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PREFACE

The present study represents the result of work carried out in the Research Department of the Bank of Finland mainly in 1980 - 1981. The aim of the study was to develop a simple macroeconomic framework suitable for fiscal and monetary policy analysis in the institutional setting of the Finnish financial market.

This theoretical work is closely linked to the empirical work done in developing the quarterly model of the Bank of Finland (the BOF3-model). The model presented here can to quite a large extent be interpreted as a static and highly aggregated version of the IS-LM framework contained within the BOF3-model.

Philadelphia, November 29, 1981

Alpo Willman

This publication is a preliminary report on a study currently in progress.

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1. INTRODUCTION

There are many reasons for claiming that the market for financial assets is not well-developed in Finland. The security market is so "narrow" that security issues play no essential role in the financing of investment, bank loans being the principal source of external finance. This also implies that deposits are the only substitute for government bonds in households' portfolios. As, in addition, deposit and loan rates are controlled by the central bank and are thus insensitive to market disequilibria, no mechanism exists for equilibrating the credit market. For this reason the Finnish economy can be called a credit-rationing economy.

The banks' borrowing from the central bank plays a major role in the monetary policy pursued by the central bank. The central bank can affect the tightness of the credit market by regulating the terms of the banks' central bank debt. Under the system which was predominant until 1975, there were specified limits up to which each bank could borrow from the central bank at a basic discount rate. Penalty rates were applied on borrowing in excess of these basic quotas. A call money market, on which both the commercial banks and the central bank operate, was introduced in 1975. This market is another channel through which the central bank can supply funds to the banks.

It is clear that the familiar IS-LM framework, which assumes a perfect capital market, is not valid in the institutional setting described above. The purpose of this paper is to formulate an IS-LM analogy suitable for an economy characterized above. Two earlier attempts in this field are those by Koskela (1979a,b) and Oksanen (1980). One fundamental difference between their approaches and the present one is that their frameworks lack links from flow variables to stock variables. Hence they were able to study only the short-term comparative static properties of their models. However, from the point of view of the crowding-out phenomenon, the long-run stability properties of the models are of great importance.

In this respect, the framework specified in this paper is intended to be more thorough. The ad-hoc nature of the model is lessened by the fact that the assumptions concerning the behaviour of the banks and the nature of the credit market have been explicitly taken into account in the specification of the financial sector.[1] The banks are assumed to be either profit maximizers or maximizers of the volume of lending under a minimum profit constraint. The credit market is assumed to be heterogeneous, i.e., there are at the same time both rationed and unrationed clients. In a heterogeneous market, the effective supply of loans is always smaller than the notional demand for credit. Thus, credit rationing prevails all the time, with only the degree of rationing varying.[2]

The structure of this paper is as follows. In Section 2 the equations for the effective supply of loans have

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1. Here the studies concerning the behaviour of the banking sector by Koskela (1976) and, in particular, by Tarkka (1980a,b) have been consulted.

2. Besides excess demand for credit, excess supply of credit may also prevail in a homogeneous credit market. This is because in a homogeneous credit market the entire market is rationed to the same extent. Thus, if one client is rationed, then all clients are rationed.

been derived under alternative assumptions concerning the behaviour of banks. In this Section it is also shown that, under certain assumptions, the differential between the interest rate applied to central bank credit and the loan rate can be used as a measure of the degree of credit rationing.

In Section 3 the sectoral balance sheet constraints included in the model are presented, and in Section 4 the model is specified.

The comparative static properties of the different variants of the model are examined in Section 5. In Section 6 the endogenous price level is included in the model and in Section 7 the long-run effects of financing the government budget deficit from alternative sources are analysed.

2. THE EFFECTIVE SUPPLY OF LOANS IN A HETEROGENEOUS CREDIT MARKET

2.1. The Banks are Profit Maximizers

We assume that the balance sheet of an individual bank consists of loans L, deposits D, the bank's borrowing from the central bank H and government bonds held by the bank B^b.

$$(2.1) \quad L - D - H + B^b = 0$$

In a concentrated credit market the bank knows that its deposits depend partly on its lending through the credit expansion mechanism. We can now write

$$(2.2) \quad D = hL + \bar{D} \qquad 0 \leq h < 1$$

where h is the bank's credit expansion multiplier and $\bar{D}$ is the exogenous component of deposits from the point of view of the bank.

Using equations (2.1) - (2.2), the profit equation of the bank can be written in the following form:

$$(2.3) \quad P = (r_L+f)L + r_B B^b - r_D hL - r_D\bar{D}$$
$$- R[(1-h)L+B^b-\bar{D}]$$

where

r_L = the interest rate on bank loans

f = a term which takes into account other revenues and expenses related to lending (for instance, risk)

r_B = the bond rate

r_D = the deposit rate
R = the interest rate applied to the bank's central bank credit

We assume that loan and deposit rates are institutionally set by the central bank. It is further assumed that the interest rate applied to the bank's central bank credit R is independent of decisions of an individual bank. Both the bond rate r_B and the bonds sold to the bank are treated as decision parameters of the central government.[1] Thus, in the profit equation (2.3) the only decision parameter of the bank is the amount of loans L.

In the case of a heterogeneous credit market, banks may diversify their treatment of clients. Thus, some clients may not be rationed at all, while some are rationed more strictly than others. For this type of rationing to be rational behaviour, it has to be profitable from the point of view of the bank. One argument presented by Tarkka (1980) is that, when the degree of credit rationing rises, the structure of the clientele becomes better from the point of view of the bank. As the risk incurred through lending decreases, the quality of bank's loan portfolio improves. In the profit equation this can be taken into account by expressing the term f as a function of the degree of credit rationing

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1. In the Finnish institutional setting it might have been more realistic to assume that the amount of bonds held by the bank is a constant proportion of deposits, i.e., $B^b = kD$. This is because bonds are included in the cash reserves (which we have abstracted from the balance sheet of the bank) and it is more profitable to hold cash reserves in bonds than in currency. In this case, bonds B^b would never appear as an argument of bank lending and the macroeconomic effects of the bonds held by the banks or the non-banking private sector would always be similar.

$$f = f\left(\frac{L^d - L}{L^d}\right) \qquad f > 0;\ f' > 0;\ f'' < 0$$

There is also another channel through which credit rationing can affect a bank's profits. The bank can affect the size of its credit expansion multiplier h by giving priority in lending to its permanent clients over those who have neither been depositors of the bank nor used the bank's other services. Thus, the credit expansion multiplier h can also be expressed as a function of the degree of credit rationing:

$$h = h\left(\frac{L^d - L}{L^d}\right) \qquad h \geq 0;\ h' > 0;\ h'' < 0$$

Because the discrimination between clients becomes increasingly difficult when credit rationing tightens, it is natural to assume that rationing has diminishing returns.

Differentiating the profit equation (2.3) with respect to loans, we get the first order condition for a maximum:

$$(2.4) \qquad P' = r_L + f - \frac{L}{L^d}f' + (R - r_D)h - (R - r_D)\frac{L}{L^d}h' - R = 0$$

Next, we take the total differential of (2.3) and solve for dL.

$$(2.5) \qquad dL = \frac{L}{L^d}dL^d + \frac{{L^d}^2}{2L^d(f' + (R - r_D)h') - L(f'' + (R - r_D)h'')}$$

$$\left\{dr_L - \left(1 + \frac{L}{L^d}h' - h\right)dR + \left(\frac{L}{L^d}h' - h\right)dr_D\right\}$$

On the basis of equation 2.5, the effective supply of loans can be written as

$$(2.6) \quad L = L(L^d, r_L, R, r_D)$$

where

$$L_{L^d} = \frac{L}{L^d} < 1; \; L_{r_L} > 0; \; L_R < 0; \; L_{r_D} \gtrless 0$$

We see that the effect of the deposit rate r_D is ambiguous. However, on the basis of equation (2.5), it can be inferred that the more concentrated the credit market is, i.e., the greater the credit expansion multiplier h is, the more likely it is that the sign of L_{r_D} is negative.

If we assume that, as is the case in Finland, $dr_L = dr_D$ (i.e., $r_L - r_D$ is constant), we can see from (2.5) that equation (2.6) may be written in the form:

$$(2.7) \quad L = L(L^d, R-r_L)$$

So far we have assumed that the bank can obtain all the credit it needs from the central bank at a given interest rate. However, this was not the case in Finland before the introduction of a call money market in 1975. Before then, the central bank determined the limits up to which each bank could borrow from the central bank at a basic discount rate. Banks were entitled to exceed their quotas, but the interest rate applied also rose.

Next we assume that the interest rate applied to each bank's central bank credit is a linear function of the amount of its central bank credit.

$$(2.8) \quad R = R_0 + R_1 H \qquad R_0, R_1 > 0$$

If we now insert (2.8) into the profit equation (2.3) and solve the profit maximization problem, we obtain the following result:

$$(2.9)\quad dL = \frac{1}{a+b}\left\{\frac{(a+c)L}{L^d}dL^d + dr_L + \left(1+\frac{L}{L^d}h'-h\right)\left[2R_1(dB^b-d\bar{D})-dR_0-2HdR_1\right] - \left(\frac{L}{L^d}h'-h\right)dr_D\right\}$$

where

$$a = \left[\frac{2(f'+(R_0-r_D)h')}{L^d} - \frac{(f''+(R_0-r_D)h'')L}{L^{d^2}} + \frac{2R_1H}{L^d}\left(h'-\frac{Lh''}{L^d}\right)\right] > 0$$

$$b = 2R_1\left(1+\frac{L}{L^d}h'-h\right)^2 > 0$$

$$c = \frac{2R_1Lh'}{L^d}\left(1+\frac{L}{L^d}h'-h\right) > 0$$

Assuming that $dr_L = dr_D$, the effective supply function of the bank lending can be written as

$$(2.10)\quad L = L(L^d, R_0-r_L, R_1, \bar{D}-B^b)$$

where[1]

$$0 < L_{L^d} < 1;\; L_{\bar{D}} = -L_{B^b} > 0;\; L_{R_0} < 0,\; L_{R_1} < 0$$

Unlike in the case of a call money market, the volume of bank lending now depends also on the exogenous

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1. A sufficient condition for $L_{L^d} < 1$ is that $c < b$. This is true because $\frac{c}{b} = \dfrac{h'}{h'+\frac{L^d}{L}(1-h)} < 1$.

component of deposits and the amount of bonds held by banks. The reason for this is that deposits and bonds affect the marginal cost of lending, because the interest rate applied to each bank's central bank credit is no longer exogenous from the point of view of the bank but instead depends on the behaviour of each bank. The partial derivative $L_{\bar{D}}$ may be either greater of smaller than one. If perfect competition prevails in the banking sector, L_D is smaller than one, but the more concentrated the banking sector is, i.e., the greater h is, the more likely it is that $L_{\bar{D}} > 1$.

2.2. The Banks Maximize the Volume of Lending

We shall next derive the equation determining bank lending when the bank maximizes its lending under the minimum profit constraint.

In this case, the first order condition for a maximum is

$$(2.11)\quad P - P_0 = 0$$

where profit P is determined by equation (2.3) and P_0 is the level of minimum profit.

We shall first assume that the market for the banks' central bank credit is a call money market. By differentiating equation (2.11), we can now solve for dL.

$$(2.12)\quad [R+\frac{L}{L^d}(f'+h'(R-r_D))-(R-r_D)h-f-r_L]\,dL =$$

$$\frac{L^2}{{L^d}^2}[f'+(R-r_D)h']dL^d + B^b dr_B - hLdr_D + (L-\bar{D})dr_L$$

$$- HdR + (R-r_D)r\bar{D} - (R-r_B)dB^b - dP^0$$

In this case, the second order condition for a maximum is that the partial derivative $\partial P/\partial L$ is negative, i.e., the term before dL has to be positive. Assuming that $dr_B = dr_D = dr_L$ and $dP_0 = 0$, the relation determining the volume of bank lending can now be written in the form:

$$(2.13)\quad L = L(L^d, R-r_L, \bar{D}, B^b)$$

where

$L_{L^d} > 0$ $\qquad$ $L_{\bar{D}} > 0$

$L_R < 0$ $\qquad$ $L_{B^b} < 0$

Equation (2.12) shows that both $L_{\bar{D}}$ and $-L_{B^b}$ can be greater than one. Assume, for instance, that there is an exogenous increase in deposits. The total impact on lending tends to be greater than the original shock, because deposits are the cheapest source of finance. This feature reduces the average cost of lending. However, in a heterogeneous credit market, the average returns also decrease, because credit rationing diminishes as a result of credit expansion. Only if this latter effect dominates, is $L_{\bar{D}} < 1$.

If penalty rate schedules are applied to the bank's borrowing from the central bank, the interest rate applied to bank's central bank credit R is no longer exogenously given. That is why R is substituted for the parameters of penalty rate schedules in the effective supply function of loans. Making the same assumptions as above, we obtain the following loan equation:

$$(2.14)\quad L = L(L^d, R_0-r_L, R_1, \bar{D}, B^b)$$

where

$L_{L^d} > 0$ $\qquad 0 < L_{\bar{D}} \gtrless 1$

$L_{R_0} < 0$ $\qquad 0 < L_{B^b} \gtrless 1$

$L_{R_1} < 0$

The use of equations (2.10), (2.13) and (2.14) as parts of a macromodel is inconvenient, since the term $\bar{D}$ cannot serve as an argument of bank lending, because it is an unobservable variable. However, by using the relation $\bar{D} = D - hL$, we can substitute $\bar{D}$ for D, which is an observable variable.[1] This operation does not change the signs of the partial derivatives. What happens is that the partial derivatives of equations (2.10), (2.13) and (2.14) become multiplied by the term 1/1-h.

2.3. The Relation between Credit Rationing and the Marginal Cost of Borrowing from the Central Bank

It is easy to show that, under certain assumptions, the degree of credit rationing can be expressed as a function of the marginal cost incurred by the banks. We have to assume that the banks are profit maximizers, the market for central bank credit is a call money market, the credit market is heterogeneous and the difference between the loan and deposit rates is constant all the time, i.e., $r_L - r_D = v$.

The first order condition for profit maximization (2.4) can now be transformed into the form:

$$(2.15) \quad [1-h+(1-\frac{L^d-L}{L^d})h'](R-r_L) + (1-\frac{L^d-L}{L^d})(f'+vh') - f - vh = 0$$

1. It is worth noting that the aggregate level h is not identical with the credit expansion multiplier in its ordinary sense but a weighted average of h_i (i=1,...,n), where n stands for the number of banks.

If we now define $z = \frac{L^d - L}{L^d}$, and recall that

$f = f(z)$ $f' = f'(z)$

$h = h(z)$ $h' = h'(z)$,

we can express the difference $R-r_L$ (the marginal cost of borrowing from the central bank) as a function, the only argument of which is the degree of credit rationing z.

$$(2.16)\quad R-r_L = \frac{f(z)+vh(z)-(1-z)(f'(z)+vh'(z))}{1-h(z)+(1-z)h'(z)} = \frac{u(z)}{w(z)}$$

$$= g(z)$$

If we differentiate equation (2.16), we obtain

$$(2.17)\quad \frac{d(R-r_L)}{dz} = \frac{1}{w}u' - \frac{u}{w^2}w' > 0$$

where $w > 0$, $u' > 0$, $w' < 0$ and $u > 0$ whenever $R-r_L > 0$. According to relation (2.17), the marginal cost of central bank credit always rises when the degree of credit rationing increases.

3. SECTORAL BALANCE SHEET CONSTRAINTS

Before specifying our model, we shall first define the sectors and the sectoral balance sheet or budget constraints. The model includes the private non-banking sector, which consists of households and firms. From now on, we shall simply call this sector the private sector. The other sectors of the model are the banks, the central bank, the government sector and the foreign sector. We assume that the banks' profits are distributed to the public and the central bank's profit to the government sector.[1] We obtain the net interest payments from the government to the private sector by adding the net interest payments from the government and banking sectors to the private sector to the profits of the banks.

$$\begin{array}{ll} & r_D D + r_B B^p - (r_L+f)L \\ & (r_L+f)L + r_B B^b - r_D D - R \cdot H \\ \hline \text{sum} & = r_B(B^p+B^b) - R \cdot H \end{array}$$

The symbols B^p and B^b refer to the bonds held in the portfolios of the public and the banks, respectively. It is further assumed that only the government can borrow from abroad. When the sources of finance are written on the left hand side and uses on the right hand side, the sectoral balance sheets can now be written in the following form:

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1. In Finland, the central bank is required by law to distribute half of its net profit to the central government, while the other half is added to the capital accounts of the central bank. Because our simplified balance sheet of the central bank does not include capital accounts, we assume that the net profit is totally distributed to the central government.

Private sector:

$$(3.1) \quad Y + r_B B - R \cdot H - T(Y) + \Delta L = E(\cdot) + \Delta N + \Delta D + \Delta B^p$$

Banks:

$$(3.2) \quad \Delta D = -\Delta H + \Delta L + \Delta B^b$$

Central bank:

$$(3.3) \quad \Delta N - \Delta H = \Delta HG + \Delta F$$

Government sector:

$$(3.4) \quad \Delta B^p + \Delta B^b + \Delta HG + \Delta FG + T(Y) + R \cdot H = G + r_F FG + r_B B$$

Foreign sector:

$$(3.5) \quad \Delta F = X(Y) - r_F FG + \Delta FG$$

Sum:

$$(3.6) \quad Y = E(\cdot) + G + X(Y)$$

where

Y = national income

$B = B^p + B^b$ = government bonds held in the portfolios of the public (p) and the banks (b)

r_B = the bond rate

R = the interest rate applied to the banks' central bank credit

H = banks' central bank credit

T = taxes

L = bank lending

E = private expenditure

N = currency

D = deposits

HG = government borrowing from the central bank

F = foreign reserves

FG = foreign debt of the government sector

r_F = the foreign interest rate

X = net exports

G = government sector expenditure

Summing the sectoral budget constraints, we obtain the national account identity (3.6). In the balance sheet of the private sector, there is only one expenditure variable which includes both consumption and investment. The balance sheet of the banks is the same as in the preceding section. It is assumed that the banks do not hold currency in their portfolios. Instead, the banks are net borrowers from the central bank. According to the balance sheet identity of the central bank, the size of the monetary base (N-H) changes when either the domestic component of the base, i.e., government borrowing from the central bank, or the foreign component, i.e., the amount of foreign reserves, changes.

According to the budget constraint of the government sector the government may finance its budget deficit by selling bonds to the private sector and the banks or by borrowing from the central bank or abroad. The balance of payments identity implies that any change in foreign reserves is equal to the sum of the current account deficit and the government's borrowing from abroad. By adding together all the sectoral balance sheets, we obtain the national income identity.

4. THE SPECIFICATION OF THE MODEL

4.1. The Goods Market

The disequilibrium theory implies that, if there are quantity constraints in one market, it will cause spillover effects in other markets as well. Ito (1980) has shown that in the case of Cobb-Douglas utility functions the deviation of effective demand from notional demand in an unconstrained market is a linear function of the extent of rationing in a constrained market. Accordingly, the effective demand for goods when the credit market is rationed is determined by equation (4.1):

$$(4.1) \quad E^{eff} = E^{not}(Y,r_L,\cdot) - a(L^d(Y,r_L)-L)$$

where

$0 < a < 1$

In a slightly less restrictive form, relation (4.1) can be expressed in the following form:

$$(4.2) \quad E^{eff} = E(Y,r_L,Z,\cdot) \qquad E_Y > 0,\ E_{r_L} < 0,\ E_Z < 0$$

where

$Z = L^d - L$

Now the equilibrium condition for the goods market can be written in the following form:

$$(4.3) \quad Y = E(Y^d,r_L,Z,W) + G + X(Y)$$

where

Y^d = disposable income of the private sector

W = financial wealth

Y^d is determined in the following way:

(4.4) $Y^d = Y + r_B B - R \cdot H - T(Y)$

and financial wealth as

(4.5) $W = N + D + B^p$

The purpose of W is to measure the liquidity of the private sector.

4.2. The Financial Sector[1]

There are two balance sheets in the financial market which have to hold all the time. They are the balance sheet of the central bank (4.6) and the balance sheet of the banks (4.7).

(4.6) $N - H - HG - F = 0$

(4.7) $D + H - L - B^b = 0$

We assume that both the amount of bonds held by the banks (B^b) and government sector borrowing from the central bank (HG) are exogenously determined by the government. We further assume that the amount of foreign reserves is determined through the balance of payments equation:

(4.8) $\dot{F} = X(Y) + \dot{FG} - r_f FG$

where net exports X are determined by the goods market and the government sector foreign borrowing FG is exogenous.

1. The financial sector presented in this section is equal to that of the BOF3-model constructed by Juha Tarkka. The main differences are that in the present analysis capital imports are assumed exogenous and the credit market heterogeneous, whereas in the BOF3-model the credit market is assumed homogeneous.

The functioning of the financial sector and the entire model depends crucially on the assumptions about the reactions in the banks' central bank credit. If we assume that it is directly under the control of the central bank and thus exogenous, the amount of currency in circulation can be solved as a residual of the balance sheet of the central bank. Under this assumption, changes in the banks' central bank credit are immediately followed by equal changes in the amount of currency, because the effects on the amount of foreign reserves are transmitted through the goods market, and this takes time. Similarly, all changes in the current account are reflected in the amount of currency in circulation. Thus, a typical situation would be that there is either excess demand for or excess supply of currency.[1]

However, unlike in the previous description, the relation between the amount of currency and national income has been very stable in Finland. It has been observed that changes in foreign reserves affect the amount of the banks' central bank credit rather than the stock of currency. This accords with the fact that in Finland the real policy parameters of the central bank are not the amount of central bank credit but the terms of central bank credit. Central bank credit operates as a buffer stock whenever there are unexpected changes in the banks' liquidity. The banks' central bank credit could play this role, if it were exogenous.

Accordingly, we assume now that the amount of currency is determined by the following demand equation:

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1. I have analysed this version of the model in an earlier unpublished paper (Willman, 1980).

(4.8) $N = N(Y, r_D) \qquad N_Y > 0;\ N_{r_D} < 0$

The amount of the banks' central bank credit can now be derived from the balance sheet of the central bank.

On the basis of Section 2, the volume of bank lending is determined by function (4.9.a) or function (4.9.b).

(4.9.a) $L = L(L^d, R - r_L, D, B^b)$

$$0 \leq L_{L^d} < 1;\ L_R < 0;\ L_D \geq 0;\ L_{B^b} \leq 0$$

(4.9.b) $L = L(L^d, R_0 - r_L, R_1, D, B^b)$

$$0 \leq L_{L^d};\ L_{R_0} < 0;\ L_{R_1} < 0;\ L_D > 0;\ L_{B^b} < 0$$

According to equation (4.9.a), the market for the banks' central bank credit is a call money market. If the banks are profit maximizers, the partial derivatives L_D and L_{B^b} are equal to zero. In equation (4.9.b), it is assumed that penalty rates are applied to the banks' borrowing from the central bank.

We now see that, because either equation (4.9.a) or equation (4.9.b) determines the effective supply of loans L, bonds B^b are exogenous and the amount of central bank credit is determined by identity (4.6) and thus, through identity (4.7), the amount of deposits is also determined.

We have now obtained equations for each endogenous component of the balance sheet of the banks and the central bank. To complete our model of the financial sector, we need an equation for the interest rate on central bank credit. We assume that the terms of central bank credit are such that the greater the amount of credit, the higher is the interest rate banks have to pay on it.[1] In a linear form, this relation can be written as

$$(4.10) \quad R = R_0 + R_1 \cdot H \qquad R_0 > 0;\ R_1 \geq 0$$

In equation (4.10) the policy variables of the central bank are the parameters R_0 and R_1.

The following illustrates how the financial sector just specified operates. We shall first study a case where the government sector deficit is financed through borrowing either from abroad or from the central bank. Since we shall concentrate on the first-round effects on the financial market, national income is assumed constant.

Because the increase in government sector debt to abroad or to the central bank is channelled to the private sector through the budget deficit, it means that private sector liquidity increases. The amount of currency, however, does not increase because it is determined by national income according to equation (4.8). All liquidity growth is channelled into deposits. Since deposits are not an argument in equation (4.9) determining the volume of bank lending, or their effects are lagged, the volume of bank lending does not change immediately. Instead, central bank credit will diminish. Bank lending will increase only after the cost of borrowing from the central bank has decreased through equation (4.10).

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1. In the case of a call money market, relation (4.10) can be interpreted as a reaction function of the central bank. When penalty rate schedules are applied, relation (4.10) is a weighted average of the penalty rate schedules of individual banks.

The banks' central bank credit is the counter item for deposits in the balance sheet of the banks, and the counter item for foreign reserves and/or government borrowing from the central bank in the sheet of the central bank.

If the government deficit is financed by means of bonds sold to the banks, private sector liquidity increases. During the first round, the increase in the amount of bonds B^b is followed by an equal (or almost equal) increase in the amount of deposits. There are hardly any immediate effects on bank lending or these effects are very small, because the partial derivatives L_D and L_{B^b} (if they deviate from zero) are equal or at least almost equal, although with opposite signs. Only if bond financing has real effects, will these effects be transmitted to the banks' central bank credit and bank lending.

The sales of bonds to the private sector have no immediate effects on the financial sector items. What happens is that there is a decrease in the deposits of bond buyers; however, these funds are channelled back to the private sector through the government sector deficit and, accordingly, the total amount of deposits does not change.

4.3. The Model

The equations specified in sections (4.1) and (4.2) are combined as follows:

$$(4.3.1) \quad Y = E\,(Y + r_B B - R \cdot H - T(Y), r_L, Z, W) + G + X(Y)$$

$$E_Y,\ E_W > 0;\ E_{r_L},\ E_Z,\ X_Y \leq 0$$

(4.3.2) $Z = L^d - L$

(4.3.3) $L^d = L^d(Y, r_L) \qquad L_Y > 0;\ L^d_{r_L} < 0$

(4.3.4.a) $L = L(L^d, R - r_L, D, B^b)$

$L_{L^d} > 0;\ L_R < 0;\ L_D \geq 0;\ L_{B^b} \leq 0$

or

(4.3.4.b) $L = L(L^d, R_0 - r_L, R_1, D, B^b)$

$L_{L^d} > 0;\ L_{R_0},\ L_{R_1} < 0;\ L_D > 0;\ L_{B^b} < 0$

(4.3.5) $N = N(Y, r_D) \qquad N_Y > 0;\ N_{r_D} \leq 0$

(4.3.6) $R = R_0 + R_1 H \qquad R_0,\ R_1 \geq 0$

(4.3.7) $H = N - F - HG$

(4.3.8) $D = L + B^b - H$

(4.3.9) $B = B^p + B^b$

(4.3.10) $W = N + D + B^p$

(4.3.11) $\dot{F} = X(Y) - r_F FG + \dot{FG}$

(4.3.12) $\dot{FG} + \dot{HG} + \dot{B} = G + r_B B + r_F FG - T(Y) - R \cdot H$

Equations (4.3.1) - (4.3.10) determine the static part of the model. In this part, there are thirteen endogenous variables, i.e., national income Y, private expenditure E, taxes T, net exports X, excess demand for credit Z, notional demand for credit L^d, effective supply of credit L, currency N, interest rate applied to the banks' central bank credit R, the banks' central bank credit H, deposits D, government bonds B and private financial wealth W. Exogenous variables are government expenditure G, bond rate r_B, loan rate r_L, deposit rate r_D, the terms of the banks' central bank credit, i.e., parameters R_0 and R_1, government borrowing from the central bank HG, bonds sold to the banks B^b and to the private sector B^p and foreign reserves F.

Equations (4.3.11) and (4.3.12) make the system dynamic. Through these equations the stock variables F and at least one of the variables B^b, B^p, HG and FG become endogenous. The links from flows to stocks are essential when studying the long-run properties of the model. However, we shall first examine the comparative static properties of the static part of the model.

5. THE COMPARATIVE STATICS OF THE MODEL

It can be seen that we have two versions of the model, depending on which of the equations (4.3.4.a) or (4.3.4.b) is used, i.e., whether the market for central bank credit is a call money market or penalty rates (which are known ex ante by the banks) are applied to the banks' borrowing from the central bank. We shall start by studying the case of a call money market.

5.1. The Case of a Call Money Market

5.1.1. The Wealth Effect Excluded

When a call money market prevails in the market for the banks' central bank credit, it is possible to simplify the model by assuming that the banks are profit maximizers and private wealth does not affect private expenditure.

The static part of the model can now be written in the form:

(5.1) $Y = E(Y+r_B B-R\cdot H-T(Y), r_L, Z, W) + G + X(Y)$

(5.2) $Z = L^d - L$

(5.3) $L^d = L^d(Y, r_L)$

(5.4) $L = L(L^d, R-r_L)$

(5.5) $N = N(Y, r_D)$

(5.6) $R = R_0 + R_1 H$

(5.7) $H = N - F - HG$

Except in the wealth variable W, deposits D do not play any role in the model. We see that, along with deposits, the banks' balance sheet constraint has lost its importance as far as the operation of the model is concerned. In fact, this means that the private non-banking sector and the banking sector have been consolidated. Hence, there is no need to make a distinction between bonds held by the private non-banking sector and the banking sector in this simple version of the model.

We can simplify our model further by using the result obtained in section (2.3). It was shown there that the degree of credit rationing can be expressed as a function of the difference $R-r_L$, i.e.,

$$(5.8) \quad \frac{L^d - L}{L^d} = g^{-1}(R-r_L) \qquad g^{-1} > 0$$

If we now use expression (5.8) as a measure of credit rationing in the private expenditure equation instead of excess demand for credit L^d-L, we can write the model in the following form:

$$(5.9) \quad Y = E(Y+r_B B-R\cdot H-T(Y), r_L, Z) + G + X(Y)$$

$$(5.10) \quad Z = R - r_L$$

$$(5.11) \quad N = N(Y, r_D)$$

$$(5.12) \quad R = R_0 + R_1 H$$

$$(5.13) \quad H = N - F - HG$$

Equation (5.10) has been substituted for equations (5.2) - (5.4). This means that the loan variables L^d and L are no longer needed.

By inserting equations (5.11) - (5.13) into (5.9) and (5.10) and differentiating them, we obtain

(5.14) $[1-E_Y(1-N_Y(R+R_1H)-T_Y)-X_Y]dY - E_Z dZ$

$= dG + E_Y r_B dB + (E_Y R+E_Y R_1 H)(dF+dHG)$

$+ (E_{r_L} - N_{r_D} E_Y(R+R_1H))dr - E_Y H dR_0 - E_Y H^2 dR_1$

(5.15) $-R_1 N_Y dY + dZ = -R_1(dF+dHG) + (R_1 N_{r_D} - 1)dr$

$+ dR_0 + HdR_1$

It is assumed that changes in the loan rate and the deposit rate are equal, i.e., $dr_L = dr_D = dr$.

From equations (5.14) and (5.15) we obtain in the (Z,Y) space the following slope and shift formulae.

Goods market equilibrium (IS):

the slope formula

$$\frac{\partial Y}{\partial Z} = \frac{E_Z}{1 - E_Y(1-N_Y(R+R_1H)-T_Y) - X_Y} = \frac{E_Z}{1-C} < 0$$

$(E_Z < 0;\ 1-C > 0)$

shift formulae

$$\frac{\partial Y}{\partial G} = \frac{1}{1-C} > 0 \qquad \frac{\partial Y}{\partial B} = \frac{E_Y r_B}{1-C} > 0$$

$$\frac{\partial Y}{\partial F} = \frac{\partial Y}{\partial HG} = \frac{E_Y(R+R_1H)}{1-C} > 0$$

$$\frac{\partial Y}{\partial r} = \frac{E_{r_L} - N_{r_D} E_Y(R+R_1H)}{1-C} = \frac{g}{1-C} \gtrless 0 \qquad (E_{r_L} < 0$$

$$N_{r_D} E_Y(R+R_1H) < 0)$$

$$\frac{\partial Y}{\partial R_0} = - \frac{E_Y H}{1-C} < 0 \qquad \frac{\partial Y}{\partial R_1} = - \frac{E_Y H^2}{1-C} < 0$$

Equilibrium in the market for central bank credit (LM):

the slope formula:

$$\frac{\partial Z}{\partial Y} = R_1 N_Y > 0$$

shift formulae

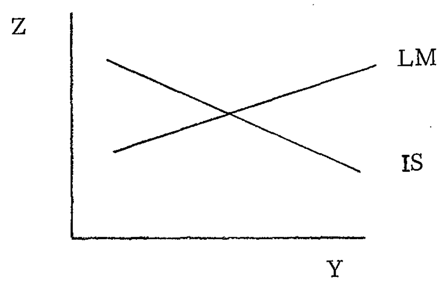
$$\frac{\partial Z}{\partial F} = \frac{\partial Z}{\partial HG} = -R_1 < 0$$

$$\frac{\partial Z}{\partial r} = R_1 N_{r_D} - 1 < 0 \qquad (N_{r_D} < 0)$$

$$\frac{\partial Z}{\partial R_0} = 1 \quad , \qquad \frac{Z}{R_1} = H$$

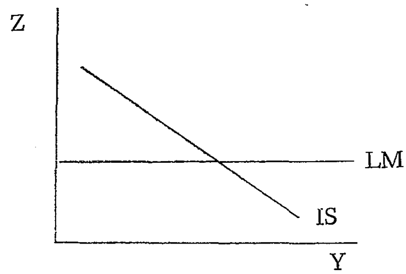
According to equations (5.14) and (5.15), the IS-curve is downward and the LM-curve upward sloping. These curves are shown in Figure 1.

Figure 1.



If it is assumed that the central bank does not follow any policy rule (i.e. $R = R_0$), the LM-curve is horizontal (Figure 2). This means that the degree of credit rationing Z is totally determined by the exogenous variables R_0 and r_L.

Figure 2.



Before studying the comparative static properties of the model it is useful to make sure that the model is stable. For this purpose, we shall specify the following two dynamic equations.

$$(5.16.a) \quad \dot{Y} = \alpha[E(Y+r_B B-R\cdot H-T(Y), r_L, R-r_L)+G+X(Y)-Y]$$

$$(5.16.b) \quad \dot{Z} = \dot{R} = \beta[N(Y,r_D)-F-HG-\frac{1}{R_1}(R-R_0)]$$

where α and β are positive constants.

According to equation (5.16.a), production will increase as long as the demand for goods is greater than their supply. Equation (5.16.b) implies that the cost of borrowing from the central bank rises as long as the demand for central bank credit is greater than the supply. The demand for and the supply of central bank credit is determined by equations (5.13) and (5.12), respectively.

Linearizing equations (5.16.a) and (5.16.b), we obtain

$$(5.17) \quad \begin{bmatrix} \dot{Y} \\ \dot{R} \end{bmatrix} = \begin{bmatrix} -\alpha(1-C) & \alpha E_Z \\ \beta N_Y & -\frac{\beta}{R_1} \end{bmatrix} \begin{pmatrix} Y-Y^* \\ R-R^* \end{pmatrix}$$

where Y^* and R^* are equilibrium values.

The system is locally stable, if the trace of the coefficient matrix is negative and the determinant is positive. This is true because the trace is

$$-\alpha(1-C) - \beta/R_1 < 0$$

and the determinant is

$$\alpha\beta[(1-C)/R_1 - N_Y E_Z] > 0$$

Using a simpler notation, equations (5.14) and (5.15) can be written as

$$(5.14)' \quad (1-C)dY - E_Z dZ = A_1$$

$$(5.15)' \quad -R_1 N_Y dY + dZ = A_2$$

where

$$A_1 = dG + E_Y r_B dB + E_Y(R+R_1 H)(dF+dHG) + gdr - E_Y H dR_0 - E_Y H^2 dR_1$$

$$A_2 = -R_1(dF+dHG) + (R_1 N_{r_D} - 1)dr + dR_0 + HdR_1$$

We can now solve for dY and dZ.

$$(5.18) \quad dY = \frac{\begin{vmatrix} A_1 & -E_Z \\ A_2 & 1 \end{vmatrix}}{\begin{vmatrix} 1-C & -E_Z \\ -R_Y N_Y & 1 \end{vmatrix}} = \frac{A_1 + A_2 E_Z}{1-C - E_Z R_1 N_Y} =$$

$$\frac{1}{1-C - E_Z R_1 N_Y}\{dG+E_Y r_B dB+[E_Y(r+R_1 H)-E_Z R_1](dHG+dF) + [g+E_Z(R_1 N_{r_D}-1)]dr-(E_Y H-E_Z)dR_0-(E_Y H^2-E_Z H)dR_1\}$$

$$(5.19)\quad dZ = \frac{\begin{vmatrix} 1-C & A_1 \\ -R_1N_Y & A_2 \end{vmatrix}}{1-C - E_ZR_1N_Y} = \frac{(1-C)A_2 + R_1N_YA_1}{1-C - E_ZR_1N_Y} =$$

$$\frac{1}{1-C - E_ZR_1N_Y}\{R_1N_YdG+R_1N_YE_Yr_BdB$$

$$+[R_1N_YE_Y(R+R_1H)-R_1(1-C)]\cdot(dHG+dF)$$

$$+[gR_1N_Y+(1-C)(R_1N_{r_D}-1)]dr+(1-C-R_1N_YE_YH)dR_0$$

$$+[(1-C)H-R_1N_YE_YH^2]dR_1\}$$

The denominator $1-C - E_ZR_1N_Y$ is always positive.

The signs of the effects of exogenous variables are presented in Table 5.1.

Table 5.1.

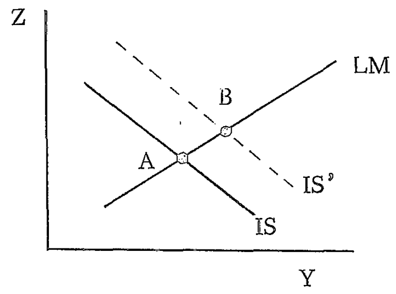
	Exogenous variables						
	G	B	HG	F	r	R_0	R_1
Y	+	+	+	+	?	–	–
Z	+	+	?	?	?	?	?

It can be seen that it is only in the case of domestic interest rates that the direction of the effects of changes in exogenous variables on national income cannot be determined. The effects on credit rationing are much more ambiguous.

<u>An increase in government expenditure or the amount of bonds</u>

Figure 5.1 shows what happens when government expenditure or the amount of bonds increases.

Figure 5.1.

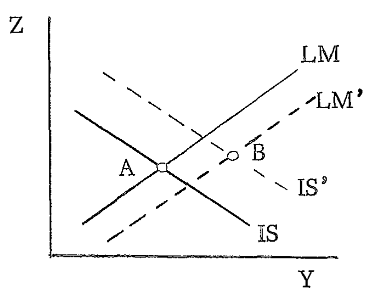


Both an increase in government expenditure and an issue of new bonds shift the IS-curve to the right and the short-run equilibrium point shifts from point A to point B. These policy measures have no effects on the location of the LM-curve.

An increase in the monetary base

The effects of government sector borrowing from the central bank and changes in the foreign reserves are similar. They decrease the banks' central bank credit and also the interest payments from the private to the public sector. This means that the IS-curve shifts to the right (Figure 5.2).

Figure 5.2.



A decrease in central bank credit also lowers the interest rate on central bank credit and so the LM-curve shifts downwards. At the new equilibrium point B, national income has increased but the effect on the degree of credit rationing is indeterminate.

A rise in domestic interest rates

The effect of a rise in domestic interest rates on the location of the IS-curve is indeterminate. A rise in the loan rate decreases the notional demand for goods and tends to shift the IS-curve to the left. A rise in the deposit rate tends, in turn, to shift the IS-curve to the right by decreasing the interest payments from the private to the public sector. The direction of the shift of the IS-curve depends on which of these two forces dominates (Figure 5.3). The rise in domestic interest rates shifts the LM-curve unambiguously downwards, because the rise in the loan rate increases the supply of bank loans and the rise in the deposit rate decreases the demand for currency. Both of these decrease the excess demand for loans.

Figure 5.3.

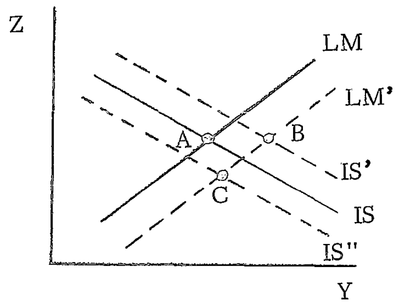
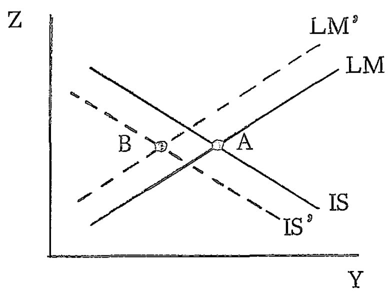


Figure 5.3 shows that, if the IS-curve shifts to the right, the rise in domestic interest rates is unambiguously an expansive policy measure. In this case, the equilibrium point shifts from point A to point B. If the IS-curve shifts to the left, it is indeterminate whether the new equilibrium point is on the right or the left side of the original equilibrium point A.

<u>A change in the parameters of the supply function of central bank debt</u>

An upward change in the parameters of the supply function of the banks' central bank credit shifts the IS-curve to the left because it increases the interest payments from the private to the public sector (Figure 5.4).

Figure 5.4.



The LM-curve shifts upwards, because a tightening in the terms of central bank credit reduces the volume of bank lending. Thus the new equilibrium point B is unambiguously on the left side of the original equilibrium point A.

5.1.2. The Wealth Effect Included

When the wealth effect is included and the market for central bank credit is a call money market, the static part of the model consists of equations (4.3.1) - (4.3.3), (4.3.4.a) and (4.3.5) - (4.3.10). If the banks are profit maximizers, the loan equation can be written in the form $L = L(L^d, R-r_L)$, i.e., in the equation (4.3.a) $L_D = L_{B^b} = 0$. Because equations (4.3.8) - (4.3.10) can be combined into one equation, i.e., $W = N+L+B-H$, the differentiation of bonds between bonds held by the banks and the private sector is of no importance.

If we differentiate the model including deposits D and bonds B^b as arguments of the loan equation and solve the IS- and the LM-equations, we obtain:

$$(5.20)\quad Q_Y dY + Q_Z dZ = dG + Q_{B^p} dB^p + Q_{B^b} dB^b + Q_F(dF+dHG) + Q_r dr + Q_{R_0} dR_0 + Q_{R_1} dR_1$$

$$(5.21)\quad S_Y dY + dZ = S_{B^b} dB^b + S_F(dF+dHG) + S_r dr + S_{R_0} dR_0 + S_{R_1} dR_1$$

where

$$Q_Y = 1-E_Y[1-T_Y-N_Y(R+HR_1)]-X_Y-\frac{E_W}{1-L_D}(L_{L^d}L^d_Y-L_D N_Y+L_R R_1 N_Y)$$

$$Q_Z = -E_Z$$

$$Q_{B^p} = (E_Y r_B+E_W)$$

$$Q_{B^b} = E_Y r_B+\frac{E_W(1+L_{B^b})}{1-L_D}$$

$$Q_F = E_Y(R+HR_1)+\frac{E_W(1-L_R R_1)}{1-L_D}$$

$$Q_r = E_{r_L} - E_Y[B+N_{r_D}(R+HR_1)] + \frac{E_W(L_{L^d}L^d_{r_L} - L_DN_{r_D} - L_R + L_RR_1N_{r_D})}{1-L_D}$$

$$Q_{R_0} = \frac{E_WL_R}{1-L_D} - E_YH$$

$$Q_{R_1} = (\frac{E_WL_R}{1-L_D}) - E_YH)H$$

$$S_Y = \frac{-[L^d_Y(1-L_D-L_{L^d}) + L_DN_Y - L_RR_1N_Y]}{1-L_D}$$

$$S_{B^b} = -\frac{(L_D+L_{B^b})}{1-L_D}$$

$$S_F = -\frac{(L_D-L_RR_1)}{1-L_D}$$

$$S_r = \frac{L^d_{r_L}(1-L_D-L_{L^d}) + L_R(1-R_1N_{r_D}) + L_DN_{r_D}}{1-L_D}$$

$$S_{R_0} = -\frac{L_R}{1-L_D}$$

$$S_{R_1} = -\frac{L_RH}{1-L_D}$$

When the banks are profit maximizers $L_D = L_{B^b} = 0$, the signs of the parameters of equations (5.20) and (5.21) are:

$Q_Y > 0$	$S_Y < 0$
$Q_Z > 0$	
$Q_{B^p} = Q_{B^b} > 0$	$S_{B^b} = 0$
$Q_F > 0$	$S_F < 0$
$Q_r \gtrless 0$	$S_r < 0$
$Q_{R_0} < 0$	$S_{R_0} > 0$
$Q_{R_1} < 0$	$S_{R_1} > 0$

As in the preceding section, the IS-curve is downward sloping and the LM-curve upward sloping. The slope of the LM-curve is positive even in the case where the interest rate on the banks' central bank credit is exogenously determined, i.e., $R = R_0$.[1] Under this assumption, the LM-curve was horizontal in the preceding section. These different results are due to the fact that now the credit rationing variable is the amount of excess demand for credit $L^d - L$ instead of the rate of excess demand for credit $\frac{L^d - L}{L}$. The location of the LM-curves depends in both cases only on the interest rates R and r_L.

If the banks are maximizers of the amount of loans, the partial derivatives L_D and $-L_{B^b}$ are positive and they may even be greater than one, as shown in section 2.2. Depending on whether $L_D < 1$ or $L_D > 1$, we obtain:

$L_D < 1$		$L_D > 1$	
$Q_Y > 0$	$S_Y < 0$	$Q_Y \gtrless 0$	$S_Y \gtrless 0$
$Q_Z > 0$		$Q_Z > 0$	
$Q_{B^p} > 0$		$Q_{B^p} > 0$	
$Q_{B^b} > 0$	$S_{B^b} < 0$	$Q_{B^b} > 0$ if $L_{B^b} > 1$; < 0 if $L_{B^b} < 1$	$S_{B^b} > 0$
$Q_F > 0$	$S_F < 0$	$Q_F \gtrless 0$	$S_F > 0$
$Q_r \gtrless 0$	$S_r \gtrless 0$	$Q_r \gtrless 0$	$S_r \gtrless 0$
$Q_{R_0} < 0$	$S_{R_0} > 0$	$Q_{R_0} \gtrless 0$	$S_{R_0} < 0$
$Q_{R_1} < 0$	$S_{R_1} > 0$	$Q_{R_1} \gtrless 0$	$S_{R_1} < 0$

1. The slope of the LM-curve is $L_Y^d(1-L_{L^d})$.

It can be seen that, if $L_D > 1$, the slope of both the IS- and the LM-curve can be either positive or negative. If the IS-curve has a positive slope, the system is unstable. We shall next assume that the IS-curve has a negative slope (i.e., $Q_Y < 0$). The negative slope of the LM-curve may also cause stability problems.[1]

By solving for dY and dZ from equations (5.20) and (5.21), we obtain:

$$(5.22)\quad dY = \frac{1}{Q_Y - S_Y Q_Z}[dG + Q_{B^p} dB^p + (Q_{B^b} - Q_Z S_{B^b}) dB^b + (Q_F - Q_Z S_F)(dF + dHG) + (Q_r - Q_Z S_r) dr + (Q_{R_0} - Q_Z S_{R_0}) dR_0 + (Q_{R_1} - Q_Z S_{R_1}) dR_1]$$

$$(5.23)\quad dZ = \frac{1}{Q_Y - S_Y Q_Z}[-S_Y dG - S_Y Q_{B^p} dB^p + (Q_Y S_{B^b} - S_Y Q_{B^b}) dB^b + (Q_Y S_F - S_Y Q_F)(dF + dHG) + (Q_Y S_r - S_Y Q_r) dr + (Q_Y S_{R_0} - S_Y Q_{R_0}) dR_0 + (Q_Y S_{R_1} - S_Y Q_{R_1}) dR_1]$$

When the banks are profit maximizers, the signs of the effects of the exogenous variables on Y and Z are as presented in Table 5.2.

Table 5.2. The Profit Maximizing Banks

	Exogenous variables						
	G	B	HG	F	r	R_0	R_1
Y	+	+	+	+	?	−	−
Z	+	+	?	?	?	?	?

1. The condition for local stability in this case is that the LM-curve has a less steep negative slope than the IS-curve.

It can be seen that Table 5.2 is identical with Table 5.1. When the banks are profit maximizers, the inclusion of the wealth effect does not change the sign of the effect of the exogenous variables. The role of the wealth variable is that it strengthens the positive effects of the stock variables F, HG and B on national income.

When the banks maximize their amount of loans, the signs of the effects of the exogenous variables are as presented in Table 5.3.

Table 5.3. Banks Maximize the Amount of Loans, Exogenous Variables

	G	B^p	B^b	HG	F	r	R_0	R_1
$Y(L_D < 1)$	+	+	+	+	+	?	–	–
$Y(L_D > 1)$	?	?	?	?	?	?	?	?
$Z(L_D < 1)$	+	+	?	?	?	?	?	?
$Z(L_D > 1)$	?	?	?	?	?	?	?	?

When $L_D < 1$, the effects of the exogenous variables on national income seem to be very similar to the previous cases. The only qualitative difference is that the effects of bonds differ depending on whether they are held by the private sector or by the banks. This is because now bonds B^b is one argument of the effective supply of loans, and the partial derivative $-L_{B^b}$ is smaller than the partial derivative L_D. In the profit maximizing case, the values of both of these partial derivatives were zero.

When $L_D > 1$, we cannot unambiguously say anything about the effect of the exogenous variables on national income and excess demand for credit. In order to be able to make conclusions, we need more information about the sizes of structural parameters.

5.2. The Case with Penalty Rates

When penalty rates are applied to the banks' borrowing from the central bank, bank lending is determined by equation (4.3.4.b) instead of equation (4.3.4.a).

$$(4.3.b) \quad L = L(L^d, R_0 - r_L, R_1, D, B^b)$$

As the penalty rate schedules are known ex ante by the banks, the parameters R_0 and R_1 appear as arguments of the bank lending equation. If the banks are profit maximizers, the partial derivative $L_D = -L_{B^b}$. If, in addition, there is perfect competition between the banks (i.e. $h = 0$), it is known that $0 < L_D < 1$. The more concentrated the banking sector is, the more likely it is that $L_D > 1$. If the banks maximize their lending, $L_D > -L_{B^b}$ and it cannot be known whether L_D is greater or smaller than one.

Differentiating equations (4.3.1) - (4.3.3), (4.3.4.b) and (4.3.5) - (4.3.10) and solving the IS-and LM-curves, we obtain:

$$(5.24) \quad Q'_Y dY + Q'_Z dZ = dG + Q'_{B^p} dB^p + Q'_{B^b} dB^b + Q'_F (dF+dHG) + Q'_r dr + Q'_{R_0} dR_0 + Q'_{R_1} dR_1$$

$$(5.25) \quad S'_Y dY + dZ = S'_{B^b} dB^b + S'_F (dF+dHG) + S'_r dr + S'_{R_0} dR_0 + S'_{R_1} dR_1$$

where

$$Q'_Y = 1 - E_Y[1-T_Y-N_Y(R+HR_1)]-X_Y-\frac{E_W}{1-L_D}(L_{L^d}L^d_Y-L_DN_Y)$$

$$Q'_Z = Q_Z,\ Q'_{B^p} = Q_{B^p},\ Q'_{B^b} = Q_{B^b}$$

$$Q'_F = E_Y(R+HR_1) + \frac{E_W}{1-L_D}$$

$$Q'_r = E_{r_L} - E_Y[B+N_{r_D}(R+HR_1)] + \frac{E_W}{1-L_D}(L_{L^d}L^d_{r_L}-L_{R_0}-L_DN_{r_D})$$

$$Q'_{R_0} = \frac{E_WL_{R_0}}{1-L_D} - E_YH$$

$$Q'_{R_1} = \frac{E_WL_{R_1}}{1-L_D} - E_YH^2$$

$$S'_Y = -\frac{[L^d_Y(1-L_D-L_{L^d}) + L_DN_Y]}{1-L_D}$$

$$S'_{B^b} = S_{B^b}$$

$$S'_F = -\frac{L_D}{1-L_D}$$

$$S'_r = \frac{L^d_{r_L}(1-L_D-L_{L^d}) + L_{R_0} + L_DN_{r_D}}{1-L_D}$$

$$S'_{R_0} = -\frac{L_{R_0}}{1-L_D}$$

$$S'_{R_1} = \frac{L_{R_1}}{1-L_D}$$

It can be seen that now the LM-curve may have a negative slope even when $L_D < 1$. However, the system is locally stable as long as the LM-curve has a less steep negative slope than the IS-curve.[1]

The signs of the parameters of equations (5.24) and (5.25) when $L_D < 1$ are

$Q'_Y > 0$	$S'_Y \gtrless 0$
$Q'_Z > 0$	
$Q'_{B^p} \geq Q'_{B^b} > 0$	$S'_{B^p} \leq 0$
$Q'_F > 0$	$S'_F < 0$
$Q'_r \gtrless 0$	$S'_r \gtrless 0$
$Q'_{R_0} < 0$	$S'_{R_0} > 0$
$Q'_{R_1} < 0$	$S'_{R_1} > 0$

When the banks are profit maximizers, the effects of the exogenous variables on national income are the same as those presented in Tables (5.1), (5.2). If the banks are quantity maximizers, the effects on national income are qualitatively similar to the effects presented in the first row of Table 5.3.

If the slope of the LM-curve is positive ($S'_Y < 0$), the effects on excess demand for credit Z are the same as those presented in Table 5.2. If the slope is negative, the effects on Z are such as presented in Table 5.4.

---

1. The conditions for local stability in this case are
$-\alpha Q'_Y - \beta < 0$
$\alpha\beta(Q'_Y - S'_Y Q'_Z) > 0$
where α and β are positive constants. The first condition always holds and the second condition holds as long as
$\left.\frac{\partial Y}{\partial Z}\right|_{LM} > \left.\frac{\partial Y}{\partial Z}\right|_{IS}$.

Table 5.4.

	G	B^p	B^b	HG	F	r	R_0	R_1
Z	–	–	–	–	–	?	+	+

As in the preceding section, it is impossible to say anything certain about the effects of the exogenous variables on national income when $L_D > 1$.

6. A MODEL WITH ENDOGENOUS PRICES

In very general terms, two alternative price determination approaches can be distinguished depending on whether excess demand (or supply) in the goods market affects the level of prices or the change in prices. The first approach has sometimes been labelled as the "Keynesian" (Wurtzberger, 1977; Merrett, 1979) and the latter as the Phillips curve approach.[1] The fundamental difference between these two approaches is that the Keynesian approach is made in static terms and the Phillips curve approach in dynamic terms.

The economy we are to analyse is a small open economy. In economic literature, it is quite commonly assumed that domestic prices in a small, open economy are almost entirely determined by foreign prices. That is why the Phillips curve approach, which is basically set in a closed-economy context, is not suitable for our purposes.

We shall now specify the following price equation:

$$(6.1) \quad P = eP^F + P_Y(Y-\bar{Y})$$

where

P = domestic price level

P^F = foreign price level (in foreign currency)

$\bar{Y}$ = capacity output

e = exchange rate (domestic/foreign currency)

and P_Y is a positive parameter.

---

1. Although the Phillips-curve approach is more generally used, there are some macroeconometric models in which the Keynesian approach is applied, e.g., the Canadian RDX2-model (Wurtzberger, 1977), the Swedish STEP-model (Ettlin, 1979) and the Finnish BOF3-model.

Equation (6.1) implies inflation parity between domestic and foreign prices but not parity between the price levels because of the excess capacity variable $(Y-\bar{Y})$. The only endogenous variable on the right side of equation (6.1) is national income Y.

The comparative static results obtained by the simplified model analysed in Section 5.1.1 and the versions analysed in Sections 5.1.2 and 5.2 were not very dramatic. That is why we introduce prices into the simplest model version. The static part of the model can now be written in the form:

$$(6.2) \quad Y = E(Y+\frac{r_B B}{P}-\frac{R \cdot H}{P}-\frac{1}{P}T(P\ Y), r_L Z) + G + X(Y, P, eP^F)$$

$$(6.3) \quad Z = R - r_L$$

$$(6.4) \quad N = N(P \cdot Y, r_D)$$

$$(6.5) \quad R = R_0 + R_1 H$$

$$(6.6) \quad H = N - F - HG$$

The static part of the model now includes equations (6.1) - (6.6).

In the expenditure equation all the nominal variables are deflated by domestic prices. The tax scales are applied to nominal income. In the net exports equation it has been assumed that imports depend positively on the domestic price level and negatively on the foreign price level in domestic currency eP^F. Exports, in turn, depend negatively on the domestic price level and positively on the foreign price level in domestic currency. Accordingly, the partial derivative $X_P < 0$

and $X_e = X_{P^F} > 0$. In addition, we assume that $-X_P = X_e$. In equation (6.9), it is assumed that the demand for currency depends on nominal national income.

The dynamic part of the model can now be written in the form:

$$(6.7) \quad \dot{F} = eP^F X(Y,P,eP^F) - er_F FG + eFG$$

$$(6.8) \quad e\dot{F}G + \dot{H}G + \dot{B} = PG + r_B B + er_F FG - T(P\cdot Y) - R\cdot H$$

Equation (6.7) shows that exports are assumed to be sold and imports bought in prices determined by world markets. According to equation (6.8), the volume of government expenditure is exogenous, whereas its value is endogenous.

When we solve the comparative static part of the model, we obtain the following IS and LM relations:

$$(6.9) \quad \{1-E_Y[1-T_Y-\frac{N_Y}{P}(1+P_Y)(R+R_1H)+P_Y(\frac{R\cdot H-r_B B+T-T_Y PY}{P^2}+X_P)]$$
$$-X_Y\}dY =$$
$$dG + E_Z dZ + E_Y\frac{r_B}{P}dB + \frac{E_Y}{P}(R+R_1H)(dF+dHG)$$
$$+ [\frac{E_Y}{P}(B-N_{r_D}(R+R_1H))+E_{r_L}]dr - \frac{E_Y H}{P}(dR_0+HdR_1)$$
$$+ [E_Y\frac{(R\cdot H-r_B B+T-T_Y PY)}{P^2}](P^F de+edP^F-P_Y d\bar{Y})$$

$$(6.10) \quad dZ = R_1 N_Y(1+P_Y)dY - R_1(dF+dHG) + (R_1 N_{r_D}-1)dr$$
$$+ dR_0 + HdR_1 + R_1 N_Y(P^F de+edP^F-P_Y d\bar{Y})$$

Examination of equation (6.9) reveals that the endogenizing of prices tends to decrease the real effects of exogenous variables on national income. There is, however, one channel through which prices can affect in the opposite direction, i.e., if the net interest payments from the government to the private sector ($\tilde{r}_B B$-RH) are negative. In this case, a rise in the price level decreases these net interest outlays of the private sector in real terms. Anyway, an increase in the price level raises the average tax rate under progressive tax scales (i.e. $T_Y > \frac{T}{PY}$), which tends to reduce the real effects of the exogenous variables on national income.[1]

In the following, we assume that ($r_B B$-RH) is positive. In this case it is certain that endogenous prices steepen the negative slope of the IS-curve more than would be the case under exogenous prices. The shifts of the IS-curve caused by exogenous variables also become smaller and the positive slope of the LM-curve becomes steeper. Because the signs of the partial derivatives of the IS- and LM-curves do not change, the qualitative effects of the exogenous variables on national income Y and the degree of credit rationing stay the same as in Table 5.1. These effects become only quantitatively smaller.

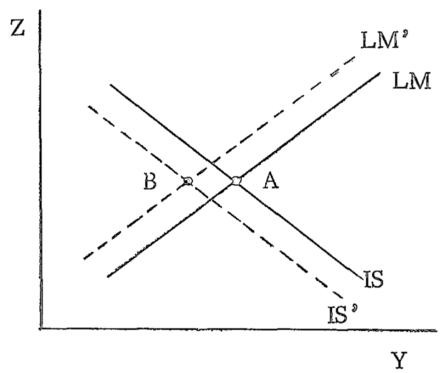
Compared to the earlier sections, we now have three additional exogenous variables (e, P^F and $\bar{Y}$) in our model. The effects of a devaluation and a rise in foreign prices are similar. These shocks shift the IS-curve to the left, because disposable income decreases, and the LM-curve upwards, because the demand for currency increases as a result of the increase in nominal income (see Figure 6.1). Thus in our model

---

1. If the wealth effect were included, the rise in the price level would decrease the value of real wealth and thus curb real private expenditure.

a devaluation is a contractive policy measure and a revaluation an expansionary measure. This is due to the fact that, on the basis of equation (6.1), changes in foreign prices and exchange rates are transmitted immediately to domestic prices, and there is thus no change in relative prices and, accordingly, no shift in demand from goods produced abroad to domestically produced goods.[1] However, the rise in the domestic price level weakens domestic demand (as far as $RH-r_B B+T-T_Y PY < 0$) and so the new short-run equilibrium point B is on the left side of point A. The effects of an increase in potential output are the reverse, because it lowers the domestic price level.

Figure 6.1.



1. The price equation (6.1) can be interpreted as a long-run steady state relation between domestic and foreign prices. In the real world, changes in foreign prices are transmitted to the domestic price level with a lag. This phenomenon allows the relative prices of domestic and foreign prices to change transitorily. The multiplier-accelerator process started by this phenomenon has been excluded from our analysis.

7. THE GOVERNMENT BUDGET CONSTRAINT AND THE LONG-RUN STABILITY OF THE MODEL

The short-run equilibrium points in Sections 5 and 6 determined national income for given values of foreign reserves F, central bank credit of the government HG and bonds held by the private sector B^P and the banks B^b. In reality, foreign reserves change through the current account and at least one of the variables HG, B^P or B^b changes through the government budget deficit. Movements of these stocks through time move the short-run equilibrium points, i.e., the IS and the LM curves move gradually as stocks accumulate. The aim of this section is to study whether a long-run stock equilibrium is reached when the government budget deficit is alternatively money- or bond-financed.

When the price level was assumed constant, the balance of payments and government budget constraint equations were defined in Section 4 by equations (4.3.11) and (4.3.12).

$$(4.3.11) \quad \dot{F} = X(Y) - r_F FG + \dot{FG}$$

$$(4.3.12) \quad \dot{FG} + \dot{HG} + \dot{B} = G + r_B B + r_F FG - T(Y) - R \cdot H$$

We shall first study the case where the government budget deficit is financed through an increase in the stock of money. In our model, this means that the government borrows either from the central bank or from abroad.

In the theoretical literature it is common to assume as a stationary condition for an open economy that the sum of the change in foreign reserves and the government budget deficit is zero (Turnovsky, 1977). This is reasonable because in this situation the monetary base does not change and accordingly the equilibrium income reached does not change any more.[1]

When we add equation (4.3.12) to equation (4.3.11) and assume that $\dot{B} = 0$, we get

$$(7.1) \quad \dot{F} + \dot{H}G = X(Y) + G + r_B B - T(Y) - R \cdot H$$

Solving next for Y from the static part of the model and defining the monetary base M = N - H = F + HG, we obtain:

$$(7.2) \quad Y = J(M,B,\cdot)$$

where the partial derivatives J_M and J_B are positive on the basis of the preceding sections. Recalling that H = N - F - HG and $R = R_0 + R_1 H$, we can write equation (7.2) in the form:

$$(7.3) \quad \dot{M} = X(J(M,B,\cdot) + G + r_B B - T(J(M,B,\cdot))$$

$$- R_0(N(J(M,B,\cdot)-M) - R_1(N(J(M,B,\cdot))-M)^2$$

A sufficient condition for the stability of the system where the government budget deficit is financed through an increase in the stock of money is that $\partial\dot{M}/\partial M < 0$.

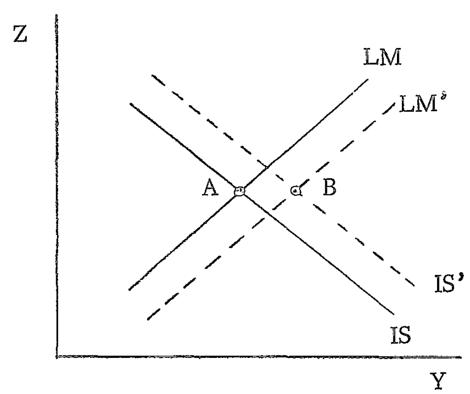
By differentiating equation (7.3) with respect to M, we obtain:

$$(7.4) \quad \frac{\partial \dot{M}}{\partial M} = J_M(X_Y - T_Y - N_Y(R_0 + 2R_1 H)) + R_0 + 2R_1 H$$

1. In a stricter sense, this is not a sufficient condition for the long-run equilibrium, as both the domestic and the foreign component of the monetary base are changing, although in opposite directions. At least if foreign reserves are diminishing, it cannot continue forever.

The first term on the right hand side of (7.4) is always negative, whereas the following two terms are positive. Accordingly, the possibility that the system is unstable is not ruled out. However, this seems improbable if we give equation (7.4) an economic interpretation. In the case of a money-financed budget deficit, the IS-curve shifts to the right (see Figure 7.1) through the wealth effect and the decline in the interest outlays of the private sector. An increase in money shifts the LM-curve downwards and the short-run equilibrium shifts from point A to point B. This means that national income and, hence, tax revenue have risen. The increase in the monetary base affects negatively the demand for the banks' central bank credit, which, in turn, decreases the interest revenue of the government sector. Because the demand for currency increases as national income increases, the banks' central bank credit does not decrease by the full amount of the increase in the monetary base. The system is unstable only if the negative interest income effect is greater than the positive tax revenue effect in the government sector

Figure 7.1.



budget, i.e., if the budget deficit at point B is greater than at point A. However, in an open economy this is not a sufficient condition for instability, because it is natural to assume that the propensity to import (X_Y) increases when the economy approaches full capacity. So it is plausible that when the economy operates at near full capacity, there is some point where the current account deficit equals the government budget deficit and the monetary base does not change any more.

If the price level is endogenous, the dynamic adjustment path is determined by equations (6.7) and (8.8). Under the same assumptions as before, these equations can be transformed into the form

$$(7.5)\quad \dot{M} = eP^F X(J(M,B,\cdot),\ P(J(M,B,\cdot)),\cdot)$$
$$+\ P(J(M,B,\cdot))\cdot G - T(P(J(M,B,\cdot))\cdot J(M,B,\cdot))$$
$$-\ R_0(N(P(J(M,B,\cdot))\cdot J(M,B,\cdot) - M)$$
$$-\ R_1(N(P(J(M,B,\cdot))\cdot J(M,B,\cdot) - M)^2$$

By differentiating (7.5) with respect to M, we get

$$(7.6)\quad \frac{\partial \dot{M}}{\partial M} = J_M(eP^F(X_Y+X_P) + P_Y(G-T_Y Y) - T_Y P$$
$$-\ N_Y(YP_Y+P)(R_0+2R_1 H)) + R_0 + 2R_1 H$$

When we compare relation (7.6) with relation (7.4), we can infer that inflation increases the likelihood that the long-run stock equilibrium is reached. Because net exports depend negatively on domestic prices, the widening of the current account deficit is faster. The budget deficit, in turn, closes faster as a result of an endogenous price level. This is because the progressive tax schedules are applied to nominal income and the demand for currency depends on nominal income, which, together with inflation, increases government sector interest income from the private sector (R·H).

If the budget deficit is financed through bond issues, both differential equations (4.3.11) and (4.3.12) (with constant prices) and differential equations (6.7) and (6.8) (with endogenous prices) have to approach zero. Thus, in the case of constant prices, the stability of the bond-financed budget deficit depends on the equations

$$(7.7)\quad \dot{F} = X(J(F,B,\cdot)) - r_F FG$$

$$(7.8)\quad \dot{B} = G + r_B B + r_F FG - T(J(F,B,\cdot)) - R_0(N(J(F,B,\cdot)) - F - HG) - R_1(N(J(F,B,\cdot)) - F - HG)^2$$

By linearizing, we get

$$(7.9)\quad \begin{bmatrix} \dot{F} \\ \dot{B} \end{bmatrix} = D \begin{bmatrix} F-F^* \\ B-B^* \end{bmatrix}$$

where

$$D = \begin{bmatrix} X_Y J_F & X_Y J_B \\ -T_Y J_F - (N_Y J_F - 1)(R_0 + 2R_1 H) & r_B - T_Y J_B - N_Y J_B (R_0 + 2R_1 H) \end{bmatrix}$$

The system is stable, if tr D < 0 and det D > 0. We get

$$\text{tr } D = X_Y J_F + r_B - T_Y J_B - N_Y J_B (R_0 + 2R_1 H)$$

$$\det D = X_Y [J_F r_B - J_B (R_0 + 2R_1 H)]$$

In the case of Section 5.1.1, when the wealth effect was excluded and the private non-banking sector and the banking sector were consolidated, the system was unstable. In this case, $J_F = E_Y(R+R_1H) - E_ZR_1$ and $J_B = E_Yr_B$ and, accordingly, $\det D = E_ZR_1r_B < 0$.

When the wealth effect is included, the banks are profit maximizers and the market for the banks' central bank credit is a call money market, it is most likely that the system is stable. In this case, we get

$$\operatorname{tr} D = X_Y[E_Y(R+R_1H) + E_W(1-L_RR_1) + E_ZL_RR_1]$$

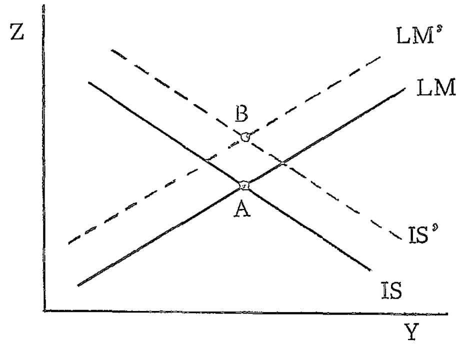
$$- N_Y(R+R_1H)E_W + [1-E_Y(T_Y+N_Y(R+R_1H)]r_B$$

$$\det D = E_W(R-r_B) + R_1[E_WH-L_Rr_B(E_Z-E_W)]$$

All other terms of the tr D are negative except the coefficient of r_B, which is less than one. So it seems quite obvious that the sum of the negative terms dominates. The det D is certainly positive, if $-E_Z > E_W$, i.e., if the partial derivative of private expenditure with respect to the extent of excess demand for credit is greater than that with respect to financial wealth. In the opposite case, the sign of the det D is indeterminate.

As there is only one level of national income when the current account is in balance, how is it possible to ensure that both the current account and the government budget balance at the same time? The net profit of the central bank distributed to the government plays an essential role in this process. The IS-curve shifts to the right as a result of bond issues and the LM-curve

Figure 7.2.



upwards through the current account deficit (see Figure 7.2). The intersection point of the IS and LM curves moves upwards and the credit market tightens. The tightening in the credit market increases the interest payments of the private sector to the central bank, which are distributed to the government sector. The process continues until the interest payments have risen so much that the budget deficit is closed. If the current account is balanced in the beginning, there is no change in national income.

The stability becomes indeterminate under bond financing, if the banks are quantity maximizers and/or penalty rates are applied.

When the price level is endogenous, the content of the coefficient matrix D is

$$D = \begin{bmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{bmatrix}$$

where

$$d_{11} = eP^F(X_Y J_F + X_P P_Y J_F) < 0$$

$$d_{12} = eP^F(X_Y J_B + X_P P_Y J_B) < 0$$

$$d_{21} = J_F(P_Y(G-T_YY)-T_YP) - (N_YYJ_F+N_YPJ_F-1)(R_0+2R_1H) \gtrless 0$$
$$d_{22} = r_B + J_B(P_Y(G-T_YY)-T_YP) - (N_YYJ_B+N_YPJ_B)(R_0+2R_1H) \gtrless 0$$

It seems quite obvious that the negativity of the trace ($tr\ D = d_{11} + d_{22}$) is always fulfilled. The coefficient d_{11} is always negative and, under progressive income taxation, the only positive term in d_{22} is the bond rate r_B.[1]

The determinate is

$$\det D = d_{11}d_{22} - d_{21}d_{12} =$$
$$eP^F(X_Y+X_pP_Y)[J_Fr_B-J_B(R_0+2R_1H)]$$

The positivity of the determinate depends exactly on the same parameters as in the case where the price level was constant. Therefore, we can infer that the inclusion of prices do not change qualitatively the conditions for the stability of the model.

1. If the budget deficit is very large in relation to the level of tax revenue, it is possible that the term $(P_YG-T_YY-T_YP)$ is also positive. In this case, a rise in the price level increases the value of public expenditure more than tax revenue, even under progressive taxation.

8. CONCLUSIONS

In this paper we have formulated a framework of the IS-LM-type appropriate for the Finnish institutional setting, where the functioning of the capital market is deficient and monetary policy is mainly transmitted through credit rationing. The credit market was assumed to be heterogeneous, i.e., both rationed and unrationed clients exist at the same time in the credit market. All interest rates except the interest rate applied to the banks' central bank credit were assumed exogenous. The banks were alternatively assumed to be profit maximizers or quantity (amount of loans) maximizers. It was assumed that either the market for central bank credit was a call money market or penalty schedules, which were known ex ante by the banks, were applied to the banks' central bank credit. These assumptions affected the specification of the effective supply function of loans. If the banks were quantity maximizers and/or the penalty rates were applied, deposits and bonds held by the banks were arguments of the loan function. However, these alternative versions of the loan equations did not change qualitatively the comparative static effects of the exogenous variables on national income, as long as the partial derivative of the effective supply of loans with respect to deposits was less than one. The inclusion on an endogenous price level did not change the direction of the effect of any exogenous variable on national income from that obtained with a constant price level. The comparative static results are summarized in Table 8.1.

Table 8.1. The Direction of the Effects of the Exogenous Variables on National Income

	G	B^p	B^b	HG	F	r	R_0	R_1	e	P^F	$\bar{Y}$
Y	+	+	+	+	+	?	−	−	−	−	+

One of the most interesting results was the observation that the issuing of government bonds held either by the private sector or by the banks unambiguously increased national income. The explanation was that because deposits were the only substitute for bonds in the households' portfolio, bonds did not crowd out real expenditure. The bond issue increases the amount of financial wealth and the interest income of the public, which has an expansionary effect on national income. The two exogenous contributions to the monetary base, government borrowing from the central bank or from abroad, also have a positive effect on national income. The effect of a simultaneous change in domestic interest rates (bond, deposit and loan rates) is indeterminate. The tightening of the terms of the banks' central bank credit has a contractive effect on national income. Devaluation and a rise in foreign prices reduces national income, because changes in these variables are fully transmitted to the domestic price level. The positive effects of devaluation through an increase in net exports are abstracted from the model, because the price equation we specified does not allow relative prices between the domestic and foreign prices to change even in the short run.

In the seventh section, we studied the long-run stability properties of the model, when the stock variables were allowed to change through the government budget deficit and the current account. It was found that the financing of the budget deficit through borrowing from the central bank or from abroad is a stable form of financing, at least if tax revenue increases, as a result of the rise in national income, faster than the interest income of the government sector decreases. If the reverse is true, which seems unlikely, the stability is indeterminate.

When the budget deficit is financed through bond issues, long-run stability is most probably reached if the banks are profit maximizers, the market for the banks' central bank credit is a call money market and the wealth effect is included. This is a peculiar result for an open economy with fixed exchange rates. The inclusion of the net profit of the central bank (interest payments of the banks to the central bank) in the budget constraint of the government sector plays a central role here. Through changes in these interest payments it is possible to attain a balanced budget without changes in national income.

If the wealth effect is excluded, bond financing is an unstable form of financing. The stability is indeterminate, if the wealth effect is included and the banks are quantity maximizers and/or penalty rates, known by the banks, are applied to the banks' central bank credit.

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