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THE RESERVE REQUIREMENT AS A POLICY INSTRUMENT IN A SMALL OPEN ECONOMY WITH FIXED EXCHANGE RATES

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Abstract:

In this paper we examine the reserve requirement as an instrument of monetary policy in a small open economy with perfect capital mobility and a fixed exchange rate. The deposit rate is assumed to be institutionally fixed. The analysis is carried out using a Tobin-Brainard type portfolio model.

In the long run the reserve requirement and open market operations are effective policy instruments. For restrictive policy, the reserve requirement may be considered more effective than open market operations; the reserve holds for expansionary policy. Financial innovations which allow the banks to avoid the reserve requirement reduce the effectiveness of the reserve requirement but increase the effectiveness of open market operations.

An increase in the required reserve ratio was found to dampen the effects of open market operations.

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Tiivistelmä:

Tämä paperi käsittelee kassavarantovelvoitetta rahapolitiikan instrumenttina pienessä avotaloudessa, jossa pääomanliikkeitä ei säädellä ja jossa valuuttakurssi on kiinteä. Talletuksille maksettava korko oletetaan säännöstellyksi. Analyysivälineenä käytetään Tobin-Brainard -tyyppistä portfoliomallia.

Pitkällä aikavälillä kassavarantovelvoite on tehoton rahapolitiikan instrumentti, jos korkoa tuottavaan ulkomaiseen varallisuuteen kuuluu sekä valuuttavaranto että yleisön hallussa oleva ulkomainen varallisuus. Jos sen sijaan valuuttavarannolle ei makseta korkoa, kassavarantovelvoitteesta tulee tehokas politiikkainstrumentti samoin kuin avomarkkinaoperaatioista.

Lyhyellä aikavälillä sekä kassavarantovelvoitteen käyttäminen että avomarkkinaoperaatiot ovat tehokkaita politiikkainstrumentteja. Kassavarantovelvoitetta voidaan pitää avomarkkinaoperaatioita tehokkaampana; jos tavoitteena on harjoittaa restriktiivistä politiikkaa ekspansiivisen politiikan harjoittamisessa avomarkkinaoperaatiot ovat sen sijaan tehokkaampi instrumentti. Finanssi-innovaatioiden havaitaan heikentävän kassavarantovelvoitteen alaisten vaateiden osuutta taseissaan. Innovaatiot sen sijaan lisäävät avomarkkinoiden tehoa.

Kassavarantovelvoitteen todetaan lisäksi vaimentavan avomarkkinaoperaatioiden vaikutuksia.

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1 INTRODUCTION

The imposition of a reserve requirement on the banking system can be studied from different aspects. One body of the literature focuses on the effects of a reserve requirement on the variances of monetary aggregates. The general result is that a reserve requirement reduces monetary variance (Kaminow (1977), Laufenberg (1979), Sherman, Sprenkle et al (1979), Winningham (1980)). Friedman (1959) even proposes a 100 % reserve requirement for the purpose of monetary stabilization.

Another way of thinking about the effects of the reserve requirement is to examine its long run welfare effects (eg. Calvo (1986), Romer (1985)). In this framework the reserve requirement is seen as reducing the interest rate banks are able to pay on deposits. When interest income declines, consumption has to decline and welfare is reduced.

The reserve requirement can also be thought of as an instrument of monetary policy. It may be considered as a substitute or a complement to the standard policy instrument, open market operations. If we think of the reserve requirement as a substitute, we would be interested in finding out whether its effects differ from those of open market operations. If, on the other hand, the reserve requirement is seen as complementing open market operations, we would be interested in its effects on the transmission of open market operations. In this paper we will be considering these aspects of the reserve requirement.

More specifically, we will discuss the effects of the reserve requirement in a small open economy with a fixed exchange rate and perfect capital mobility. The well known Mundell-Fleming results indicate that open market operations are ineffective in this setting. We will examine whether this holds for changes in the reserve requirement as well, and whether the imposition of reserve requirements changes the effects of open market operations.

Two versions of an open economy IS-LM -model will be used. In both versions we explicitly model the banking sector. The long run version assumes perfect substitutability of foreign and domestic assets, leading to an exogenous interest rate. The short run version allows imperfect substitutability of all assets. Balance of payments disequilibrium is possible in the short run as interest rate differentials lead to capital movements, and changes in income affect the current account. The short run is, however, assumed to be a time period short enough that the stock of foreign assets does not change.

Throughout the analysis we maintain the assumptions of a fixed exchange rate, perfect capital mobility and an institutionally fixed deposit rate. The idea is to give the analysis the flavor of today's institutional arrangements in Finland.

We also assume that no interest is paid on the required reserves. This assumption offers a simplified characterization of a situation in which the reserves earn interest, but less interest than the market rate.

2 LONG RUN MODEL

We first illustrate the long run effects of a change in the reserve requirement and compare them to the effects of open market operations. Our long run model assumes perfect substitutability of foreign and domestic securities. We also consider the stock of net foreign assets (net foreign wealth) to be fixed, i.e. we require the current account to be in balance. There are four assets in this model: domestic currency, depostis, domestic and foreign securities. To keep the modelling of the banking sector as simple as possible, we think of banks as taking in depostis and allocating the funds to required reserves and domestic securities. The balance sheets of the various sectors are shown below.

BANKS

Reserves	Deposits
Domestic Securities	

PUBLIC

Deposits	Net Wealth
Currency	
Domestic Securities	
Foreign Securities	

CENTRAL BANK

Foreign Reserves	Currency
Domestic Securities	Required Reserves

The stock of net foreign securities consists of private holdings and central bank reserves, both of which receive interest at the foreign interest rate. This gives us the following balance of payments condition.

(1) $$X - \underset{+}{M}(y) + r^*(FP + R) = 0$$, where

X, M = exports and imports
y = real domestic output
r^* = foreign interest rate
FP = private holdings of foreign securities
R = central bank foreign exchange reserves
The signs refer to the signs of partial derivatives

Money market equilibrium is defined as an equality between the supply and the demand for high-powered money. The supply of high-powered money is endogenous and can be written as a sum of central bank reserves and central bank holdings of government securities. Demand for high-powered money is the sum of the public's demand for currency and banks' holdings of required reserves. The LM-equation then takes the form:

$$(2) \qquad kD(\underset{+}{r_d}, \underset{-}{r^*}, \underset{+}{y}, \underset{+}{W}) + CU(\underset{-}{r_d}, \underset{-}{r^*}, \underset{+}{y}, \underset{+}{W}) = R + SC \quad \text{, where}$$

k = reserve requirement
D = deposits
CU = currency
SC = central bank holdings of government securities
r_d = deposit rate
W = net wealth of the public.

Banks are required to hold in reserves k percent of the deposits they receive. The amount of deposits is determined entirely by the portfolio choice of the public because banks are assumed to accept all deposits offered at the institutionally fixed deposit rate. For this reason no equation describing the equilibrium in the deposit market is needed. Perfect substitutability of foreign and domestic securities guarantees that the domestic securities rate equals the foreign interest rate. Thus, the opportunity cost for both deposits and currency is the foreign interest rate which can be taken as exogenous for our small economy. The only endogenous variable affecting money demand is then real income, which is assummed to affect positively both the demand for deposits and the demand for currency.

As we are assuming perfect substitutability of foreign and domestic securities we can aggregate them. This market equilibrium condition is omited by Walras' law, leaving only one equation, eq. (2), characterizing the equilibrium in the financial sector.

To close the model we write the goods market equilibrium as

$$(3) \qquad y = A(\underset{+}{y}, \underset{-}{r^*}, \underset{+}{W}) + X - M(\underset{+}{y}).$$

By making use of the balance sheets we can write the net wealth of the public as the sum of central bank reserves, the stock of domestic securities and private holdings of foreign securities:

$$W = R + S + FP$$

and substitute this for W in eq. (3).

By differentiating the above long run equilibrium equations we can solve for the long run effects of both open market operations and a change in reserve requirement. The endogenous variables are real income, central bank reserves and the stock of private holdings of foreign securities.

TABLE 1 The effects of open market operations and a change in k on output, central bank reserves and private holdings of foreign securities
(subscripts denote partial derivatives)

$$dR/dSC = -dF/dSC = \frac{-\left[r^*(1-A_y+M_y) - A_wM_y\right]}{r^*(1-A_y+M_y) + A_wM_y} < 0$$

$$dY/dSC = dY/dk = 0$$

$$dR/dk = -dF/dk = \frac{D\left[r^*(1-A_y) + (r^*-A_w)M_y\right]}{r^*(1-A_y+M_y) + A_wM_y} > 0 \text{ (if } r^*>A_w)$$

The results (see table 1) are in accordance with the Mundell-Fleming conclusions of monetary policy ineffectiveness under fixed exchange rates. Furthermore, the results show that it does not make any difference whether monetary policy is carried out through open market operations or through changes in the ratio of required reserves. In both cases restrictive monetary policy leads to an excess demand for high-powered money. If the ratio of required reserves is increased ($dk > 0$), banks' demand for money increases. If restrictive open market operations are used instead ($dSC < 0$), the supply of money is reduced while demand is left unaffected. Excess demand for money leads to an offsetting capital inflow (that is not dependent on the policy instrument used) as the banks and/or the public start selling their portfolios of foreign securities. These portfolio shifts stop when central bank reserves have increased sufficiently to restore money market equilibrium. The results in table 1 also show that the increase in reserves is accompanied by an exactly offsetting decrease in private holdings of foreign securities, leaving the total holdings of foreign securities unaffected.

We have shown that in the long run both the use of open market operations and the use of reserve requirements as monetary policy instruments are equally ineffective in affecting output or interest rates in a world of fixed exchange rates, perfect substitutability[1] of foreign and domestic assets, and perfect capital mobility.

Roth (1976) arrived at similar long run results using basically the same kind of open economy IS-LM -model.

Mathieson (1975), however, concludes that the monetary policy ineffectiveness result does not apply to the use of reserve requirement as a policy instrument even though it applies to open market operations. This surprising result is derived using a model with similar assumptions of asset substitutability, interest rate exogeneity, fixed exchange rates and aggregate demand. Mathieson explains this result by the fact that a higher reserve ratio reduces banks' demand for government securities. As the stock of government securities is given, the reduced domestic demand must be offset by increased foreign holdings -- plausible assumption because domestic securities are perfect substitutes for foreign securities. Increased foreign holdings of domestic assets imply larger interest payments to foreigners which, for balance of payments equilibrium, must be compensated for by greater net exports of goods. Permanently greater net exports are possible only when real absorption and output are decreased.

The result does not survace in our model because the changes in central bank reserves and in private holdings of foreign securities

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[1]The result are not dependent on the assumption of perfect substitutability. Similar results could be derived under conditions of imperfect substitutability.

offset each other, leaving unchanged the amount of interest payments in the balance of payments equation. If we write this equation as Mathieson does assuming that central bank reserves are excluded from the net foreign wealth that generates interest payments,[2] our results change (see appendix 1). The signs of the partial derivatives are now ambiguous so that the results are not as neat as those in table 1. It is clear, however, that a change in the reserve requirement affects not only central bank reserves and private holdings of foreign securities but real income as well. Conclusion is therefore that the reserve requirement is an effective instrument of monetary policy even under our long run conditions to the extent that it causes changes in the interest-yielding net foreign wealth.

In contrast to what Mathieson claims, also open market operations appear to have similar effects in this setting (see appendix 1). Mathieson does not explicitly treat open market operations; he assumes their inefficacy as given. In fact open market operations should werk in the same way as increases in the reserve requirement. When banks sell domestic securities in response to an increase in the reserve requirement, it creates an excess supply just as if the central bank performed a restrictive open market operation. The two instruments should have similar effects, and their relative efficiency cannot be determined.

In conclusion to this section on the long run effects of changes in the reserve requirement, we note that the efforts are similar to those of open market operations. Only if the interest yielding net foreign wealth changes will the policy be effective.

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[2]Note that our model differs from Mathieson's model in the specification of the interest payments in the balance of payments equation. We assume that the country is a net creditor, i.e. holds net foreign assets, whereas Mathieson assumes that the country is a net debtor, i.e. holds negative net foreign assets. A decrease in net foreign wealth in our model is thus equivalent to an increase in net foreign indebtedness in Mathieson's model.

3 SHORT RUN MODEL

In the short run, domestic and foreign assets are assumed to be less than perfect substitutes, although we continue to assume perfect capital mobility. We allow balance of payments disequilibrium in the short run which, together with the imperfect substitutability assumptions, makes it possible for the central bank to affect domestic interest rates. This in turn allows us to compare the effects and the relative effectiveness of the two monetary policy instruments.

In the long run model all the banks' liabilities (deposits) were subject to the reserve requirement. In reality, however, banks have other sources of funding. These other sources may partly result from financial innovation which allows banks to avoid the reserve requirement. Financial innovations are taken into account in our short run model by dividing the deposits into demand deposits and time deposits; only demand deposits are subject to the reserve requirement. Increased innovations lead to a larger share of time deposits as a percentage of the total amount deposits available for banks.

The short run model consists of five equations describing equilibrium in each of the five different asset markets: money, domestic securities, loans, foreign securities and time deposits. In contrast to our long run model we now have domestic interest rates as endogenous variables. Our model closely resembles that of Tobin (1969). The asset and liability structure of the various sectors is shown in Table 2.

TABLE 2 Balance sheets

BANKS		PUBLIC	
Required Reserves	Deposits: - demand - time	Deposits: - demand - time	Net wealth
		Currency	
Securities		Securities	
Loans		Foreign assets	

CENTRAL BANK		FIRMS	
Foreign Reserves	Currency	Working Capital	Loans
Securities	Required Reserves		

3.1 Equations

The market equilibrium for the stock of foreign securities requires that the stock of foreign securities ((F) which is regarded as given) equals the sum of central bank's foreign reserves (R) and private holdings of foreign assets (FP). Written in equation from, this relationship is

$$(4) \qquad F = R + FP(\underset{-}{r_d}, \underset{-}{r_s},, \underset{+}{r^*}, \underset{-}{y}, \underset{+}{W})$$

where r_s = rate on domestic securities.

As in the long run model, the total amount of deposits', banks' liabilities, is determined entirely by the public's portfolio choice. However, the division of banks' liabilities into demand deposits and time deposits depends on the exogenous level of financial innovations. the higher the level of innovations, the larger the share of time deposits (θ) not subject to the reserve requirement. Modelling innovations in this fashion makes it possible to trace the effects of a change in the share of assets which are under the control of the monetary authority. The exogenous division of deposits makes demand deposits and time deposits complements rather than substitutes. As before, banks take all the demand deposits they are offered at the fixed deposit rate (r_d). The time deposit rate (r_t) is determined in such a way that banks willingly take all the time deposits the public offers. The equilibrium condition for time deposit markets is

$$(5) \qquad \underset{+\;\;\;+\;\;\;-}{T(r_s,\ r_l,\ r_t)} = \underset{+\;\;\;-\;\;\;-\;\;\;+\;\;\;+}{D(r_d,\ r_s,\ r^*,\ y,\ W)}$$

where T = supply of time deposits by banks
r_t = time deposit rate
r_l = loan rate
θ = share of total deposits held as time deposits (reflecting the level of innovations).

Banks have three assets:

- required reserves ($k(1-\theta)D$, where k = required reserve ratio)
- domestic bonds ($(b(1-k(1-\theta))D$, where $b = b(r_s,r_l)$ = the fraction of assets other than required reserves held in domestic bonds)
- loans ($((1-b)(1-k(1-\theta))D)$.

Equilibrium in the domestic securities market is achieved when the sum of banks' holdings (SB) and private holdings (SP) of securities equals the supply of securities (S) less central bank holdings of securities (SC):

$$(5) \qquad b(\underset{+}{r_s},\underset{-}{r_l})(1-k(1-\theta))D(\underset{+}{r_d},\underset{-}{r_s},\underset{-}{r^*},\underset{+}{y},\underset{+}{W})$$

$$+ SP(\underset{-}{r_d},\underset{+}{r_s},\underset{-}{r^*},\underset{-}{y},\underset{+}{W}) = S - SC.$$

Money market equilibrium can now be written as

$$(7) \qquad k(1-\theta)D(\underset{+}{r_d},\underset{-}{r_s},\underset{-}{r^*},\underset{+}{y},\underset{+}{W}) + CU(\underset{-}{r_d},\underset{-}{r_s},\underset{-}{r^*},\underset{+}{y},\underset{+}{W}) = R + SC,$$

where the supply of high-powered money (R + SC) equals the sum of banks' demand for reserves and private demand for currency (CU).

The signs of the partial derivatives are subject to the standard restrictions:

$$D_i + CU_i + SP_i + FP_i = 0, \quad i = r_d,\ r_s,\ r^*,\ y$$
$$D_W + CU_W + SP_W + FP_W = 1.$$

Note that we have made the assumption that an increase in y increases both D and CU but decreases SP and FP. The intuition behind this assumption is that an increase in y increases transactions demand for money which must be compensated for by reducing the holdings of domestic and foreign securities, since this is a stock equilibrium in which the stock of wealth is given.

Finally, we define loan market equilibrium as

$$(8) \qquad (1-b)(1-k(1-\theta))D = L^d(y,r_l),$$

where L^d denotes the demand for loans. We will follow Kähkönen (1984) and van Wijnbergen (1983) in modelling L^d and assume that only the corporate sector takes loans. These loans are used to finance production. The demand for loans is assumed to depend positively on output and negatively on the loan rate. The corporate sector holds no other assets besides its working capital.

3.2 Equilibrium solutions

Our five equations determine the equilibrium in the financial markets and are the equivalent of the LM equation in a standard IS-LM model. By Walras' law we can omit one equation and solve the remaining four for the four endogenous variables, r_s, r_l, r_t and R. Because we are concerned with the financial sector of the economy, we will consider y to be exogenous at this point.

We use the first four equations to determine the partial derivatives of the endogenous variables with respect to the exogenous variables, y, SC and k.

The partial derivatives with respect to y have an ambiguous sign (see Appendix 2). This ambiguity can be interpreted as resulting from two opposing influences. An increase in y induces the public to reduce their holdings of domestic securities, placing an upward pressure on the interest rate. On the other hand, with the increase in deposits, banks demand more domestic securities, and this tends to lower the securities' rate. The net result of these influences will determine the effect on the securities' rate. In a similar fashion, changes in the demand for and supply of loans affect the loan rate. An increase in y will increase the demand for loans as firms need more funds to finance production. There will also be an increase in the supply of loans resulting from the increase in deposits. Thus the net effect on the loan rate depends on the relative magnitudes of these changes. As the effects on the loan rate and on the securities' rate are ambiguous, it can be seen from equation (5) that the effect on the time deposit rate remains ambiguous as well.

Partial derivatives with respect to SC are reported below. Subscripts s, l, t and y denote the partial derivates with respect to r_s, r_l, r_t and y, respectively.

$$\frac{d\, r_s}{d\, SC} = \frac{1}{k(1-\theta)D_s + CU_s + FP_s} < 0$$

$$\frac{d\, r_1}{d\, SC} = \frac{b_s D + (b-1)D_s}{-b_1 D(k(1-\theta)D_s + CU_s + FP_s)} < 0$$

$$\frac{d\, r_t}{d\, SC} = \frac{(T_s - \theta D_s)Db_1 - T_1(b_s D + D_s(b-1))}{-T_t Db_1(k(1-\theta)D_s + CU_s + FP_s)} < 0$$

$$\frac{d\, R}{d\, SC} = \frac{FP_s}{-(k(1-\theta)D_s + CU_s + FP_s)} < 0$$

The signs of the partial derivatives with respect to SC are unambiguosly negative. This is the standard result: expansionary monetary policy using open market operations as a policy instrument (an increase in SC) leads to a decrease in interest rates and foreign reserves. Our short run assumptions of imperfect substitutability and of no binding balance-of-payments condition thus restore the effectiveness of monetary policy.

We note that an increase in the required reserve ratio, k, will dampen the effects of open market operations; the partial derivatives will be smaller (see also Tobin and Brainard (1963)). A simple example illustrates the reasoning: consider restrictive policy which reduces the money supply. Interest rates rise and with a fixed deposit rate, the public reduces its deposits. But the reduction in deposits decreases banks' required reserves. Currency is released from banks' reserves, partially offsetting the initial reduction in the money supply.

The partial derivatives also show the effects of financial innovations. Increased innovations (larger θ) make the derivates larger in absolute terms, meaning that open market operations become a more efficient instrument in affecting interest rates and foreign exchange reserves. The reason for this result is that the more innovations, the smaller are the banks' required reserves. The offsetting changes in banks' demand for high-powered money resulting from open market operations are then smaller.

In addition, note that an increase in the substitutability between domestic and foreign assets (an increase in FP_s) will make the derivatives smaller. As in our long run model, when the substitutability becomes perfect (FP_s becomes infinite) open market operations will have no effect on domestic interest rates.

Finally, partial derivatives with respect to k are:

$$\frac{d\, r_s}{d\, k} = \frac{1}{-\left(\dfrac{kD_s + CU_s + FP_s}{1-\theta}\right)} > 0$$

$$\frac{d\, r_l}{d\, k} = \frac{(1-\theta)D[(b-1)SP_s - b_s(1-k(1-\theta))D]}{-b_l(1-k(1-\theta))[(1-k(1-\theta))D_s+SP_s)]} > 0$$

$$\frac{d\, r_t}{d\, k} = \frac{(T_s-\theta D_s)Db_l + T_l\left[\dfrac{(b-1)SP_s}{1-k(1-\theta)} - bsD\right]}{Ttbl\left[\dfrac{kD_s + CU_s+FP_s}{1-\theta}\right]}$$

$$\frac{d\, R}{d\, k} = \frac{FP_sD}{\dfrac{kD_s + CU_s + FP_s}{1-\theta}} > 0$$

The partial derivatives with respect to k are all unambiguosly positive. An increase in k is a restrictive policy measure which leads to an increase in interest rates and foreign reserves.

A higher reserve requirement on the other hand, can offer an incentive to financial innovations. The above partial derivatives show that innovations dampen the effects the reserve requirement has on the securities rate, time deposit rate and foreign exchange reserves. Sørensen (1987) concludes similarly that the effectiveness of the reserve requirement as a monetary policy instrument is reduced by financial innovations.

We now turn to the real side of the economy and write the IS equation as

$$(5) \qquad y = A(\underset{+}{y}, \underset{-}{r_l}, \underset{+}{W}) + X - \underset{-}{M(y)}.$$

We include the loan rate in the equation because it is the rate that affects investment. From equations (4) - (8) we know that r_l can be written as

$$r_l = r_l(\underset{?}{y}, \underset{-}{SC}, \underset{+}{k}).$$

Substituting this expression for r_l in the IS equation and differentiating gives us

$$\frac{dy}{dk} = \frac{A_l r_{lk}}{1 - A_y + M_y} > 0$$

and

$$\frac{dy}{dSC} = \frac{A_l r_{lsc}}{1 - A_y - A_l r_{ly} + M_y} < 0.$$

The direct effect of k on y is negative as it we would expect. An increase in k will increase the loan rate and thereby lead to a decrease in income.

With the exception of $A_l r_{ly}$ all the signs in the expression for dy/dSC are known. We assume that the term $A_l r_{ly}$ is small relative to the other terms in the denominator because income likely has larger effects on absorption and imports than on interest rates. By this reasoning we can consider the denominator to be positive yielding a positive partial derivative. Again, this result is quite standard: larger central bank holdings of domestic securities imply an increase in the supply of high-powered money and this leads to an increase in income.

The above discussion reveals that an increase in k reduces the impact of changes in SC on the loan rate. In other words, r_{lsc} is smaller when k is higher, making the numerator smaller. We cannot determine, however, what will happen to the denominator. Although the effect of k on y is negative, the effect of y on r_l may be either positive or negative. r_{ly} may increase or decrease as a result of a change in k. If we consider the changes in r_{ly} to be negligible, we can conclude that an increase in k will reduce the effects of open market operations on income.

3.3 Relative Effectiveness of the Reserve Requirement and Open Market Operations

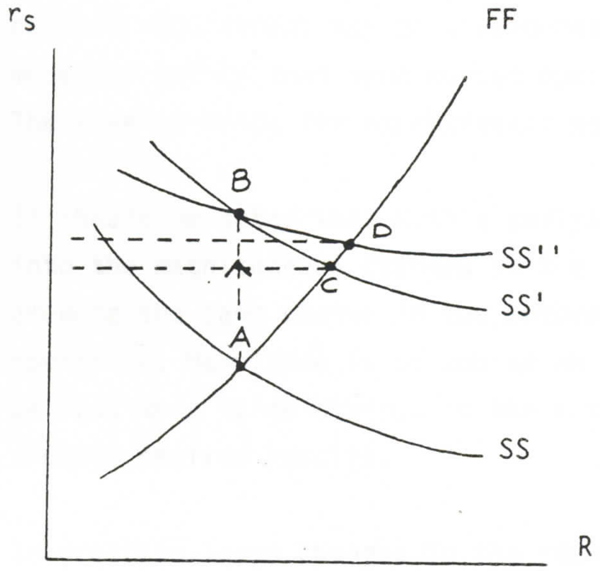
Now that we have established that both open market operations and changing the reserve requirement affect interest rates and income in the short run, it would be interesting to discover which one of these instruments is more powerful. Determining the strength of the instruments, however, presents some difficulties. First, how should this effectiveness be measured? And second, how can we make comparable the effects of open market operations and of changes in the reserve requirement? Because a unit change in the money supply is likely to have different effects from a unit change in the reserve requirement, comparing the partial derivatives is not meaningful.

Roth (1976) makes an attempt in this direction. He defines effectiveness as the ability to cause a change in the interest rate. The instrument that causes the larger change is the more effective. His model differs from our model in that he does not model the banking sector explicitly but takes it into account only in the LM equation. Also, there is no loan market in Roth's model. Roth's LM equation defines the money market equilibrium for the broad monetary aggregate which is the money multiplier times the stock of high-powered money. A change in the reserve requirement will change the money multiplier and thereby the supply of broad money. In Roth's model, both instruments work through changing the money supply. Roth then compares the effects of the policy instruments by considering two situations. In both cases there has been a change in the money supply of an equal amount but in one case it is the result of an open market operation and in the other it is the result of a change in the reserve requirement. Roth finds that changing the reserve requirement is the more effective instrument when monetary policy is restrictive. This is because the offsetting capital inflows that are the result of the initial increase in domestic interest rates will increase domestic liquidity less in the case of changing the reserve requirement than in the case of open market operations. The short run increase in the interest rate will remain larger in the case of changing the reserve requirement. The reverse holds for expansionary policy.

We can use our model to illustrate Roth's point; however, since our LM equation defines the equilibrium in the money market in terms of high-powered money, changes in k will affect the demand side of the equation and open market operations will affect the supply side. We must therefore construct the experiment in a slightly different way. We will consider restrictive policy which in one case is conducted through raising k and in the other through reducing SC. In both cases the interest rate rises by an equal amount on impact.

To keep the analysis analogous to Roth's, we will look at equations (4) and (7) which jointly determine the securities rate and central bank reserves. The equations can be drawn in r_s,R -space (Figure 1). The curve FF represents the foreign asset market equilibrium (equation (4)) and is upward sloping because an increase in r_s reduces private holdings of foreign assets and must be compensated for by an increase in central bank reserves. The curve SS, the money market equilibrium condition, (equation (7)) is downward sloping because an increase in central bank reserves increases the supply of high-powered money; to induce the public to hold this larger money supply the interest rate must fall.

FIGURE 1



Prior to the change in policy, both markets are in equilibrium at point A. In the case of open market operations the change in the policy shifts the SS curve upwards to SS'; for a given stock of reserves the stock of high-powered money is now lower and the interest rate is higher. In the case of a change in the reserve requirement the SS curve shifts upwards to SS'' and its slope changes. The upward shift results from the excess demand for high-powered money at all levels of R due to the increase in k. The slope changes because now a given change in the interest rate induces larger changes in the demand for money and must be offset with larger changes in reserves. The curves SS' and SS'' intersect at point B, reflecting the fact that were reserves to remain unchanged, the policies would have the same effect on the interest rate.

With perfect capital mobility the increase in the domestic interest rate induces the public to shift its portfolios from foreign assets to domestic securities. This increases central bank reserves as we move towards the new short run equilibrium at either point C or point D. We can see from the figure that the resulting increase in the domestic securities rate is larger at point D, reflecting equilibrium in the case of a change in the reserve requirement. This is precisely Roth's reasoning, and in this sense changing the reserve requirement may be considered a more effective instrument of monetary policy than open market operations for restrictive policy. The reverse holds for expansionary policy.

It should be noted that Roth's analysis does not give any insight into the magnitude of changes in the reserve requirement needed to produce the same change in the interest rate as a given open market operation. Magnitude is of course an empirical issue, but it might be that very large changes in the reserve requirement are needed to produce desired results.

In practice large changes in the reserve requirement could be difficult to implement. Changes in the reserve requirement are also likely to affect the competitive position between the banks that have different liability structures. A higher reserve requirement, in addition to being an incentive to financial innovations at home, also reduces the international competitiveness of the domestic financial markets. In a system of low and institutionally fixed deposit rates, however, the reserve requirement can be thought of as a way to tax the banks for the extra regulation. A further practical problem in using the reserve requirement as a policy instrument is that it cannot be changed easily, on a day-to-day basis, whereas open market operations are more flexible.

4 CONCLUDING COMMENTS

In this paper we have studied the effects of a change in the reserve requirement and compared them to those of open market operations. We assumed a small open economy, a fixed exchange rate, an institutionally fixed deposit rate and perfect capital mobility throughout the analysis.

We found neither instrument to be effective under long run conditions of perfect asset substitutability when net foreign wealth is defined as the sum of central bank reserves and private holdings of foreign securities. These are the standard results. However, if the interest bearing net foreign wealth is defined as only private net foreign wealth, both instruments were found to be effective. This result is in contrast to Mathieson who claims that only the reserve requirement would be an effective policy instrument in such a case. We could draw no absolute conclusions regarding the relative efficiency of the two instruments.

In the short run, when domestic and foreign assets are regarded as in perfect substitutes and the balance of payments may be in disequilibrium, we found the two policy instruments to be effective, having the same qualitative kind of effects. Further, as Roth points out, a change in the reserve requirement may be considered as a more effective policy instrument when monetary policy is restrictive. The reverse holds for expansionary policy. We also found that the effectiveness of the reserve requirement as a policy instrument is reduced by financial innovations because they allow bansk to avoid the reserve requirement. Financial innovations, however, increase the effectiveness of open market operations.

Finally, we found that an increase in the required reserve ratio will dampen the effects of open market operations in our short run model.

The results described above were derived using the simplest possible open economy IS-LM model with an explicit banking sector. The results should therefore be viewed as tentative. More careful modelling of the banking sector an of the process of financial innovation is required; however, we feel that even our tentative results provide some insights into the workings of the reserve requirement as an instrument of monetary policy.

REFERENCES

CALVO, GUILLERMO A. (1986)
Welfare, Banks, and Capital Mobility in Steady State: The Case of Predetermined Exchange Rates. In Sebastian Edwards and Liaquat Ahamed (Eds.): Economic Adjustment and Exchange Rates in Developing Countries. NBER. The University of Chicago Press.

FRIEDMAN, MILTON (1959)
A Program for Monetary Stability. New York. Fordham Univ. Press.

KAMINOW, IRA (1977)
Required Reserve Ratios, Policy Instruments, and Money Stock Control. Journal of Monetary Economics, 3.

KÄHKÖNEN, JUHA (1984)
Luotonsäännöstely, markkinaraha ja korkopolitiikka. Yearbook of the Finnish Society for Economic Research 1983/84.

LAUFENBERG, DANIEL (1979)
Optimal Reserve Requirement Ratios Against Bank Deposits for Short-run Monetary Control. Journal of Money, Credit and Banking. Vol 11, no 1.

MATHIESON, DONALD (1975)
Monetary Policy in an Inside-Money, Open Economy. Quarterly Journal of Economics.

ROMER, DAVID (1985)
Financial Intermediation, Reserve Requirements, and Inside Money. Journal of Monetary Economics, 16.

ROTH, J.-P. (1976)
Une comparaison de l'efficacité respective de la politique d'open-market et des réserves obligatoires en changes fixes. Schweizerische Zeitschrift fur Volkswirtschaft und Statistik. Jahrgang 112, No.4.

SHERMAN, LAWRENCE, SPRENKLE, CASE and STANHOUSE, BRYAN (1979)
Reserve Requirements and Control of the Money Supply. Journal of Money, Credit and Banking. Vol 11, no 4.

SORENSEN, ANETTE (1987)
Finansielle innovationer og pengepolitikkens effektivitet. Nationalokonomisk Tidsskrift. Nr.2.

TOBIN, JAMES and BRAINARD, WILLIAM (1963)
Financial Intermediaries and the Effectiveness of Monetary Controls. American Economic Review. Papers and Proceedings, 53, No. 2.

TOBIN, JAMES (1969)
A General Equilibrium Approach to Monetary Theory. Journal of Money, Credit and Banking.

van WIJNBERGER, S. (1987)
Interest Rate Management in LDC's. Journal of Monetary Economics, 12.

WINNINGHAM, Scott (1980)
Reserve Ratios and Short-run Monetary Control. Federal Reserve Bank of Kansas City. Research Working Paper.

APPENDIX 1

LONG RUN MODEL WITH DIFFERENT INTEREST RATES ON CENTRAL BANK FOREIGN RESERVES AND FOREIGN SECURITIES HELD BY THE PUBLIC

If we assume that central bank reserves earn an interest different from that foreign securities held by the public, our long-run model becomes:

(1A) $X - M(y) + r^*FP = 0$

(2A) $kD(r_d, r^*, y, W) + CU(r_d, r^*, y, W) = R + SC$

(3A) $y = A(y, r^*, W) + X - M(y).$

The partial derivatives with respect to k now take the form

$$\frac{dy}{dk} = \frac{DA_W r^*}{A} \neq 0$$

$$\frac{dR}{dk} = \frac{D\{(1-A_y+M_y)r^* - A_W M_y\}}{A} \neq 0$$

$$\frac{dFP}{dk} = \frac{DA_W M_y}{A} \neq 0$$

where $A = r^*\{(kD_y+CU_y)(-A_W) - (1-A_y+M_y)(kD_W+CU_W-1)\} - A_W M_y.$

We now see that even dy/dk is different from zero, i.e. a change in the reserve requirement will affect real income. If we take A to the negative, which requires that $A_W(kD_y+CU_y) > (1-A_y+M_y)(kD_W+CU_W-1)$, we obtain the plausible results: $dy/dk < 0$ and $dFP/dk < 0$ (an increase in k reduces real income and private holdings of foreign securities). The effects on central bank reserves remain ambiguous; to obtain the plausible result that $dR/dk > 0$, we need to make the further assumption that $A_W M_y > (1-A_y+M_y)r^*$.

The partial derivatives with respect to SC are

$$\frac{dy}{dSC} = \frac{-A_w r^*}{A} \neq 0$$

$$\frac{dR}{dSC} = \frac{-(1-A_y+M_y)r^* + A_w M_y}{A} \neq 0$$

$$\frac{dFP}{dSC} = \frac{-A_w M_y}{A} \neq 0$$

These results are analoguous to the ones with respect to k. Thus open market operations were in the same way as changes in the reserve requirement in this setting.

APPENDIX 2

Short run model: partial derivates with respect to y.

$$\frac{dr_s}{dy} = \frac{FP_y + aD_y + CU_y}{-[aDs + CUs + FPs]} \gtrless 0$$

$$\frac{dr_l}{dy} = \frac{(SP_y + (1-a)D_y)((b-1)D_s + b_sD) + D_y(1-b)[(1-a)D_s - SP_s]}{-Db_l(aD_s + CU_s + FP_s)} \gtrless 0$$

$$\frac{dr_t}{dy} = \frac{(T_s-\theta D_s)Db_l[SP_s+1-a)D_y] - T_l[FP_s(b-1)D_y + ((b-1)D_s+b_sD)(SP_y+(1-a)DY-FP_y) + (1-b)D_y((1-a)D_s+SP_s)] + \theta D_yDb_l((1-a)D_s + SP_s)}{-T_tDb_l(aD_s + CU_s + FP_s)} \gtrless 0$$

$$\frac{dR}{dy} = \frac{FP_s(SP_y + (1-a)D_y) + FP_y((1-a)D_s + SP_s)}{-(aD_s + CU_s + FP_s)} \gtrless 0$$

$a = k(1-\theta)$

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