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Endogenous Money Supply and Monetary Policy in Asset Markets with Alternative Rationing Schemes*

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In this paper we consider quantity determination in financial markets where the rates of return on deposits and bank loans are assumed to be rigid but the rate on securities is flexible, and the agents taking part in the financial markets make dual decisions and portfolio selections. Our model is motivated by observations of Japan's postwar financial markets. We also examine and compare the effects of monetary policy instruments between the two regimes which differ from each other in the effective disequilibrium condition in the market for bank loans. *J. Japan. Int. Econ.*, March 1987, **1**(1), pp. 110–129. Institute of Social Sciences, University of Tsukuba, Sakura, Ibaraki 305, Japan. © 1987 Academic Press, Inc.

1. INTRODUCTION

Japan's postwar growth process, especially that of the pre-oil-shock period, has often been characterized as being led by its vigorous export and domestic investment. The so-called "artificial low interest rate policy" or "low interest rate policy" (LIRP) has supported the maintained

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growth process from the financial aspects. The main purpose of this policy was to reduce the interest costs of private corporations by fixing interest rates at low, disequilibrium levels, the rates being the discount rate, contracted loan rates, and deposit rates. As a result of this policy, the variability of interest rates in Japan was much smaller than that in Western industrialized countries.

Also, the LIRP gave rise, at least indirectly, to the main characteristics of Japan's financial structure: the "overloan" (i.e., excessive dependence of commercial banks on central bank loans); segmentation of financial markets, e.g., between bank loan markets and security markets; and underdevelopment of open markets. The last in turn caused the private corporations to resort chiefly to indirect finance in Japan. To put it more concretely, since, in the postwar period, the discount rate was always lower than short-term money market rates for commercial banks, they (or, more accurately, the city banks) got into debt positions vis-à-vis the Bank of Japan to accommodate the brisk demand for commercial loans by private corporations.

In the bond markets also, the demand for funds by corporations was adjusted (rationed) by limited bond floatings at low interest rates. The facts that bond flotation was limited severely in number and that, before the oil shocks, the amount of outstanding government bonds was quite small, both led to delay in the development of open markets and also induced private economic agents to finance funds among them indirectly, particularly through commercial banks. Because of these features of Japan's capital markets as well as because expected rates of return from new capital equipments were fairly high, the ability of corporations to augment their productive capacity depended on, and was decisively limited by, the amount of bank financing they could obtain.

The LIRP enabled policymakers, through credit rationing and its allocation, to conduct selective, strategic finance to promote economic growth, and indirect financing was more efficient than direct financing in sorting out loan applicants with promising investment projects. On the other hand, one cannot deny that the LIRP, because it involved various measures of market intervention, has caused several inefficiencies in resource allocation, both overt and covert.

But these broader evaluations of Japan's LIRP aside, it will be an interesting exercise to examine the modus operandi of monetary policy when some interest rates are inflexible, at least in the short run. We shall not necessarily limit ourselves to Japan's financial markets in the high growth period, for the inflexibility in some asset yields, particularly those of deposits and bank loans, has been reported and analyzed in both theoretical and empirical research areas. (See, e.g., Rimbara and Santomero, 1976; Iwata and Hamada, 1980, Chap. 6; Ito and Ueda, 1981. For surveys of the literature on credit rationing, see Friedman, 1972; Baltensperger, 1978.)

As a framework which supposes non-Walrasian equilibria brought about by quantity adjustments when some market prices are rigid, we have fix-price models with quantity rationing as developed by Barro and Grossman (1971), Benassy (1975), Malinvaud (1977), and others. (See also Clower, 1965, and Patinkin, 1965, who anticipated the above developments.) Also, the frameworks for examining the impact effects of monetary policy with several financial assets involved have been proposed by Tobin and Brainard (1963), Brainard and Tobin (1968), Tobin (1969), and more recently by Santomero and Siegel (1982), among others. Although they touch on the rigidity of some yields and resulting disequilibria in financial markets (see Brainard and Tobin, 1968, in particular), it seems that the introduction of effective demand and supply (i.e., of the dual decision) still remains to be done.

In this paper we attempt to apply the fix-price method with rationing to the financial markets involving several assets, some yields of which are assumed to be rigid in the short run, to examine the working of these markets and the effectiveness of monetary policy in such a situation. As noted above, since so far we have few if any such applications to financial markets, our attempt should shed some light on the working of, and quantity determination in, the financial markets.

We shall consider four kinds of financial assets: high-powered money, deposits, securities, and commercial bank loans. The yields of these assets, except that of securities, are assumed to be rigid, either institutionally or legally, during the period of analysis. Also, we distinguish between two regimes according to the sign of effective disequilibria assumed in the markets for deposits and bank loans: In Regime I there exist excess demand for bank loans and excess supply of deposits, whereas in Regime II we assume that there are excess supplies in both markets. Our main purposes, then are, to examine, for each regime, the determination of actual (realized) quantities of financial assets (particularly, deposits, bank loans, and the supply of money) and the effects of changes in the rigid rates of return, as well as in the monetary policy tools in the hand of the central bank, on the rate of return on securities and the quantity of money in circulation.

The next section describes the outlines and assumptions of the model. In Section 3 we develop, for each of two regimes, the behavior of commercial banks and the nonbank public, and then show their demand–supply functions for assets. Secton 4 discusses the quantity determination of the main financial assets and effectiveness of monetary policy. Finally, Section 5 brings together and compares the analytical results for the two regimes and then concludes the paper with several remarks.

TABLE I
STOCK-OF-FUNDS MATRIX

Rates of return	Asset	Sector: Central bank	Commercial banks	Nonbank public	Exogenous supply
0	High-powered money	$-M_c$	$+M_b$	$+M_p$	0
r_d	Deposits	0	$-D_b$	$+D_p$	0
r_s	Securities	$+S_c$	$+S_b$	$+S_p$	$+S_g$
r_l	Commercial bank loans	0	$+L_b$	$-L_p$	0
	Net worth (except physical capital)	0	0	$+A$	$+A = +S_g$

2. Outlines of the Model

In this section we describe the outlines of the financial markets to be studied and the main assumptions made in this paper (additional assumptions are stated in the appropriate places in the following).

(i) The economy is composed of three sectors: the central bank, the commercial banks, and the nonbank public (firms and households).

(ii) The economy contains four financial assets: high-powered money (i.e., the base money or central bank money), deposits, securities, and commercial bank loans; the physical asset, capital stock, is not considered here, for it is assumed constant throughout. The assets and liabilities of those sectors are summarized in the stock-of-funds matrix in Table I. Entries with plus (respectively, minus) signs in the table show that they are assets (respectively, liabilities) for the relevant sectors. The leftmost column presents the real rates of return on the financial assets listed. The price level is assumed given, so the real rates of return are equal to their nominal counterparts.

(iii) The amount of the central bank's security holdings S_c is assumed to be a policy variable, and the government's outstanding security issues S_g to be a constant parameter. We assume that the central bank supplies high-powered money to the economy through open market operations by security purchases. (An alternative method of supplying high-powered money is discussed briefly in footnote 10 and Appendix E; mathematical appendixes A to E may be obtained upon request from the author.)

(iv) We assume that the assets are normal and gross substitutes for each other. In notation this implies

TABLE II
EFFECTIVE DISEQUILIBRIA (CONSTRAINED SECTORS)

Regime	Market: Commercial bank loans	Deposits
I	Excess demand (nonbank public)	Excess supply (commercial banks)
II	Excess supply (commercial banks)	Excess supply (commercial banks)

$$X_{ij} \begin{cases} > 0 & \text{if } i = j, \\ < 0 & \text{if } i \neq j;\ i, j = 1, \ldots, n, \end{cases}$$

where X_{ij} is the partial derivative of (notional or effective) demand for the ith asset X_i with respect to the jth yield, and n is the number of financial assets.

(v) With regard to the yield sensitivity of asset demands, we assume that the sum of the jth yield sensitivities over all assets is nonnegative. In notation this means

$$\sum_{i=1}^{n} X_{ij} \geq 0, \qquad j = 1, \ldots, n.^{1}$$

(vi) Of the three positive rates of return, only the security rate r_s moves flexibly to clear its market, while the deposit rate r_d and the rate on bank loans r_l are assumed to be rigid during the period of analysis, and so these two rates do not perform the market-clearing function.

(vii) It is further assumed that the deposit rate is at such levels that its market always has effective excess supply, and that the bank loan market is either in excess demand or in excess supply in the effective sense, depending on the rates of return assumed to be rigid and other parameters.

(viii) Table II distinguishes between the two regimes according to the effective disequilibria in the two markets.[2] The sectors in parentheses in

[1] A similar assumption is made in the Appendix of Tobin and Brainard (1967). They employ the assumption with a strict inequality; however, to be consistent with comparative statics for the banking sector in this paper (see Eq. (7)), we use the assumption with a weak inequality.

[2] In this paper we do not deal with two other conceivable regimes (i.e., one with excess demand for deposits and bank loans, and the other with excess demand for deposits and excess supply of bank loans, all in the effective sense), because the assumption that there is excess demand for deposits does not seem plausible enough to take up these regimes separately.

the table are the constrained sectors (i.e., sectors on the "long-side" of the markets). In each of the financial markets the supply or the demand on a "short-side" is realized as an actual quantity, and the sector, which is on a long-side and so is rationed in the market, presents effective demand or supply in the *other* markets as a result of the dual decision.

(ix) Under the above assumptions the commercial banks and the nonbank public make portfolio selection, which, via quantity adjustments in both deposits and bank loans, leads the financial markets to temporary equilibrium with rationing.

Let us now examine, for two regimes, the behavior of market participants and the property of quantity determination in the financial markets as well as the effects of parameter changes on the security rate of interest and the money supply, the latter being defined as the sum of high-powered money in circulation and deposits held by the nonbank public.[3]

3. The Behavior of Banks and the Nonbank Public

3.1 *The Banks' Behavior*

Regime I. To start with, we consider the behavior of commercial banks in Regime I. Here the banks are on a short-side in the loan market and on a long-side in the deposit market. Profit Π of the representative commercial bank is given by

$$\Pi = r_l L_b + r_s S_b - r_d \overline{D}_b - C(L_b, S_b, \overline{D}_b), \tag{1}$$

where $C(\cdot)$ denotes the cost involved in the transactions of the bank's loans, securities, and deposits, or, briefly, the "real resource" cost,[4] and also the bar over deposits D_b means that the deposits are the perceived constraint for the bank. Regarding the cost function we assume that

$$\begin{gathered} C_i > 0, \qquad i = L_b, S_b, \overline{D}_b; \\ C_{ii} > C_{ij} > 0, \qquad C_{ij} = C_{ji}, \qquad i, j = L_b, S_b, \overline{D}_b,\ i \neq j, \end{gathered} \tag{2}$$

where $C_i \equiv \partial C/\partial i$ and $C_{ij} \equiv \partial^2 C/\partial i \partial j$. The inequalities $C_{ii} > C_{ij} > 0$ imply increasing marginal cost or decreasing marginal productivity in bank operation.

[3] The frameworks introducing both the interest rates and the quantity of money as transmission mechanisms between the real and financial sectors can be found in Fujino (1975) and Tobin (1978)

[4] See the survey of Baltensperger (1980) for models of bank behavior with this kind of cost functions.

Now from Table I, the bank's balance sheet reads

$$L_b + S_b + M_b = \overline{D}_b.$$

We next assume that the bank's cash holdings consist solely of legally required reserves on deposits, i.e., that $M_b = k\overline{D}_b$, where k is the required reserve ratio on deposits, with $0 < k < 1$.[5] Hence, the balance sheet can be written as

$$L_b + S_b = (1 - k)\overline{D}_b. \tag{3}$$

Being constrained by the nonbank public's deposit demand $\overline{D}_b$, the bank maximizes the profit (1) subject to the balance sheet (3) with respect to its choice variables in this regime, L_b and S_b. Defining the Lagrangian,

$$Z \equiv r_l L_b + r_s S_b - r_d \overline{D}_b - C(L_b, S_b, \overline{D}_b) - \lambda[L_b + S_b - (1 - k)\overline{D}_b],$$

we obtain the following first-order conditions for the bank's optimum,

$$Z_L = 0 = r_l - C_L - \lambda, \tag{4}$$

$$Z_S = 0 = r_s - C_S - \lambda, \tag{5}$$

$$Z_\lambda = 0 = -[L_b + S_b - (1 - k)\overline{D}_b], \tag{6}$$

where, for simplicity, use is made of subscripts "L" and "S" in (4) and (5) to denote partial derivatives with respect to the variables L_b and S_b, respectively.[6]

Let us next differentiate (4) to (6) to examine the bank responses to parameter changes; thus,

$$\begin{bmatrix} 0 & 1 & 1 \\ 1 & C_{LL} & C_{LS} \\ 1 & C_{SL} & C_{SS} \end{bmatrix} \begin{bmatrix} d\lambda \\ dL_b \\ dS_b \end{bmatrix} = \begin{bmatrix} (1 - k)d\overline{D}_b - \overline{D}_b dk \\ -C_{LD} d\overline{D}_b + dr_l \\ -C_{SD} d\overline{D}_b + dr_s \end{bmatrix},$$

where if one writes the determinant of the coefficient matrix as Δ,

$$\Delta = 2C_{LS} - C_{SS} - C_{LL} < 0$$

[5] Therefore, we assume here a kind of a reserve accounting system which enables the bank to dispense with excess reserve holdings during the period under study.

[6] The second-order condition is that $C_{LL} + C_{SS} - 2C_{LS} > 0$, which is ensured by the assumption on the $C(\cdot)$ function, (2).

by the second-order condition. Using Cramer's rule we then find

$$\frac{\partial L_{\mathrm{b}}}{\partial \overline{D}_{\mathrm{b}}} = -\frac{1}{\Delta}[(1-k)(C_{\mathrm{SS}} - C_{\mathrm{LS}}) + C_{\mathrm{SD}} - C_{\mathrm{LD}}],$$

$$\frac{\partial S_{\mathrm{b}}}{\partial \overline{D}_{\mathrm{b}}} = -\frac{1}{\Delta}[(1-k)(C_{\mathrm{LL}} - C_{\mathrm{SL}}) + C_{\mathrm{LD}} - C_{\mathrm{SD}}].$$

With respect to the above derivatives, we assume that

$$\frac{\partial L_{\mathrm{b}}}{\partial \overline{D}_{\mathrm{b}}} > 0, \qquad 1 > \frac{\partial S_{\mathrm{b}}}{\partial \overline{D}_{\mathrm{b}}} > 0,$$

where the assumption $\partial S_{\mathrm{b}}/\partial \overline{D}_{\mathrm{b}} < 1$ is made because the bank will allocate the increment of deposits to loans and reserves as well as to security holdings.[7] Further, the above matrix equation yields

$$\frac{\partial L_{\mathrm{b}}}{\partial r_{\mathrm{l}}} = -\frac{\partial S_{\mathrm{b}}}{\partial r_{\mathrm{l}}} = -\frac{\partial L_{\mathrm{b}}}{\partial r_{\mathrm{s}}} = \frac{\partial S_{\mathrm{b}}}{\partial r_{\mathrm{s}}} = -\frac{1}{\Delta} > 0, \tag{7}$$

$$\frac{\partial L_{\mathrm{b}}}{\partial k} = \frac{\overline{D}_{\mathrm{b}}}{\Delta}(C_{\mathrm{SS}} - C_{\mathrm{LS}}) < 0, \qquad \frac{\partial S_{\mathrm{b}}}{\partial k} = \frac{\overline{D}_{\mathrm{b}}}{\Delta}(C_{\mathrm{LL}} - C_{\mathrm{SL}}) < 0. \tag{8}$$

The above comparative statics are summed up as the commercial banks' effective supply of loans and effective demand for securities of the forms

$$L_{\mathrm{b}}^{\mathrm{d}\prime} = L_{\mathrm{b}}^{\mathrm{d}\prime}(\underset{+}{\overline{D}_{\mathrm{b}}}, \underset{-}{r_{\mathrm{s}}}, \underset{+}{r_{\mathrm{l}}}, \underset{-}{k}), \tag{9}$$

$$S_{\mathrm{b}}^{\mathrm{d}\prime} = S_{\mathrm{b}}^{\mathrm{d}\prime}(\underset{+}{\overline{D}_{\mathrm{b}}}, \underset{+}{r_{\mathrm{s}}}, \underset{-}{r_{\mathrm{l}}}, \underset{-}{k}), \qquad 0 < \frac{\partial S_{\mathrm{b}}^{\mathrm{d}\prime}}{\partial \overline{D}_{\mathrm{b}}} < 1, \tag{10}$$

where the plus or minus signs under arguments represent the signs of partial derivatives with respect to the relevant arguments. Also in (9) and (10), superscript "d" refers to demand, and the prime means that the variable is an effective quantity.

[7] Thus we assume that the "marginal productivity" of deposits in the bank's "production" of loan supply and security demand is positive, and the latter is less than unity. A sufficient condition for this set of assumptions to be the case is that $C_{\mathrm{DS}} \cong C_{\mathrm{DL}}$, i.e., that the slope of the marginal cost of deposits concerning securities is sufficiently close to that concerning bank loans. A stronger sufficient condition is that the $C(\cdot)$ function is additively separable. The assumptions, however, are for simplicity, and dropping them will not alter the following discussion in any essential way.

Regime II. We next turn to bank behavior in Regime II. When the financial markets locate themselves in Regime II, the commercial banks are on the "long-side" in the loan and deposit markets, and so are constrained in both markets. From the balance sheet of the banking sector (3), therefore, its effective demand for securities is given simply by

$$S_b^{d'} = (1 - k)\bar{D}_b - \bar{L}_b, \tag{11}$$

where $\bar{D}_b$ and $\bar{L}_b$ are the perceived constraints of deposit demand and loan demand, respectively, that the banks confront.

3.2 *The Nonbank Public's Behavior*

Regime I. When the economy lies in Regime I, the nonbank public is constrained in the loan market, so its effective demand for deposits can be assumed to have the form

$$D_p^{d'} = D_p^{d'}(\underset{+}{\bar{L}_p}, \underset{+}{r_d}, \underset{-}{r_s}, \underset{+}{S_g}), \tag{12}$$

where S_g $(=A)$ is the nonbank public's wealth (we are abstracting from its physical wealth, which is assumed given during the period of analysis) and $\bar{L}_p$ is the perceived constraint of loans for the nonbank public. Next, its effective demand function for securities is written as

$$S_p^{d'} = S_p^{d'}(\underset{+}{\bar{L}_p}, \underset{-}{r_d}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}), \qquad 0 < \frac{\partial S_p^{d'}}{\partial \bar{L}_p} < 1, \tag{13}$$

where the inequality $\partial S_p^{d'}/\partial \bar{L}_p < 1$ mirrors the assumption that the increment of constrained loans goes into the increases in deposits and cash as well as in security purchases.

Regime II. In this regime the nonbank public is not constrained in either the loan or the deposit market and, hence, this sector presents notional demands in these markets as well as in the security market. We then express the demands for loans, deposits, and securities, respectively, by

$$L_p^d = L_p^d(\underset{+}{r_d}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}), \tag{14}$$

$$D_p^d = D_p^d(\underset{+}{r_d}, \underset{-}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}), \tag{15}$$

$$S_p^d = S_p^d(\underset{-}{r_d}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}), \tag{16}$$

where the symbols without a prime are notional quantities, and the absence of constraints in these functions results from the fact that each is a notional demand.[8]

4. Money Supply, the Interest Rate, and Monetary Policy

4.1 *Analysis of Regime I*

Before examining how the model works in Regime I, it is convenient to collect the relevant behavior relations pertaining to the commercial banks and the nonbank public, and also the equilibrium condition for securities. Since bank loans and deposits are market determined, i.e., their effective demands and constraints are equalized, as a result of quantity adjustments in this regime, we use the same symbols, respectively, for the quantities of loans and for deposits appearing in the various equations in Regime I.

Therefore, for the banks' effective loan supply (9), we write

$$L^* = \hat{L}^* (\underset{+}{D^*}, \underset{-}{r_s}, \underset{+}{r_l}, \underset{-}{k}), \tag{9'}$$

where the asterisk denotes that the variable is a market-determined quantity, and the caret simply distinguishes the functional form. Similarly, the effective deposit demand of the nonbank public (12) is rewritten as

$$D^* = \hat{D}^* (\underset{+}{L^*}, \underset{+}{r_d}, \underset{-}{r_s}, \underset{+}{S_g}). \tag{12'}$$

Next, the banks' effective demand for securities is

$$S_b^{d\prime} = S_b^{d\prime} (\underset{+}{D^*}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{-}{k}), \qquad 0 < \frac{\partial S_b^{d\prime}}{\partial D^*} < 1, \tag{10'}$$

and the nonbank public's effective demand for them is

$$S_p^{d\prime} = S_p^{d\prime} (\underset{+}{L^*}, \underset{-}{r_d}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}), \qquad 0 < \frac{\partial S_p^{d\prime}}{\partial L^*} < 1. \tag{13'}$$

Further, by assumption (vi) the security market is constantly cleared

[8] The signs of partial derivatives in (14) to (16) follow from the gross substitutability assumption (iv) (note that L_p^d is a liability).

owing to the adjustment in the security rate, and its equilibrium is shown as

$$S_g = S_b^{d'} + S_b^{d'} + S_c. \tag{17}$$

In summary, Eqs. (9′), (12′), and (17), which incorporates (10′) and (13′), together determine bank loans L^*, deposits D^*, and security rate of interest r_s as functions of the parameters.[9]

In view of (10′) and (13′) the equilibrium for securities is given in more detail as

$$S_g = S_b^{d'}(D^*, r_s, r_l, k) + S_p^{d'}(L^*, r_d, r_s, r_l, S_g) + S_c,$$

or, writing $S_b^{d'}(\cdot) + S_p^{d'}(\cdot) \equiv S^{d'}(\cdot)$,

$$S_g = S^{d'}(\underset{+}{D^*}, \underset{+}{L^*}, \underset{-}{r_d}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{-}{k}, \underset{+}{S_g}) + S_c.$$

Next, solving the above equation for r_s and dropping S_g yields[10]

$$r_s = r_s(\underset{-}{D^*}, \underset{-}{L^*}, \underset{-}{S_c}, \underset{+}{r_d}, \underset{+}{r_l}, \underset{+}{k}). \tag{18}$$

If we substitute this into (9′), we have the banks' effective loan supply function,

$$L^* = \hat{L}^*[\underset{+}{D^*}, \underset{-}{r_s}(\underset{-}{D^*}, \underset{-}{L^*}, \underset{-}{S_c}, \underset{+}{r_d}, \underset{+}{r_l}, \underset{+}{k}), \underset{+}{r_l}, \underset{-}{k}],$$

which allows for constant equilibrium of the security market; or, from

[9] So far, we have not been concerned with the market for high-powered money, to which we now turn briefly. In view of the assumption that the commercial banks' cash holdings consist solely of required reserves, their effective demand for high-powered money is $M_b^{d'} = k\bar{D}_b$. Also, from the balance sheet of the nonbank public, which is shown in the fifth column in Table I, their effective demand for high-powered money in Regime I is $M_p^{d'} = L^* - D^* - S_p^{d'} + A = L^* - D^* - S_p^{d'} + S_g$, since $A = S_g$. As is seen from the table, if the balance sheets of the three sectors are met and if the markets for deposits, securities, and bank loans are in equilibrium in the effective sense, the market for high-powered money is also in equilibrium.

[10] Since here we assume the supply of high-powered money via open market operations, the amount of outstanding government bonds S_g does not play any role. However, if we introduce the supply of high-powered money through government deficits, the amount of S_g becomes important. In Appendix E we consider the role of S_g as the nonbank public's net wealth, when discussing the supply of high-powered money via government deficits. In Japan, before the oil shocks, high-powered money was supplied chiefly via the latter route and central bank loans (to city banks).

this, L^* can be solved explicitly as

$$L^* = L^*(\underset{+}{D^*}, \underset{+}{S_c}, \underset{-}{r_d}, \underset{+}{r_l}, \underset{-}{k}) \qquad 0 < \frac{\partial L^*}{\partial D^*} < 1 - k. \tag{19}$$

Appendix A details the derivation of Eq. (19).

Now substituting (18) into (12′), we have the effective deposit demand of the nonbank public when equilibrium in the security market is taken into account. This is given by

$$D^* = \hat{D}^*[\underset{+}{L^*}, \underset{+}{r_d}, \underset{-}{r_s}(\underset{-}{D^*}, \underset{-}{L^*}, \underset{-}{S_c}, \underset{+}{r_d}, \underset{+}{r_l}, \underset{+}{k})],$$

and solving for D^*, we have

$$D^* = D^*(\underset{+}{L^*}, \underset{+}{S_c}, \underset{+}{r_d}, \underset{-}{r_l}, \underset{-}{k}).^{11} \tag{20}$$

We are now ready to determine the quantities of deposits, bank loans, and stock of money, and also the effects of monetary policy instruments on these quantities, in temporary equilibrium of the financial markets. Equation (19) represents the commercial banks' effective supply of loans, given the constraint of deposit demand by the nonbank public; and Eq. (20) is the nonbank public's effective demand for deposits which is constrained by the banks' loan supply. We also recall that both functions embody equilibrium in the security market. Equilibrium loans and deposits are then given as those which satisfy both (19) and (20).

To show these equations and their intersection diagrammatically in a $D^* - L^*$ space, we need to know their relative slope. This will be seen by a stability argument as follows. Since, in Regime I, loans are supply determined whereas deposits are demand determined, we consider the following quantity adjustment process which should occur behind the equilibrium relations, (19) and (20):

$$\dot{L}^* = \alpha[L^*(D^*, \ldots) - L^*], \qquad \alpha\text{: const} > 0,$$
$$\dot{D}^* = \beta[D^*(L^*, \ldots) - D^*], \qquad \beta\text{: const} > 0.$$

[11] Relation (20) can be derived in a manner quite similar to the manner in which (19) was derived, as follows. First, we may prove that the coefficient of dD^*, when one totally differentiates the immediately preceding relation $D^* = \hat{D}^*[\cdot]$ (i.e., $1 - (\partial\hat{D}^*/\partial r_s)(\partial r_s/\partial D^*)$), is positive by using assumption (v), $\partial r_s/\partial D^* = -(\partial S^{d\prime}/\partial D^*)/(\partial S^{d\prime}/\partial r_s)$, and $\partial S_b^{d\prime}/\partial D^* < 1$. Second, we can take $\partial D^*/\partial r_d > 0$ by the gross substitutability assumption (iv).

The necessary and sufficient condition for stability of the linear approximation system is

$$\frac{\partial L^*}{\partial D^*}\frac{\partial D^*}{\partial L^*} < 1,$$

which, after a slight modification, yields

$$\left.\frac{dL^*}{dD^*}\right|_{(20)} > \left.\frac{dL^*}{dD^*}\right|_{(19)} \qquad (> 0),$$

where the derivatives stand for the slopes of (20) and (19), respectively. Using this inequality, the readers can easily depict a figure showing Eqs. (19) and (20) in a $D^* - L^*$ space, with D^* measured along the horizontal axis; this figure is referred to as "the figure" in the following. The intersection point of the two equations in the figure, assumed to be unique, represents temporary equilibria in the loan and deposit markets.

Before carrying out comparative statics analysis, let us note the determination of the money stock. Here, as usual, we define the supply of money M as the sum of high-powered money and deposits in the hands of the nonbank public, namely,

$$M \equiv M_{\mathrm{p}} + D^*.$$

Then, from the balance sheet of the nonbank public, which can be read in Table I,

$$M_{\mathrm{p}} + D^* = L^* - S_{\mathrm{p}}^{\mathrm{d}\prime} + A.$$

But since $A = S_{\mathrm{g}}$ from Table I, we have

$$M_{\mathrm{p}} + D^* = L^* - S_{\mathrm{p}}^{\mathrm{d}\prime} + S_{\mathrm{g}};$$

hence, using (13′) we have

$$M = L^* - S_{\mathrm{p}}^{\mathrm{d}\prime}\,(L^*, r_{\mathrm{d}}, r_{\mathrm{s}}, r_{\mathrm{l}}, S_{\mathrm{g}}) + S_{\mathrm{g}}. \tag{21}$$

The equilibrium quantity of money is given by substituting the quantities of loans and deposits satisfying (19) and (20) into L^* and r_{s} in (21) (see (18)), and so is the function of S_{c}, r_{d}, r_{l}, and k.

Now consider the consequences of the increase in high-powered money by the central bank's open market operations. When the central bank buys securities, the security rate, which is assumed to always clear the security market, decreases (see (18)), and this in turn increases both the banks' loan supply and the nonbank public's deposit demand. In terms of the figure (not drawn) the curve showing Eq. (19) shifts upward and the curve showing (20) shifts rightward. The outcome of these shifts is higher levels of loans and deposits. In notation, dropping the effect on deposits, which is not used below, we can write the consequences of the central bank's open market purchases as

$$\frac{dL^*}{dS_c} > 0, \qquad \frac{dr_s}{dS_c} < 0.$$

In a similar manner it is straightforward to see that

$$\frac{dL^*}{dk} < 0, \qquad \frac{dr_s}{dk} > 0.$$

When the deposit rate (respectively, the loan rate) increases, both (19) and (20) in the figure shift to the right (respectively, to the left), so one cannot see the directions of changes from the figure. But differentiating Eqs. (19) and (20) we find (see Appendix B)

$$\frac{dL^*}{dr_d} = \frac{1}{\delta}\left(\frac{\partial L^*}{\partial r_d} + \frac{\partial L^*}{\partial D^*}\frac{\partial D^*}{\partial r_d}\right), \qquad \frac{\partial L^*}{\partial r_l} = \frac{1}{\delta}\left(\frac{\partial L^*}{\partial r_l} + \frac{\partial L^*}{\partial D^*}\frac{\partial D^*}{\partial r_l}\right), \tag{22}$$

where $\delta > 0$, and $\partial L^*/\partial D^* = \partial \hat{L}^*/\partial D^* + \partial \hat{L}^*/\partial r_s \cdot \partial r_s/\partial D^*$ with $0 < \partial L^*/\partial D^* < 1 - k$ from (19). Therefore, in the light of assumption (v) the latter in (22) is certainly positive. Also, because $\partial L^*/\partial D^*$ is the sum of a positive term and the banks' marginal productivity of deposits in the loan production, we assume that $\partial L^*/\partial D^*$ is sufficiently close to $1 - k$ and its own rate effect on deposits is so large that $dL^*/dr_d > 0$;[12] that is,

$$\frac{dL^*}{dr_d} > 0, \qquad \frac{dL^*}{dr_l} > 0.$$

Moreover, under the assumption of gross substitutability in the total demand for securities $S^{d\prime}$ (assumption (iv)), we can find (see Appendix C)

$$\frac{dr_s}{dr_d} > 0, \qquad \frac{dr_s}{dr_l} > 0. \tag{23}$$

[12] This assumption is merely to make the comparative statics result (here regarding money supply) a definite one and does not affect the essential point of our argument. See Section 5.

Having examined the effects on the security rate, we next seek the consequences on the money supply of changes in policy variables and institutionally or legally fixed parameters. These are given, with the aid of the above results, as

$$\frac{dM}{dS_c} = \frac{dL^*}{dS_c}\left(1 - \frac{\partial S_p^{d'}}{\partial L^*}\right) - \frac{\partial S_p^{d'}}{\partial r_s}\frac{dr_s}{dS_c} > 0$$

because $0 < \partial S_p^{d'}/\partial L^* < 1$;

$$\frac{dM}{dr_d} = \frac{dL^*}{dr_d} - \left(\frac{\partial S_p^{d'}}{\partial L^*}\frac{dL^*}{dr_d} + \frac{\partial S_p^{d'}}{\partial r_s}\frac{dr_s}{dr_d} + \frac{\partial S_p^{d'}}{\partial r_d}\right),$$

where the term in parentheses is the total effect of deposit rate r_d on the nonbank public's security demand $S_p^{d'}$ and, hence, is negative by assumption (iv), namely,

$$\frac{dM}{dr_d} > 0;$$

$$\frac{dM}{dr_l} = \frac{dL^*}{dr_l} - \left(\frac{\partial S_p^{d'}}{\partial L^*}\frac{dL^*}{dr_l} + \frac{\partial S_p^{d'}}{\partial r_s}\frac{dr_s}{dr_l} + \frac{\partial S_p^{d'}}{\partial r_l}\right) > 0,$$

where the term in parentheses is negative by virtue of assumption (iv); and

$$\frac{dM}{dk} = \frac{dL^*}{dk} - \frac{\partial S_p^{d'}}{\partial r_s}\frac{dr_s}{dk} < 0.$$

The increase in central bank's security holdings S_c augments equilibrium bank loans L^* and reduces security rate r_s. The latter fall then curtails the security holdings of nonbank public $S_p^{d'}$. Therefore, by (21) money supply M increases. A similar explanation can be applied to the effect of change in required reserve ratio k. Finally, the increase in deposit rate r_d or in loan rate r_l reduces the nonbank public's security holdings, so that the total effect is evidently to increase the quantity of money supply. In Table III, these comparative statics are summarized and compared with the corresponding ones in Regime II.

4.2. *Analysis of Regime II*

When the financial markets are in Regime II, the commercial banks are on the long-side and so are constrained in both the loan and the deposit markets. On the other hand, the nonbank public is not constrained in either market. To carry on the analysis of this regime further, we recall the relevant behavior relations of the two sectors. The banks' effective demand for securities (11) is written as

$$S_b^{d\prime} = (1 - k)D_p^d - L_p^d, \tag{11$'$}$$

where the perceived constraints of deposits and loans are replaced, respectively, by the nonbank public's notional demands for them, because the latter become the actual (realized) quantities in this regime. On the other hand, the nonbank public's notional demands for loans, deposits, and securities are

$$L_p^d = L_p^d(\underset{+}{r_d}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}), \tag{14}$$

$$D_p^d = D_p^d(\underset{+}{r_d}, \underset{-}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}), \tag{15}$$

$$S_p^d = S_p^d(\underset{-}{r_d}, \underset{+}{r_s}, \underset{-}{r_l}, \underset{+}{S_g}). \tag{16}$$

The equation system for Regime II is completed by adding an equilibrium condition for the security market,

$$S_g = S_b^{d\prime} + S_p^d + S_c,$$

which, after substitution of (11′) and (16), becomes

$$S_g = (1 - k)D_p^d - L_p^d + S_p^d(r_d, r_s, r_l, S_g) + S_c. \tag{24}$$

Equations (14), (15), and (24) determine the quantities of loans L_p^d and deposits D_p^d, and also the rate on securities r_s, as functions of the parameters. Here we attach superscript "d" and subscript "p" to loans and deposits to remind us that these actual quantities coincide with notional demands by the nonbank public (compare Regime I).[13]

Now, substituting (14) and (15) into (24) and then solving for r_s gives

$$r_s = r_s(\underset{-}{S_c}, \underset{-}{r_d}, \underset{-}{r_l}, \underset{+}{k}), \tag{25}$$

[13] The bank's effective demand for high-powered money in this regime is $M_b^{d\prime} = kD_p^d$, and, from the balance sheet of the nonbank public, the latter's notional demand for high-powered money is $M_p^d = L_p^d - D_p^d - S_p^d + A = L_p^d - D_p^d - S_p^d + S_g$. The remark in the last sentence in footnote 9 can be applied here also.

the derivation of which is relegated to Appendix D; as before, here and in what follows, we delete the net wealth of the nonbank public S_g from the argument (see footnote 10). Equation (25) shows the comparative statics effects on security rate r_s of the various parameter changes. The actual quantity of bank loans L_p^d can be expressed, by substituting (25) into (14), as a function of the parameters; thus,

$$L_p^d = \hat{L}_p^d[\underset{+}{r_d}, \underset{+}{r_s}(\underset{-}{S_c}, \underset{-}{r_d}, \underset{-}{r_l}, \underset{+}{k}), \underset{-}{r_l}] \equiv L_p^d(\underset{-}{S_c}, \underset{+}{r_d}, \underset{-}{r_l}, \underset{+}{k}), \tag{26}$$

where $\partial L_p^d/\partial r_d > 0$ follows from assumption (iv) (note that L_p^d here is a liability). Moreover, for future reference, we derive the security demand of the nonbank public as a function of the parameters, which is given from (16) and (25) by

$$S_p^d = \hat{S}_p^d[\underset{-}{r_d}, \underset{+}{r_s}(\underset{-}{S_c}, \underset{-}{r_d}, \underset{-}{r_l}, \underset{+}{k}), \underset{-}{r_l}] \equiv S_p^d(\underset{-}{S_c}, \underset{-}{r_d}, \underset{-}{r_l}, \underset{+}{k}). \tag{27}$$

We have come to the final step of the comparative statics: the effects on the quantity of money of changes in the parameters. Bearing in mind that the supply of money is given by

$$M = L_p^d - S_p^d + S_g,$$

and that the actual quantities of loans and nonbank public's security holdings are now given by (26) and (27), we have, from the first relations in (26) and (27),

$$\frac{dM}{dS_c} = \left(\frac{\partial \hat{L}_p^d}{\partial r_s} - \frac{\partial \hat{S}_p^d}{\partial r_s}\right) \frac{\partial r_s}{\partial S_c} \geq 0$$

because the term in parentheses is nonpositive by assumption (v); next, from the second relations in (26) and (27),

$$\frac{dM}{dr_d} = \frac{\partial L_p^d}{\partial r_d} - \frac{\partial S_p^d}{\partial r_d} > 0;$$

$$\frac{dM}{dr_l} = \frac{\partial L_p^d}{\partial r_d} - \frac{\partial S_p^d}{\partial r_d} \leq 0$$

in view of assumption (v); and, finally, assumption (v) again helps us to see that

$$\frac{dM}{dk} = \left(\frac{\partial \hat{L}_p^d}{\partial r_s} - \frac{\partial \hat{S}_p^d}{\partial r_s}\right) \frac{\partial r_s}{\partial k} \leq 0.$$

TABLE III
EFFECTS OF MONETARY POLICY AND PARAMETER CHANGES

Variable		Parameter			
		S_c	r_d	r_l	k
r_s	Regime I	−	+	+	+
	Regime II	−	−	−	+
M	Regime I	+	+	+	−
	Regime II	+(0)	+	−(0)	−(0)

The increase in central bank's security holdings S_c induces the drop in security rate r_s, which lowers nonbank public's security holdings S_p^d to a greater extent than its loan demand L_p^d, or lowers S_p^d and L_p^d by an equal amount, because of assumption (v). Therefore money supply M increases or remains unchanged. The rise in deposit rate r_d enlarges loan demand and lowers the nonbank public's security holdings, so its total effect is to increase money supply unambiguously. Also, the increase in loan rate r_l diminishes both bank loans and the nonbank public's security holdings but, because of assumption (v), the latter fall dominates the former in absolute value, so that the net effect is to decrease money supply or to leave it at its original level. Finally, when required reserve ratio k is raised, both bank loans and the nonbank public's security holdings increase, following the rise in the security rate, but assumption (v) ensures that the increase in security holdings dominates the change, so the net effect is to decrease the supply of money or to leave it unchanged.

The comparative statics results in the two regimes are summarized in Table III. The plus (minus) sign indicates that, by an increase in the relevant parameter, the money supply or the security rate will increase (decrease); the zero in parentheses implies that the variable may remain constant through the parameter change. We note from this table the qualitatively different effects of r_d and r_l on r_s, and of r_l on M, between the two regimes. We shall return to this point in the next section.

5. CONCLUDING REMARKS

Motivated by the observations of postwar Japanese asset markets, this paper has discussed transmission mechanisms and the effectiveness of monetary policy, using a model which embodies some features of Japan's financial system. Our model assumed short-run rigidity in some rates of interest and disequilibria in financial markets, which resulted in quantity constraints on and dual decisions by market participants. Our discussion therefore may be viewed as an inquiry into the properties of temporary equilibria which are brought about by dual decisions and quantity adjustments in addition to adjustments of a flexible interest rate, using a framework similar to that of Brainard and Tobin (1968), who conduct a simulation study of disequilibrium behavior in the financial markets.

The conclusions obtained from our model can be summarized as follows: The effects of open market operations and of the change in the required reserve ratio on the supply of money and the rate of interest are largely the same as those suggested by conventional analyses and those of the two regimes, in the qualitative sense. The points worth noting are that, depending on which regime the asset markets find themselves in, the changes in the rigid rates on bank loans and on deposits have qualitatively different effects on the flexible deposit rate, and the change in the loan rate affects the money supply in qualitatively different manners. In addition, even for other comparative statics effects possessing the same sign in the two regimes, we can almost certainly presume that their quantitative magnitudes are different, because the two regimes involve quite different behavior relations to determine the rate on securities and the stock of money (Appendix E offers concrete examples illustrating this point).

The framework we have explored so far is built on several simplifying assumptions, so the conclusions drawn therefrom need careful interpretations. Yet so long as the assumptions of short-run interest rate inflexibility and of resulting market disequilibria capture some aspects of actual financial markets, our analysis suggests that there exist certain relationships between the transmission mechanism and effectiveness of monetary policy, on the one hand, and the location and degree of disequilibria in asset markets, on the other.

Also, as is noted in the Introduction, Japan's high growth period, especially in the 1960s, has been characterized by the LIRP, coupled with brisk corporate demand for investment which was largely financed by commercial bank loans. After the oil shocks, however, the corporate demand for bank loans (as a proportion of GNP) seems on a declining trend, aside from business cycle factors (see, e.g., Economic Planning Agency, 1984; Chap. 4). We might therefore regard our Regime I as reflecting the financial markets of pre-oil-shock Japan, and Regime II as corresponding to its post-oil-shock counterpart; and accordingly the empirical test of this tentative hypothesis will be an interesting agendum for future research.

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