58)}{0.003499}\, S$$
$$-\underset{(-0.04)}{0.002537}\, rcd+\underset{(0.01)}{0.001944}\, rb-\underset{(-0.38)}{0.03342}\, rc$$
$$-\underset{(-1.90)}{0.05500}\, B4_{-1}-\underset{(-1.78)}{0.03305}\, NC4_{-1}+\underset{(1.21)}{0.009383}\, L4_{-1}$$
$\bar{R}^2=0.9008$, $SSR=0.5675$, $SE=0.2013$, $DW=2.74$

$$(37)\quad rl5=\underset{(1.44)}{1.974}+\underset{(4.52)}{0.5925}\, rl5_{-1}+\underset{(0.09)}{0.0006611}\, W5+\underset{(1.38)}{0.0006546}\, S$$

$$+0.02638\ rcd - 0.1649\ rb + 0.07042\ rc$$
$$(0.91) \quad (-2.09) \quad (2.42)$$
$$-0.01651\ B5_{-1} - 0.009899\ NC5_{-1} + 0.006624\ L5_{-1}$$
$$(-1.62) \quad (-1.14) \quad (1.00)$$
$$\bar{R}^2=0.9446,\ SSR=0.1190,\ SE=0.09219,\ DW=2.30$$

(38) $$rl6=3.285+0.4226\ rl6_{-1} - 0.01461\ W6 + 0.0007272\ S$$
$$(4.62) \quad (3.77) \quad (-0.90) \quad (2.04)$$
$$-0.003781\ rcd - 0.02420\ rb + 0.05813\ rc$$
$$(-0.17) \quad (-0.52) \quad (2.44)$$
$$-0.01970\ B6_{-1} + 0.04551\ NC6_{-1} + 0.01667\ L6_{-1}$$
$$(-0.87) \quad (0.90) \quad (1.07)$$
$$\bar{R}^2=0.9573,\ SSR=0.06997,\ SE=0.07069,\ DW=1.91$$

V. *New Specification*

Because the loan markets are in disequilibrium, the actual asset holding functions are specified as follows, taking into account the spill-over effect. Equation (39) shows the adjustment of government bonds and call and bills holding. ESm_t, which is defined in equation (40), denotes the difference between mth institution's effective loan supply and the actual loan. Following the short-side hypothesis, the actual loan amount is equal to the loan demand, if the market is in excess supply, and consequently ESm_t implies this excess supply amount. Dm_t is a dummy variable and is equal to one if the mth institution's loan market is in excess supply. $\sigma_{ij}{}^m$ is a parameter showing the market's adjustment speed.

(39) $$\Delta Am_{it}=\sum_{j=1}^{3}\sigma_{ij}{}^m(Am_{jt}{}^* - Am_{j,t-1}) + \pi_i{}^m Dm_t \cdot ESm_t,$$
$$i=1,2;\ m=1,\dots,6$$

(40) $$ESm_t \equiv Lm_t{}^e - Lm_t$$

(41) $$\pi_1{}^m>0,\quad \pi_2{}^m>0$$

(42) $$\Delta Lm_t + Dm_t \cdot ESm_t = \sum_j \sigma_{3j}{}^m (Am_{jt}{}^* - Am_{j,t-1})$$

(43) $$\Delta Lm_t + Dm_t \cdot ESm_t \begin{cases} =(Lm_t - Lm_{t-1}) + (Lm_t{}^e - Lm_t) = Lm_t{}^e - Lm_{t-1}, & [\text{if } Dm_t=1] \\ =Lm_t - Lm_{t-1} = Lm_t{}^e - Lm_{t-1}, & [\text{if } Dm_t=0] \end{cases}$$

Equation (42) shows the adjustment process of loan holding. As equation (43) shows, (42) is deduced from equation (2) and $\sigma_{3j}{}^m$ is equal to $\theta_{3j}{}^m$. But $\sigma_{1j}{}^m$ and $\sigma_{2j}{}^m$ are not always equal to $\theta_{1j}{}^m$ and $\theta_{2j}{}^m$ respectively, where $\sum_{i=1}^{3}\sigma_{ij}{}^m=1$ does not always hold. $\pi_1{}^m$ and $\pi_2{}^m$ are expected to be positive.

Equations (44)–(46) are gained from equations (1), (39) and (42). Simultaneous equations consisting of these three equations and equations (4), (11) and (16) are estimated in the next section.

$$(44)\quad Bm_t = \sum_{i=1}^{3} \sigma_{1i}{}^m \alpha_i{}^m Wm_t + \sum_i \sigma_{1i}{}^m \beta_i{}^m rb_t + \sum_i \sigma_{1i}{}^m \gamma_i{}^m rc_t + \sum_i \sigma_{1i}{}^m \delta_i{}^m rlm_t$$
$$+ \sum_i \sigma_{1i}{}^m c_i{}^m + (1-\sigma_{11}{}^m) Bm_{t-1} - \sigma_{12}{}^m NCm_{t-1} - \sigma_{13}{}^m Lm_{t-1} + \pi_1{}^m Dm_t \cdot ESm_t$$

$$(45)\quad NCm_t = \sum_i \sigma_{2i}{}^m \alpha_i{}^m Wm_t + \sum_i \sigma_{2i}{}^m \beta_i{}^m rb_t + \sum_i \sigma_{2i}{}^m \gamma_i{}^m rc_t + \sum_i \sigma_{2i}{}^m \delta_i{}^m rlm_t$$
$$+ \sum_i \sigma_{2i}{}^m c_i{}^m - \sigma_{21}{}^m Bm_{t-1} + (1-\sigma_{22}{}^m) NCm_{t-1} - \sigma_{23}{}^m Lm_{t-1} + \pi_2{}^m Dm_t \cdot ESm_t$$

$$(46)\quad Lm_t + Dm_t \cdot ESm_t = \sum_i \sigma_{3i}{}^m \alpha_i{}^m Wm_t + \sum_i \sigma_{3i}{}^m \beta_i{}^m rb_t + \sum_i \sigma_{3i}{}^m \gamma_i{}^m rc_t$$
$$+ \sum_i \sigma_{3i}{}^m \delta_i{}^m rlm_t + \sum_i \sigma_{3i}{}^m c_i{}^m - \sigma_{31}{}^m Bm_{t-1} - \sigma_{32}{}^m NCm_{t-1} + (1-\sigma_{33}{}^m) Lm_{t-1}$$

VI. *Estimation*

In this section, the six institution groups' amounts of excess supply of loans are gained through estimation, and the asset holding functions are measured in order to calculate the equilibrium yields of government bonds and also those of the call and bills.

The amounts of excess supply of loans by the six institution groups are estimated as follows. Whether the loan market of a certain period is in equilibrium or not is assumed to be a common factor in all six markets. This is judged using the fund position diffusion indexes of the BOJ's *Short-Term Economic Survey of Enterprises*. If the proportion of the *Survey*'s replies of "Easy" is greater (or smaller) than those of "Tight," the market is judged to be in excess supply (or demand). According to these indexes, periods which are judged to be in excess supply are from 1978II to 1979IV and from 1981IV to 1984I. Those judged to be in excess demand are from 1980II to 1981III and that judged to be in equilibrium is 1980I. The loan amounts which are observed in these excess demand periods and in equilibrium periods are both equal to the effective loan supplies because of the short-side hypothesis. These data are used to estimate equation (7) or similar equations. Using these estimated coefficients and the value of independent variables, the amounts of effective loan supplies are obtained.

Because the data of Bm_t, NCm_t, Lm_t and Wm_t may have multicollinearity, measurement using the pooling method will be tried. First, equation (47) is measured by means of the individual institutions' cross-sectional data, where the subscript k denotes kth institution. The coefficients of the left-hand sides of equations (48), (49) and (50) are gained from the estimation results of equation (47), and the left-hand sides' time-series values of equations (48), (49) and (51) are calculated. Then, using these values the simultaneous equations system which consists of equations (4), (11), (16), (48), (49) and (51) are measured.

$$(47)\quad Am_{jtk} = \kappa_j{}^m Bm_{t-4,k} + \lambda_j{}^m NCm_{t-4,k} + \mu_j{}^m Lm_{t-4,k} + \nu_j{}^m Wm_{tk}, \quad j=1,2,3$$

$$(48)\quad Bm_t - (1-\sigma_{11}{}^m) Bm_{t-4} + \sigma_{12}{}^m NCm_{t-4} + \sigma_{13}{}^m Lm_{t-4} - \sum_i \sigma_{1i}{}^m \alpha_i{}^m Wm_t$$
$$= \sum_i \sigma_{1i}{}^m \beta_i{}^m rb_t + \sum_i \sigma_{1i}{}^m \gamma_i{}^m rc_t + \sum_i \sigma_{1i}{}^m \delta_i{}^m rlm_t + \sum_i \sigma_{1i}{}^m c_i{}^m + \pi_1{}^m Dm_t \cdot ESm_t$$

(49) $NCm_t+\sigma_{21}{}^m Bm_{t-4}-(1-\sigma_{22}{}^m)NCm_{t-4}+\sigma_{23}Lm_{t-4}-\sum_i \sigma_{2i}{}^m\alpha_i{}^m Wm_t$

$=\sum_i \sigma_{2i}{}^m\beta_i{}^m rb_t+\sum_i \sigma_{2i}{}^m\gamma_i{}^m rc_t+\sum_i \sigma_{2i}{}^m\delta_i{}^m rlm_t+\sum_i \sigma_{2i}c_i{}^m+\pi_2{}^m Dm_t\cdot ESm_t$

(50) $Lm_t+\sigma_{31}{}^m Bm_{t-4}+\sigma_{32}{}^m NCm_{t-4}-(1-\sigma_{33}{}^m)Lm_{t-4}-\sum_i \sigma_{3i}{}^m\alpha_i{}^m Wm_t$

$=\sum_i \sigma_{3i}{}^m\beta_i{}^m rb_t+\sum_i \sigma_{3i}{}^m\gamma_i{}^m rc_t+\sum_i \sigma_{3i}{}^m\delta_i{}^m rlm_t+\sum_i \sigma_{3i}{}^m c_i{}^m-Dm_i\cdot ESm_t$

(51) $Lm_t+Dm_t\cdot ESm_t+\sigma_{31}{}^m Bm_{t-4}+\sigma_{32}{}^m NCm_{t-4}-(1-\sigma_{33}{}^m)Lm_{t-4}-\sum_i \sigma_{3i}{}^m\alpha_i{}^m Wm_t$

$=\sum_i \sigma_{3i}{}^m\beta_i rb_t+\sum_i \sigma_{3i}{}^m\gamma_i{}^m rc_t+\sum_i \sigma_{3i}{}^m\delta_i{}^m rlm_t+\sum_i \sigma_{3i}{}^m c_i{}^m$

The data used in the cross-sectional estimation are collected from the *Analysis of Financial Statements of All Banks* published by the Federation of Bankers Association of Japan and the *Financial Statements* of the mutual loan and savings banks. The estimation results of equation (47) are from (52) to (66).

(52) $B1=0.4212\ B1_{-4}-0.1663\ NC1_{-4}-0.04834\ L1_{-4}+0.06650\ W1$
(3.63)** (−3.94)** (−1.54)* (2.36)**
$\bar{R}^2=0.9660$, $SSR=505499$, $SE=82.65$

(53) $NC1=-0.8659\ B1_{-4}+0.3562\ NC1_{-4}-0.5306\ L1_{-4}+0.4841\ W1$
(−3.99)** (4.53)** (−9.05)** (9.21)**
$\bar{R}^2=0.9452$, $SSR=1760350$, $SE=154.2$

(54) $L1=0.4447\ B1_{-4}-0.1899\ NC1_{-4}+0.5790\ L1_{-4}+0.4494\ W1$
(2.39)** (−2.82)** (11.53)** (9.97)**
$\bar{R}^2=0.9997$, $SSR=1292640$, $SE=132.2$

(55) $B2=0.8100\ B2_{-4}+0.001253\ NC2_{-4}-0.04612\ L2_{-4}+0.06270\ W2$
(21.60)** (0.10) (−2.69)** (4.13)**
$\bar{R}^2=0.9784$, $SSR=69125345173$, $SE=13595$

(56) $NC2=-0.6343\ B2_{-4}+0.1487\ NC2_{-4}-0.6997\ L2_{-4}+0.6354\ W2$
(−9.45)** (6.59)** (−22.76)** (23.37)**
$\bar{R}^2=0.8408$, $SSR=221468479237$, $SE=24334$

(57) $L2=-0.1757\ B2_{-4}-0.1499\ NC2_{-4}+0.7458\ L2_{-4}+0.3019\ W2$
(−2.84)** (−7.22)** (26.37)** (12.07)**
$\bar{R}^2=0.9994$, $SSR=187494985064$, $SE=22390$

(58) $B3=0.7143\ B3_{-4}+0.1171\ NC3_{-4}-0.4509\ L3_{-4}+0.4085\ W3$
(6.64)** (0.90) (−5.60)** (5.51)**
$\bar{R}^2=0.9875$, $SSR=509059$, $SE=95.34$

(59) $NC3=-0.4760\ B3_{-4}+0.4037\ NC3_{-4}-0.3871\ L3_{-4}+0.3518\ W3$
(−4.99)** (3.48)** (−5.41)** (5.34)**
$\bar{R}^2=0.7149$, $SSR=400929$, $SE=84.61$

(60) $L3=-0.2383\ B3_{-4}-0.5208\ NC3_{-4}+0.8381\ L3_{-4}+0.2396\ W3$
(−2.32)** (−4.18)** (10.90)** (3.39)**
$\bar{R}^2=0.9997$, $SSR=463418$, $SE=90.97$

(61) $B4=0.9357\,B4_{-4}+0.04765\,NC4_{-4}-0.007261\,L4_{-4}+0.01403\,W4$
(22.03)** (1.59)* (−2.13)** (4.82)**
$\bar{R}^2=0.9554$, $SSR=4199$, $SE=4.885$

(62) $NC4=0.1566\,B4_{-4}+0.7139\,NC4_{-4}+0.01179\,L4_{-4}-0.004697\,W4$
(1 90)** (12.34)** (1.78)** (−0.83)
$\bar{R}^2=0.7876$, $SSR=15813$, $SE=9.479$

(63) $L4=-1.092\,B4_{-4}-0.7615\,NC4_{-4}-0.004529\,L4_{-4}+0.9907\,W4$
(−11.33)** (−11.16)** (−0.59) (149.99)**
$\bar{R}^2=0.9995$, $SSR=21646$, $SE=11.09$

(64) $B6=1.261\,B6_{-4}-0.2535\,NC6_{-4}-0.1136\,L6_{-4}+0.1109\,W6$
(11.94)** (−0.81) (1.48)* (1.64)*
$\bar{R}^2=0.8921$, $SSR=82610$, $SE=26.69$

(65) $NC6=-0.1132\,B6_{-4}+0.5515\,NC6_{-4}-0.08834\,L6_{-4}+0.08023\,W6$
(−4.78)** (7.82)** (−5.14)** (5.29)**
$\bar{R}^2=0.6670$, $SSR=4157$, $SE=5.987$

(66) $L6=-1.148\,B6_{-4}-0.2980\,NC6_{-4}+0.2019\,L6_{-4}+0.8089\,W6$
(−11.12)** (−0.97) (2.69)** (12.25)**
$\bar{R}^2=0.9996$, $SSR=79014$, $SE=26.10$

(67)–(84) show the two-stage least squares (TSLS) estimation results of equations (44), (45) and (46). (85)–(99) and (100)–(117) show the TSLS estimation results of (48), (49) and (51) using the cross-sectional results, (47)–(66). The financial institutions for agriculture, forestry and fisheries are treated as an exogenous sector in (85)–(99), and as endogenous sector in (100)–(117).

(67) $B1=-3.659+0.02105\,W1-0.4798\,rb-2.798\,rc+6.854\,rl1$
(−0.14) (0.20) (−0.14) (−1.80)** (1.84)**
$+0.4183\,B1_{-1}-0.1406\,NC1_{-1}-0.02287\,L1_{-1}+0.1680\,D{\cdot}ES1$
(1.27) (−1.40)* (−0.22) (1.45)*
$\bar{R}^2=0.6898$, $SSR=178.9$, $SE=3.454$

(68) $NC1=-54.47+0.5900\,W1+3.255\,rb-1.700\,rc+4.409\,rl1$
(−1.77)** (4.67)** (0.80) (−0.92) (1.00)
$-0.6141\,B1_{-1}+0.04787\,NC1_{-1}-0.6241\,L1_{-1}+0.2697\,D{\cdot}ES1$
(−1.57)* (0.40) (−4.93)** (1.96)**
$\bar{R}^2=0.9001$, $SSR=252.7$, $SE=4.105$

(69) $L1+D{\cdot}ES1=79.76+0.7034\,W1+2.503\,rb+7.800\,rc$
(1.68)* (4.47)** (0.41) (2.99)**
$-23.72\,rl1-0.3695\,B1_{-1}+0.1609\,NC1_{-1}+0.3841\,L1_{-1}$
(−4.70)** (−0.64) (0.86) (2.25)**
$\bar{R}^2=0.9976$, $SSR=665.3$, $SE=6.448$

(70) $B2=-102.0+0.1889\,W2+3.479\,rb-2.952\,rc+9.157\,rl2$
(−3.12)** (2.54)** (1.41)* (−2.68)** (3.43)**
$-0.3838\,B2_{-1}+0.1921\,NC2_{-1}-0.02884\,L2_{-1}+0.005677\,D{\cdot}ES2$
(−1.09) (1.19) (−0.42) (0.04)
$\bar{R}^2=0.9508$, $SSR=127.3$, $SE=2.913$

(71) $NC2=-69.39+0.1381\,W2+6.889\,rb-2.428\,rc+6.016\,rl2$
$\quad(-1.36)^{*}\quad(1.19)\quad(1.79)^{**}\quad(-1.42)^{*}\quad(1.45)^{*}$
$\quad-0.4627\,B2_{-1}+0.06578\,NC2_{-1}-0.1163\,L2_{-1}+0.6741\,D{\cdot}ES2$
$\quad(-0.84)\quad(0.26)\quad(-1.08)\quad(3.11)^{**}$
$\quad\bar{R}^2=0.6112,\quad SSR=308.3,\quad SE=4.533$

(72) $L2+D{\cdot}ES2=181.4+0.7416\,W2-11.58\,rb+5.830\,rc$
$\quad(2.46)^{**}\quad(4.78)^{**}\quad(-2.11)^{**}\quad(2.37)^{**}$
$\quad-17.72rl2+0.7587\,B2_{-1}-0.3483\,NC2_{-1}+0.1165\,L2_{-1}$
$\quad(-3.21)^{**}\quad(0.95)\quad(-0.98)\quad(0.75)$
$\quad\bar{R}^2=0.9935,\quad SSR=702.1,\quad SE=6.625$

(73) $B3=-137.0+0.5007\,W3-0.9158\,rb-0.2913\,rc+10.09\,rl3$
$\quad(-2.68)^{**}\quad(5.80)^{**}\quad(-1.00)\quad(-0.61)\quad(2.49)^{**}$
$\quad+0.1592\,B3_{-1}-0.06990\,NC3_{-1}-0.3021\,L3_{-1}+0.2701\,D{\cdot}ES3$
$\quad(1.13)\quad(-0.46)\quad(-1.98)^{**}\quad(0.74)$
$\quad\bar{R}^2=0.9979,\quad SSR=42.59,\quad SE=1.685$

(74) $NC3=90.86+0.4338\,W3+0.6813\,rb-0.03188\,rc-2.840\,rl3$
$\quad(1.75)^{*}\quad(4.97)^{**}\quad(0.74)\quad(-0.07)\quad(-0.69)$
$\quad-0.2117\,B3_{-1}+0.1928\,NC3_{-1}-0.6605\,L3_{-1}+0.8001\,D{\cdot}ES3$
$\quad(-1.48)^{*}\quad(1.25)\quad(-4.27)^{**}\quad(2.15)^{**}$
$\quad\bar{R}^2=0.9058,\quad SSR=43.56,\quad SE=1.704$

(75) $L3+D{\cdot}ES3=43.36+0.07004\,W3+0.2320\,rb+0.2888\,rc$
$\quad(6.26)^{**}\quad(6.02)^{**}\quad(1.80)^{**}\quad(4.57)^{**}$
$\quad-6.816\,rl3+0.04327\,B3_{-1}-0.1206\,NC3_{-1}+0.9571\,L3_{-1}$
$\quad(-14.39)^{**}\quad(2.32)^{**}\quad(-5.65)^{**}\quad(45.34)^{**}$
$\quad\bar{R}^2=0.99999,\quad SSR=0.9023,\quad SE=0.2375$

(76) $B4=-29.37+0.04439\,W4-0.1166\,rb-0.8055\,rc+1.415\,rl4$
$\quad(-2.79)^{**}\quad(0.81)\quad(-0.11)\quad(-2.16)^{**}\quad(1.70)^{*}$
$\quad+0.2997\,B4_{-1}-0.1313\,NC4_{-1}+0.04395\,L4_{-1}-0.1293\,D{\cdot}ES4$
$\quad(1.20)\quad(-1.10)\quad(1.03)\quad(-1.43)^{*}$
$\quad\bar{R}^2=0.9747,\quad SSR=35.11,\quad SE=1.530$

(77) $NC4=-41.18+0.2452\,W4+0.4073\,rb-1.587\,rc+3.432\,rl4$
$\quad(-1.88)^{**}\quad(2.16)^{**}\quad(0.18)\quad(-2.05)^{**}\quad(1.99)^{**}$
$\quad-1.033\,B4_{-1}+0.2354\,NC4_{-1}-0.1468\,L4_{-1}-0.1759\,D{\cdot}ES4$
$\quad(-2.00)^{**}\quad(0.95)\quad(-1.65)^{*}\quad(-0.94)$
$\quad\bar{R}^2=0.2405,\quad SSR=151.2,\quad SE=3.175$

(78) $L4+D{\cdot}ES4=20.89+1.202\,W4-2.358\,rb+1.329\,rc$
$\quad(0.50)\quad(6.69)^{**}\quad(-0.54)\quad(0.87)$
$\quad-7.665\,rl4-1.063\,B4_{-1}+0.01511\,NC4_{-1}-0.1485\,L4_{-1}$
$\quad(-2.27)^{**}\quad(-1.18)\quad(0.03)\quad(-0.91)$
$\quad\bar{R}^2=0.9935,\quad SSR=653.7,\quad SE=6.392$

(79) $B5=-72.10+0.3915\,W5-0.2973\,rb+1.097\,rc+1.458\,rl5$
$\quad(-1.84)^{**}\quad(1.94)^{**}\quad(-0.14)\quad(1.43)^{*}\quad(0.28)$
$\quad-0.01867\,B5_{-1}+0.07679\,NC5_{-1}-0.02024\,L5_{-1}+0.2161\,D{\cdot}ES5$
$\quad(-0.06)\quad(0.27)\quad(-0.10)\quad(0.93)$
$\quad\bar{R}^2=0.9794,\quad SSR=118.8,\quad SE=2.814$

(80) $NC5=62.07+0.1673\ W5+0.2070\ rb-1.747\ rc-2.546\ rl5$
$\quad (1.73)^{*} \quad (0.91) \quad (0.11) \quad (-2.48)^{**} \quad (-0.53)$
$\quad +0.09981\ B5_{-1}+0.05642\ NC5_{-1}-0.3429\ L5_{-1}+0.7441\ D{\bullet}ES5$
$\quad (0.33) \quad (0.22) \quad (-1.80)^{**} \quad (3.51)^{**}$
$\bar{R}^2=0.8800, \quad SSR=99.69, \quad SE=2.578$

(81) $L5+D{\bullet}ES5=10.49+0.4471\ W5+0.04390\ rb+0.6898\ rc$
$\quad (0.80) \quad (6.80)^{**} \quad (0.06) \quad (2.92)^{**}$
$\quad +0.7952\ rl5-0.09252\ B5_{-1}-0.1404\ NC5_{-1}+0.3680\ L5_{-1}$
$\quad (0.50) \quad (-0.86) \quad (-1.52)^{*} \quad (5.48)^{**}$
$\bar{R}^2=0.9990, \quad SSR=13.54, \quad SE=0.9199$

(82) $B6=29.67+0.5386\ W6-1.083\ rb+0.2575\ rc-4.428\ rl6$
$\quad (5.59)^{**} \quad (6.71)^{**} \quad (-6.13)^{**} \quad (3.25)^{**} \quad (-5.24)^{**}$
$\quad -0.008341\ B6_{-1}+0.3837\ NC6_{-1}-0.4553\ L6_{-1}+0.7877\ D{\bullet}ES6$
$\quad (-0.07) \quad (1.55)^{*} \quad (-5.77)^{**} \quad (8.06)^{**}$
$\bar{R}^2=0.9945, \quad SSR=1.865, \quad SE=0.3526$

(83) $NC6=-7.739+0.09336\ W6+0.09858\ rb-0.0002432\ rc$
$\quad (-1.53)^{*} \quad (1.22) \quad (0.58) \quad (-0.03)$
$\quad +1.090\ rl6-0.1501\ B6_{-1}-0.2663\ NC6_{-1}-0.09646\ L6_{-1}$
$\quad (1.35)^{*} \quad (-1.23) \quad (-1.13) \quad (-1.28)$
$\quad +0.1594\ D{\bullet}ES6$
$\quad (1.71)^{*}$
$\bar{R}^2=0.5629, \quad SSR=1.697, \quad SE=0.3364$

(84) $L6+D{\bullet}ES6=-22.32+0.3596\ W6+0.9683\ rb-0.2576\ rc$
$\quad (-8.72)^{**} \quad (9.50)^{**} \quad (11.1)^{**} \quad (-6.65)^{**}$
$\quad +3.426 rl6+0.1738\ B6_{-1}-0.1216\ NC6_{-1}+0.5591\ L6_{-1}$
$\quad (8.46)^{**} \quad (2.89)^{**} \quad (-1.01) \quad (14.9)^{**}$
$\bar{R}^2=0.99997, \quad SSR=0.4737, \quad SE=0.1721$

(85) $B1{*}$
$=21.86-0.1452\ D{\bullet}ES1-1.798\ rb-2.407\ rc+2.350\ rl1$
$\quad (1.26) \quad (-2.42)^{**} \quad (-0.77) \quad (-2.93)^{**} \quad (1.24)$
$\bar{R}^2=0.4481, \quad SSR=206.5, \quad SE=3.593$

(86) $NC1{*}$
$=-88.04+0.1703\ D{\bullet}ES1+6.674\ rb+0.7710\ rc+5.033\ rl1$
$\quad (-5.93)^{**} \quad (3.32)^{**} \quad (3.36)^{**} \quad (1.10) \quad (3.10)^{**}$
$\bar{R}^2=0.8560, \quad SSR=151.13, \quad SE=3.073$

(87) $L1{*}+D{\bullet}ES1$
$=180.1-17.46\ rb-0.4437\ rc-5.106\ rl1$
$(2.67)^{**} \quad (-1.88)^{**} \quad (-0.13) \quad (-0.63)$
$\bar{R}^2=0.3582, \quad SSR=3965.4, \quad SE=15.27$

(88) $B2{*}$
$=28.96-0.3201\ D{\bullet}ES2-6.856\ rb-0.8342\ rc+4.914\ rl2$
$\quad (1.28) \quad (-2.98)^{**} \quad (-2.51)^{**} \quad (-1.17) \quad (2.48)^{**}$
$\bar{R}^2=0.3755, \quad SSR=216.8, \quad SE=3.681$

(89) $NC2*$
$= -59.96 + 0.3720\ D{\cdot}ES2 + 6.385\ rb + 0.3834\ rc + 0.5060\ rl2$
$(-2.78)^{**}\ (3.62)^{**}\quad (2.44)^{**}\quad (0.56)\quad (0.27)$
$\bar{R}^2 = 0.3178,\quad SSR = 198.2,\quad SE = 3.519$

(90) $L2* + D{\cdot}ES2$
$= 164.32 - 13.12\ rb + 0.8121\ rc - 7.830\ rl2$
$(3.91)^{**}\ (-2.31)^{**}\quad (0.46)\quad (-1.59)^{*}$
$\bar{R}^2 = 0.4796,\quad SSR = 1454.6,\quad SE = 9.250$

(91) $B3*$
$= -81.57 - 0.2877\ D{\cdot}ES3 + 0.6159\ rb + 0.0473\ rc + 10.11\ rl3$
$(-2.61)^{**}\ (-0.91)\quad (0.26)\quad (0.08)\quad (2.61)^{**}$
$\bar{R}^2 = 0.4091,\quad SSR = 177.5,\quad SE = 3.330$

(92) $NC3*$
$= 81.86 - 0.2987\ D{\cdot}ES3 + 0.3906\ rb + 0.1738\ rc - 10.22\ rl3$
$(3.35)^{**}\ (-1.22)\quad (0.22)\quad (0.40)\quad (-3.40)^{**}$
$\bar{R}^2 = 0.3988,\quad SSR = 106.7,\quad SE = 2.582$

(93) $L3* + D{\cdot}ES3$
$= 26.59 - 7.128\ rb - 0.2170\ rc + 3.272\ rl3$
$(0.57)\ (-2.32)^{**}\ (-0.26)\quad (0.56)$
$\bar{R}^2 = 0.1666,\quad SSR = 438.5,\quad SE = 5.079$

(94) $B4*$
$= 2.651 - 0.1934\ D{\cdot}ES4 - 3.288\ rb - 0.9230\ rc + 4.155\ rl4$
$(0.24)\ (-2.24)^{**}\quad (-2.28)^{**}\ (-2.45)^{**}\ (3.58)^{**}$
$\bar{R}^2 = 0.4121,\quad SSR = 83.26,\quad SE = 2.281$

(95) $NC4*$
$= -15.12 - 0.6094\ D{\cdot}ES4 + 1.111\ rb - 1.984\ rc + 3.049\ rl4$
$(-0.71)\ (-3.72)^{**}\quad (0.41)\quad (-2.77)^{**}\quad (1.38)^{*}$
$\bar{R}^2 = 0.4078,\quad SSR = 300.2,\quad SE = 4.332$

(96) $L4* + D{\cdot}ES4$
$= 66.11 - 4.410\ rb + 1.020\ rc - 3.990\ rl4$
$(1.12)\ (-0.58)\quad (0.51)\quad (-0.64)$
$\bar{R}^2 = -0.1176,\quad SSR = 2614.6,\quad SE = 12.40$

(97) $B6*$
$= 5.504 + 1.089\ D{\cdot}ES6 - 0.9197\ rb - 0.2100\ rc + 0.2970\ rl6$
$(0.45)\ (2.67)^{**}\quad (-1.03)\quad (-0.86)\quad (0.21)$
$\bar{R}^2 = 0.4200,\quad SSR = 35.01,\quad SE = 1.479$

(98) $NC6*$
$= 9.218 + 0.006012\ D{\cdot}ES6 - 0.1949\ rb + 0.2107\ rc - 1.077\ rl6$
$(3.23)^{**}\quad (0.06)\quad (-0.94)\quad (3.71)^{**}\quad (-3.26)^{**}$
$\bar{R}^2 = 0.3724,\quad SSR = 1.883,\quad SE = 0.3430$

(99) $L6{*}+D{\cdot}ES6$

$$=-15.01+1.096\,rb+0.0009145\,rc+0.8306\,rl6$$
$$(-1.44)^{*}\quad(1.43)^{*}\quad(0.004)\quad(0.68)$$
$$\bar{R}^2=0.2495,\quad SSR=27.73,\quad SE=1.277$$

(100) $B1{*}$

$$=25.68-0.1498\,D{\cdot}ES1-2.379\,rb-2.339\,rc+2.403\,rl1$$
$$(1.53)^{*}\quad(-2.51)^{**}\quad(-1.09)\quad(-2.84)^{**}\quad(1.27)$$
$$\bar{R}^2=0.4427,\quad SSR=208.6,\quad SE=3.610$$

(101) $NC1{*}=-84.51+0.1644\,D{\cdot}ES1+6.078\,rb+0.7789\,rc+5.209\,rl1$

$$(-6.00)^{**}\quad(3.27)^{**}\quad(3.29)^{**}\quad(1.12)\quad(3.26)^{**}$$
$$\bar{R}^2=0.8590,\quad SSR=148.0,\quad SE=3.041$$

(102) $L1{*}+D{\cdot}ES1$

$$=165.8-14.97\,rb-0.6387\,rc-5.690\,rl1$$
$$(2.56)^{**}\quad(-1.71)^{*}\quad(-0.19)\quad(-0.71)$$
$$\bar{R}^2=0.3651,\quad SSR=3922.9,\quad SE=15.19$$

(103) $B2{*}$

$$=23.34-0.3019\,D{\cdot}ES2-6.047\,rb-0.8973\,rc+4.837\,rl2$$
$$(1.11)\quad(-2.92)^{**}\quad(-2.43)^{**}\quad(-1.29)\quad(2.49)^{**}$$
$$\bar{R}^2=0.3934,\quad SSR=210.6,\quad SE=3.628$$

(104) $NC2{*}$

$$=-46.48+0.3304\,D{\cdot}ES2+4.489\,rb+0.5713\,rc+0.6003\,rl2$$
$$(-2.34)^{**}\quad(3.39)^{**}\quad(1.91)^{**}\quad(0.87)\quad(0.33)$$
$$\bar{R}^2=0.3538,\quad SSR=187.7,\quad SE=3.425$$

(105) $L2{*}+D{\cdot}ES2$

$$=151.5-10.86\,rb+0.5591\,rc-8.285\,rl2$$
$$(3.75)^{**}\quad(-2.04)^{**}\quad(0.32)\quad(-1.71)^{*}$$
$$\bar{R}^2=0.4906,\quad SSR=1423.9,\quad SE=9.152$$

(106) $B3{*}$

$$=-78.81-0.3262\,D{\cdot}ES3+0.05963\,rb+0.1114\,rc+10.27\,rl3$$
$$(-2.55)^{**}\quad(-1.05)\quad(0.03)\quad(0.20)\quad(2.67)^{**}$$
$$\bar{R}^2=0.4146,\quad SSR=175.8,\quad SE=3.315$$

(107) $NC3{*}$

$$=83.50-0.3380\,D{\cdot}ES3-0.1391\,rb+0.2199\,rc-9.995\,rl3$$
$$(3.47)^{**}\quad(-1.40)^{*}\quad(-0.08)\quad(0.52)\quad(-3.34)^{**}$$
$$\bar{R}^2=0.4001,\quad SSR=106.4,\quad SE=2.579$$

(108) $L3{*}+D{\cdot}ES3$

$$=20.00-5.589\,rb-0.4196\,rc+2.762\,rl3$$
$$(0.44)\quad(-1.96)^{**}\quad(-0.51)\quad(0.48)$$
$$\bar{R}^2=0.1989,\quad SSR=421.5,\quad SE=4.980$$

(109) $B4{*}$

$$=-0.8655-0.1851\,D{\cdot}ES4-2.657\,rb-0.9972\,rc+4.028\,rl4$$
$$(-0.08)\quad(-2.20)^{**}\quad(-2.00)^{**}\quad(-2.73)^{**}\quad(3.57)^{**}$$
$$\bar{R}^2=0.4385,\quad SSR=79.51,\quad SE=2.229$$

(110) $NC4*$
$$=-10.24-0.6247\ D{\cdot}ES4+0.1861\ rb-1.909\ rc+3.305\ rl4$$
$$(-0.50)\quad(-3.85)^{**}\quad(0.07)\quad(-2.71)^{**}\quad(1.52)^{*}$$
$$\bar{R}^2=0.4160,\quad SSR=296.1,\quad SE=4.302$$

(111) $L4*+D{\cdot}ES4$
$$=60.82-3.350\ rb+0.9191\ rc-4.293\ rl4$$
$$(1.06)\quad(-0.46)\quad(0.47)\quad(-0.69)$$
$$\bar{R}^2=-0.1147,\quad SSR=2607.6,\quad SE=12.39$$

(112) $B5=41.97+0.3315\ W5-2.868\ rb+1.504\ rc-4.175\ rl5$
$$(1.09)\quad(1.69)^{*}\quad(-1.55)^{*}\quad(2.29)^{**}\quad(-1.50)^{*}$$
$$+0.5671\ B5_{-4}-0.06401\ NC5_{-4}-0.3001\ L5_{-4}+0.03567\ D{\cdot}ES5$$
$$(1.78)^{**}\quad(-0.27)\quad(-1.41)^{*}\quad(0.14)$$
$$\bar{R}^2=0.9796,\quad SSR=66.89,\quad SE=2.361$$

(113) $NC5=-5.932+0.3813\ W5+1.253\ rb-1.836\ rc-4.431\ rl5$
$$(-0.13)\quad(1.64)^{*}\quad(0.57)\quad(-2.37)^{**}\quad(-1.35)$$
$$-0.6603\ B5_{-4}-0.07446\ NC5_{-4}-0.1211\ L5_{-4}+0.5790\ D{\cdot}ES5$$
$$(-1.75)^{*}\quad(-0.26)\quad(-0.48)\quad(1.99)^{**}$$
$$\bar{R}^2=0.8765,\quad SSR=93.63,\quad SE=2.793$$

(114) $L5+D{\cdot}ES5=-25.57+0.4101\ W5+2.109\ rb+0.1210\ rc$
$$(-1.05)\quad(3.32)^{**}\quad(1.79)^{**}\quad(0.29)$$
$$+7.478\ rl5+0.1164\ B5_{-4}+0.1382\ NC5_{-4}+0.2348\ L5_{-4}$$
$$(4.35)^{**}\quad(0.56)\quad(0.87)\quad(1.93)^{**}$$
$$\bar{R}^2=0.9963,\quad SSR=29.93,\quad SE=1.517$$

(115) $B6*$
$$=7.150+1.062\ D{\cdot}ES6-1.217\ rb-0.1690\ rc+0.3475\ rl6$$
$$(0.59)\quad(2.64)^{**}\quad(-1.45)^{*}\quad(-0.71)\quad(0.25)$$
$$\bar{R}^2=0.4367,\quad SSR=34.01,\quad SE=1.458$$

(116) $NC6*$
$$=8.570+0.01455\ D{\cdot}ES6-0.09857\ rb+0.1934\ rc-1.076\ rl6$$
$$(3.08)^{**}\quad(0.16)\quad(-0.51)\quad(3.51)^{**}\quad(-3.32)^{**}$$
$$\bar{R}^2=0.3959,\quad SSR=1.812,\quad SE=0.3366$$

(117) $L6*+D{\cdot}ES6$
$$=-16.10+1.330\ rb-0.02700\ rc+0.7618\ rl6$$
$$(-1.57)^{*}\quad(1.85)^{**}\quad(-0.13)\quad(0.63)$$
$$\bar{R}^2=0.2680,\quad SSR=27.05,\quad SE=1.261$$

Equation group (67)-(84) is called Case A, (85)-(99) is called Case B and (100)-(117) is called Case C. In the call and bills functions of the first, second and fifth financial institution groups and in the government bond functions of the sixth group in all cases, the coefficients of $D{\cdot}ESm_t$ are significant and their signs are as expected. In the call and bills functions of the sixth group in all cases, its coefficients are insignificant but their signs are as expected. Its coefficient in the call and bills function of the third group is significant and its sign is as expected in case A, but their coefficients are not significant in case B and

TABLE 3. ESTIMATION RESULTS

Case / Independent variables / Dependent variables	A			B			C		
	rb	*rc*	*rl*	*rb*	*rc*	*rl*	*rb*	*rc*	*rl*
B 1		○			○	○		○	○
NC 1			×*		○			○	
L 1		×	×	○	○		○	○	
B 2	◎*	◎	×		○	×		○	×
NC 2	×*			×			×		
L 2	◎*		×*	◎*		×*	◎*		×*
B 3			○	○		○	○		○
NC 3		○	○	○			○		
L 3	○	○	○	○	○	○	○	○	○
B 4		○			○			○	
NC 4				○			○		
L 4	○		×						
B 5									○
NC 5		×	○						
L 5		×	○						◎*
B 6	×	×	◎	○		○	◎*		○
NC 6			×*	○	◎	◎	○	◎	◎
L 6	×	◎	◎	○	○	○	○	○	○

Note: ◎: significant and sign is as expected
○: insignificant and sign is as expected
×: significant and sign is not significant
* : significant at 10% level

C. Thus, the spill-over effects exist in the call and bills function of all groups except for the fourth, but do not exist in the government bond function of all groups except for the sixth.

Next, the effects of interest rate variables are investigated. The expected signs of β_i^m, γ_i^m and δ_i^m are unique as shown in (8), but coefficients obtained from (44)–(46) or (48), (49) and (51) are functions of β_i^m, γ_i^m and δ_i^m, and their expected signs are not determined. Therefore, to examine them, simultaneous equations which consisted of the coefficients must be solved. Their standard errors are calculated by assuming the covariance between the estimates of the structural parameters is zero.[5] Table 3 shows the results.

According to these results, those which have significant rates of return and positive coefficients are the government bonds of the second institution group and the sixth group's loan in case A. In case B the results were the sixth group's call and bills, and the fifth group's loan, while in case C it was the sixth group's government bonds and the call and bills. Those which had significant rates of return but their coefficients were not positive are the first, second and fourth group's loans, the fifth group's call and bills and the sixth group's government bonds in case A. In case B it was the second group's loan and in case C, the second group's

[5] See, Klein [5], pp. 258–9.

TABLE 4. RESULTS OF THE TOTAL TESTS

Case	Variables	Root mean square error (RMSE)	Inequality coefficient
A	*rb*	3.560	0.453
	rc	2.219	0.292
B	*rb*	0.702	0.087
	rc	5.174	0.651
C	*rb*	0.792	0.099
	rc	5.153	0.649

FIG. 1. TOTAL TEST (CASE A, *rb*)

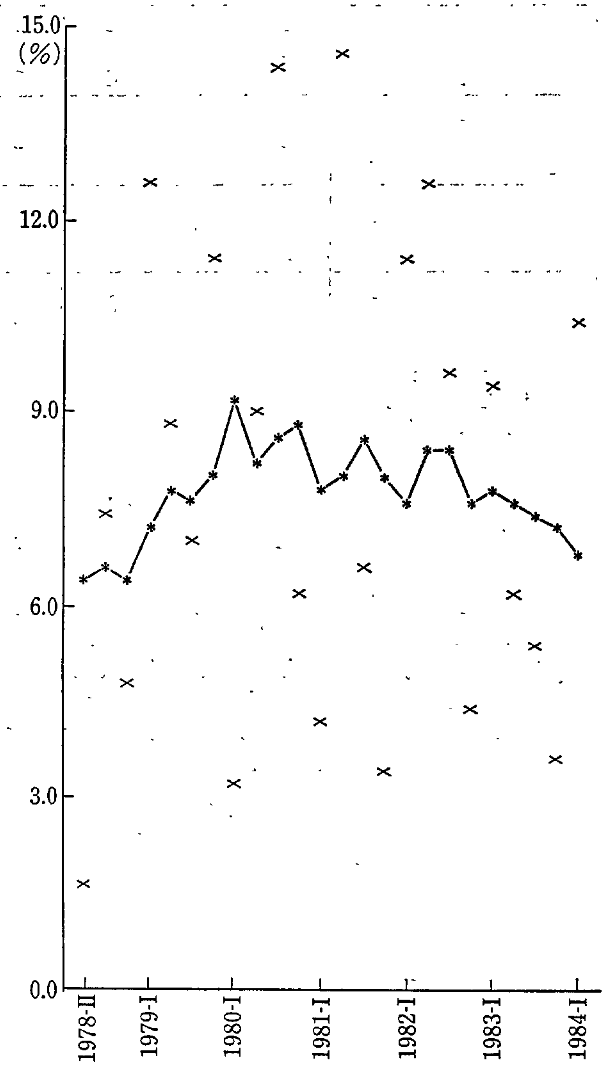
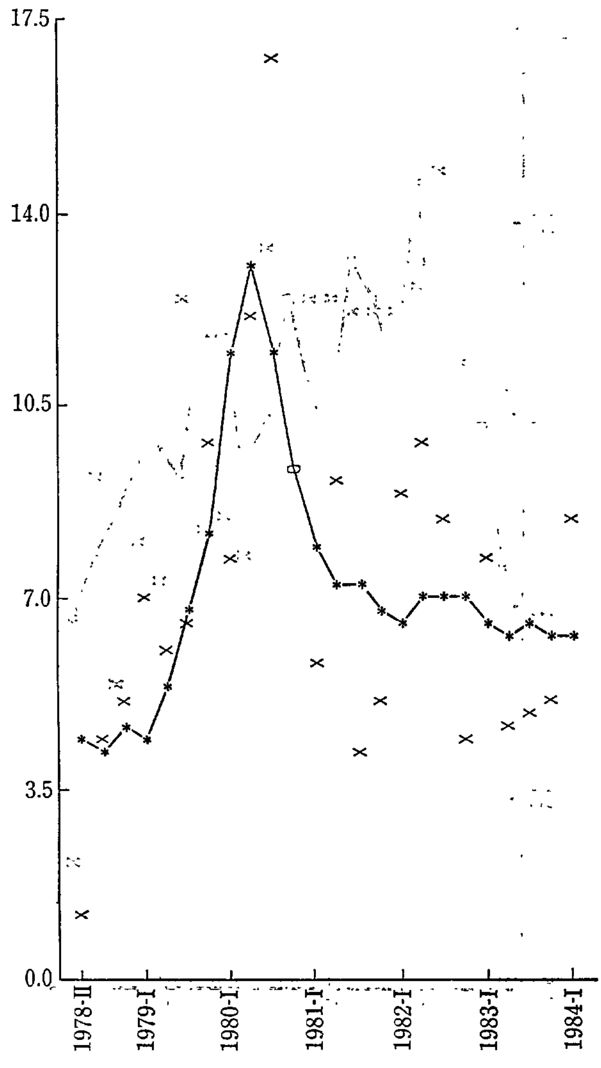
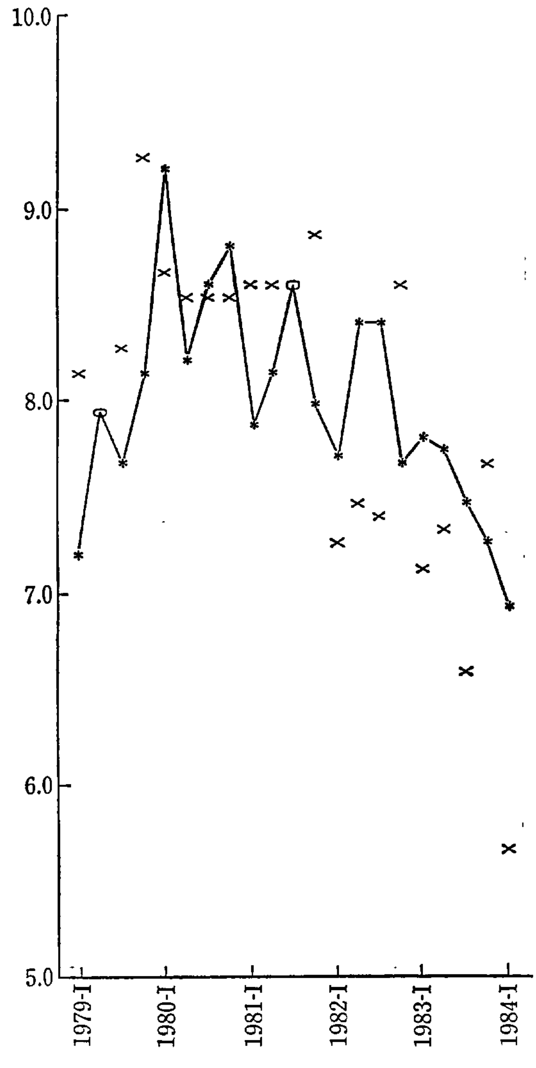


FIG. 2. TOTAL TEST (Case A, *rc*)



loan. The fifth and sixth groups' loans supply follows the price mechanism in contrast with the first, second and fourth groups and is explained as follows. The financial institutions for agriculture, forestry and fisheries (the fifth group) and the life insurance companies (the sixth group) are the so called marginal suppliers of the loans. When the loan interest rates rise in tight money periods, demand for funds of these institutional groups which are not under the BOJ's window guidance, increases and the actual loans increase. On the other hand, the city banks, the regional banks and the mutual loan and savings banks are under the window guidance and they can't increase loans in tight money periods even if the interest rates rise. When the loan interest rates fall in easy money periods, the funds

FIG. 3. TOTAL TEST (Case B, *rb*)

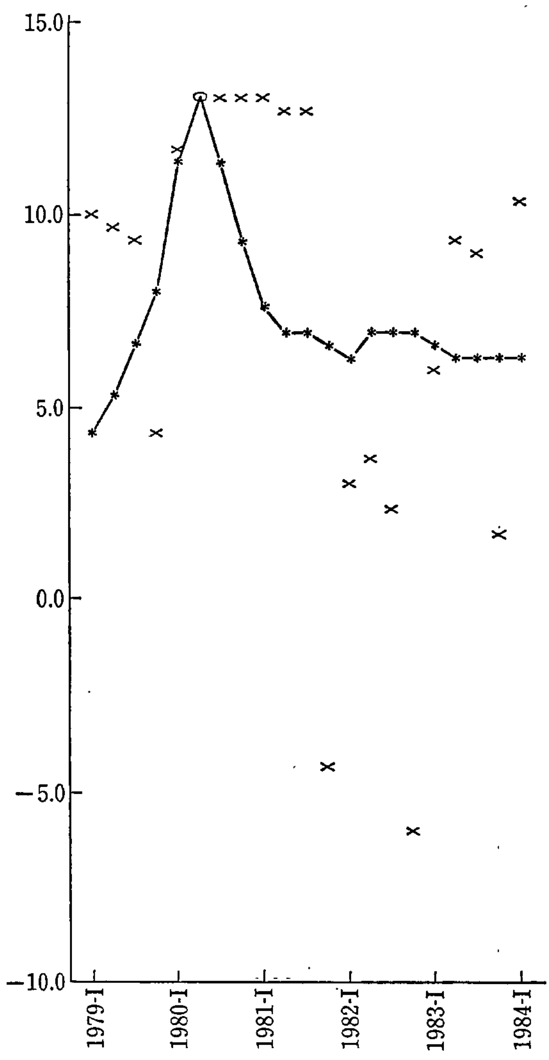


demand of the agricultural financial institutions and the life insurance companies are the first to fall.

As for government bonds, the life insurance companies' own rates of return are positive in two cases (and in one case, it is significant at 10% level), while those of the city banks are negative (but not significant) in all cases. These results are explained as follows. The city banks which are short of funds sell the bonds to raise funds regardless of the yield level, but the life insurance companies sell and buy the bonds according to their price movements, taking the bonds as measures of asset operation.

Next, the government bonds yields and the call and bills rate are determined using

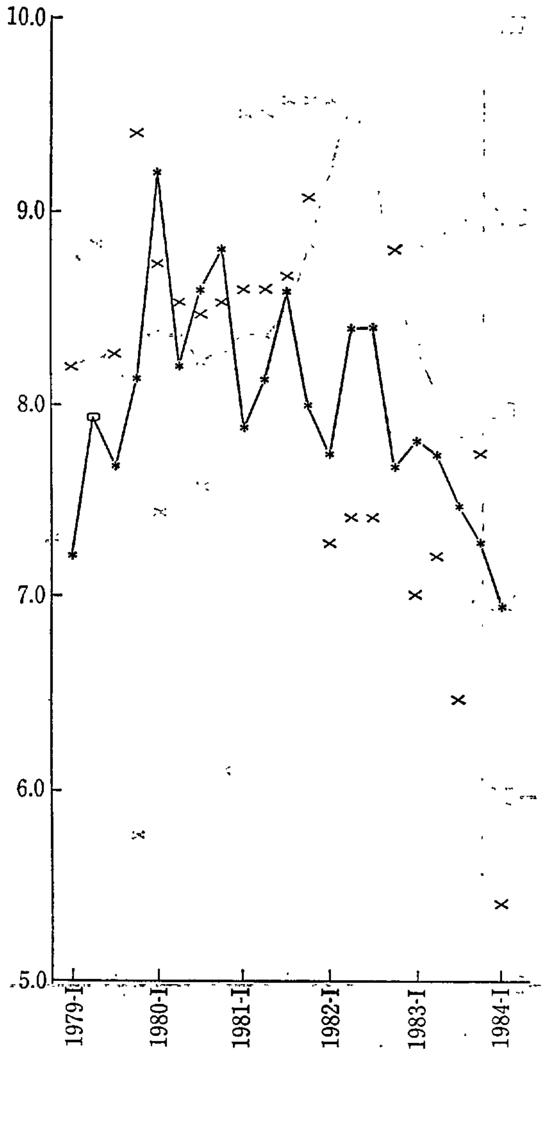
FIG. 4. TOTAL TEST (CASE B, *rc*)



the results of the simultaneous equations which include market clearing conditions, and these estimated values are compared with the actual ones in order to look into the performance of the models. The estimated values are calculated by the total tests. Table 4 and Figure 1–6 show the results. In this figure, solid lines denote the actual values and x denotes the estimated value. Inequality coefficients are obtained using Theil's new indexes.

These results show that the estimated values of case A's call and bills rate, case B and C's government bonds' yields follow closely the actual values' movement, but other estimated rates do not. That is, in half of occasions, the yields and rates determined by the structural equations system explain the actual ones well.

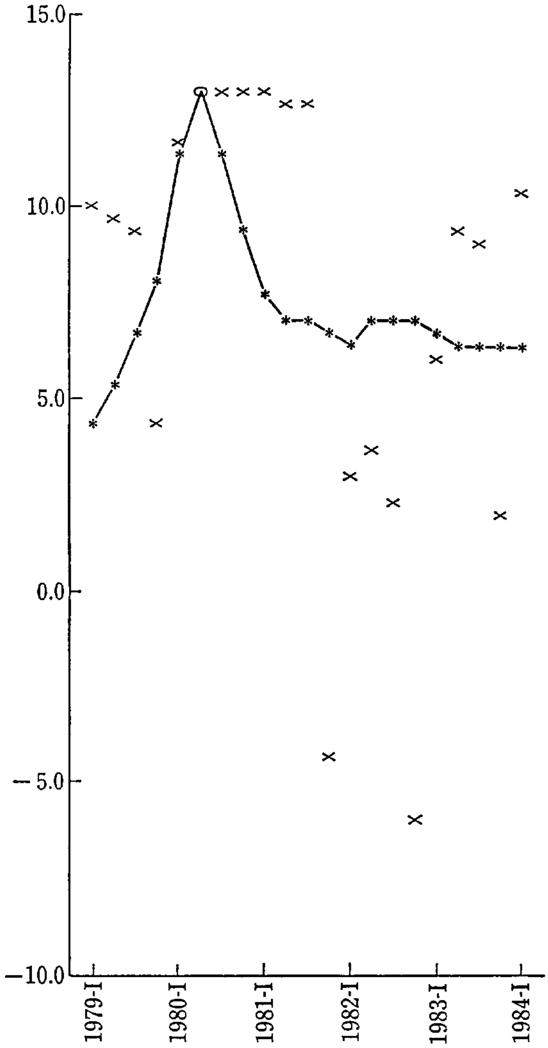
FIG. 5. TOTAL TEST (Case C, *rb*)



VII. *Concluding Comments*

The results obtained in this paper are as follows. First, in this paper's estimation period, the market of the government bonds and that of the call and bills are in equilibrium but the loan markets which are assumed to be constituted by the six submarkets are not in equilibrium. This does not depend upon whether the loan interest rates which are used in the measurement are the nominal rates or the effective ones. Second, the spill-over effects of the loans' excess supply exist in the life insurance companies' government bonds

FIG. 6. TOTAL TEST (Case C, *rc*)



holding alone, and in all the groups' call and bills holding except the mutual loan and savings banks and the credit associations. Third, some of the rate variables affect the asset holding in terms of the price mechanism, but others do not. These phenomena can be explained by taking into account the "marginal" financial institutions. Finally, the government bond yields and the call and discount rates calculated from the estimated equations and market clearing conditions, explain the actual yields and rates to some extent.

Issues to be investigated are as follows. Exogeneous economic unit, such as the household and investment trusts have to be analysed. Expectation formation process of various interest rates should also be taken into account.

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