RESEARCH PROGRAM IN FINANCE

WORKING PAPER NO. 31

THE USE OF THE DISCOUNT RATE AND OPEN MARKET OPERATIONS UNDER ALTERNATIVE EXCHANGE RATE REGIMES

by

Steven W. Kohlhagen

February 1975

Steven W. Kohlhagen is Assistant Professor, Graduate School of Business Administration, University of California, Berkeley. Research for this paper was supported in part by a grant from the Dean Witter Foundation.
THE USE OF THE DISCOUNT RATE AND OPEN MARKET OPERATIONS
UNDER ALTERNATIVE EXCHANGE RATE REGIMES

by

Steven W. Kohlhagen

This paper extends previous comparative statics analyses of the relative strengths of monetary and fiscal policy under alternative exchange rate regimes by dividing "monetary policy" into two components: open market operations and rediscounting. I specifically analyze under both flexible and fixed regimes whether open market operations or changes in the central bank discount rate (given an open discount window) have a greater effect on domestic monetary targets.

This study takes the view that activity in the foreign exchange markets is a direct result of disequilibrium in domestic money and bond markets, along the lines of the monetarist model of the balance of payments summarized by Johnson (1972). For example, with fixed exchange rates an excess supply of money is satisfied by a trade deficit that soaks up the excess liquidity, while with flexible exchange rates the adjustment is realized through exchange rate movements and resulting effects on the price level.

The assumption in many such models of perfectly mobile short-term capital ties the domestic interest rate to the foreign (or international) rate and implies that the domestic money stock is endogenous in a world of fixed exchange rates. If domestic authorities attempt to maintain a domestic interest rate independent of foreign rates (without imposing capital controls), then they must give up control of the exchange rate or the nominal stock of money. For the purposes of this paper, I assume less than perfectly mobile capital so that I can analyze more realistically the effectiveness of monetary policies on capital flows, the domestic interest rate, and the supply of money. This assumption modifies somewhat the now-standard conclusions that monetary authorities have significant control over monetary variables with flexible exchange rates but are powerless when they peg the exchange rate.

This analysis is concerned primarily with how monetary authorities can best control monetary variables when faced with exogenous short-run disturbances (e.g., shifts in liquidity preference or changes in foreign interest rates), rather than with longer-run questions such as rates of inflation.

The author wishes to thank Ronald McKinnon and John Scadding for their invaluable contributions to earlier drafts of this paper. All errors are, of course, the responsibility of the author.
or economic growth. Which of the tools available to monetary authorities affords them the most control over domestic short-run liquidity conditions under alternative exchange rate regimes?

1. THE MODEL

There are three short-term assets in the model, domestic and foreign short-term interest bearing assets and domestic noninterest bearing assets (money) in the form of demand deposits. To introduce the complete model, which is similar in design to that of Kouri and Porter (1974) but includes a more complete monetary sector, the assets and liabilities of the four financial sectors are analyzed.

The first sector, the public and firms, is assumed to demand a stock quantity of money (N), a stock of domestic bonds (R^D), and a stock of foreign bonds (R^FP) denominated in domestic currency, against which they balance their total gross stock of indebtedness (B^S) and their net worth, expressed as the total stock of financial wealth (W^D):

\[ W^D + B^S = N + R^D + R^FP. \] (1)

The public's net position in domestic bonds is then expressed as \( R^D - B^S (= R^D') \). Domestic financial wealth is expressed by the identity:

\[ W^D = N + (R^D - B^S) + R^FP. \] (2)

I abstract from real capital accumulation in this model because of the short-run horizon of the analysis. As will be seen, all additions to the money stock are of the inside variety (through open market operations). The only source for an increase in domestic wealth is therefore an exogenous change in the current account or long-term capital account of the balance of payments.

Taking the partial derivatives of the wealth identity (2) (while holding wealth constant):

\[ \frac{N}{W^D} + \frac{R^D'}{W^D} + \frac{R^FP}{W^D} = 1, \] (3)

and

\[ \frac{N}{J^D} + \frac{R^D'}{J^D} + \frac{R^FP}{J^D} = 0, \quad J^D = \gamma^D, \quad \eta^D, \quad \eta^F, \quad \gamma, \] (4)

where a subscript denotes a partial derivative (e.g., \( \frac{N}{W^D} = \frac{\partial N}{\partial W^D} \)). The comparative static effects on the system of a one-unit change in wealth can then be shown by treating domestic wealth as an exogenous variable.

The demand for money (N) is an increasing function of domestic income (Y^D), the total stock of domestic wealth (W^D), and an exogenous liquidity preference shift variable (h), and a decreasing
function of the domestic interest rate \( r^d \), and the foreign interest rate covered against foreign exchange risk through the forward market \( r^{fc} \). In stock equilibrium, the total demand for money must equal the supply \( M^s \):

\[
N(D, W, r^d, r^{fc}, h) = M^s, \quad (5)
\]

where

\[
r^{fc} = \frac{X^*(f)}{X'}, \quad \text{and}
\]

\[
N_{D}^{N}, N_{W}^{N}, N_{B} > 0, N_{r^d}^{N}, N_{r^{fc}} < 0,
\]

where \( r^f \) is the foreign interest rate; and \( X \) and \( X' \) are the spot and forward exchange rates, respectively, defined in terms of foreign currency per unit of domestic currency.

The commercial banks supply the total domestic money stock \( M^s \), against which they hold as assets a stock of domestic bonds (equal to their demand for domestic bonds \( B^D \)), foreign bonds \( B^{FE} \), and deposits with the central bank \( D \). (Loans to the private sector are included in the banks' demand for domestic bonds and the public's net indebtedness.) In addition, commercial banks may borrow at the discount window from the central bank \( B^N \) at the prevailing discount rate \( i \) determined by the central bank.

The balance sheet identity for the banks is then:

\[
D + R^B + B^{FE} = B^N = M^s, \quad (6)
\]

where

\[
B^N = B^N(r^d, i, r^{fc}), \quad \text{and} \quad (7)
\]

\[
B^N_{r^d}, B^N_{r^{fc}} > 0, B^N_x < 0,
\]

where \( B^N_{r^{fc}} > 0 \) implies \( B^N_{r^{fc}}, B^N_x > 0 \), and \( B^N_x < 0 \). Those holding foreign bonds are assumed then to always cover their foreign exchange risk in the forward market.

In a fractional reserve system (assuming no excess reserves), where \( \phi \) is the minimum reserve requirement ratio (and \( \phi = \frac{1}{q^r} \)):

\[
M^s = qD = q(M^r + C).
\]

The member banks' deposits are held at the central bank, against which the central bank holds a stock of bonds used in open market operations \( B^{Cen} \), the stock of gold and foreign exchange used in exchange rate pegging operations \( G \), and discounts and advances to member banks at the discount
window \( (B^W) \):

\[
B^\text{Com} + G + B^N = D = H^I + G.
\] (9)

The fourth financial sector is the "foreign" sector, which provides foreign bonds \( (F^S) \) at an infinitely elastic supply at the foreign interest rate (implying that with fixed exchange rates there is an infinitely elastic supply of high-powered money):

\[
B^F = B^PF + B^FS = B^FS
\] (10)

where the total demand function for foreign bonds by domestic residents \( (B^D) \) is a function of domestic income, an increasing function of the stock of domestic wealth (assuming all short-term assets so that interest rate and exchange rate changes are ignored), the level of the foreign interest rate, and the spot exchange rate, and a decreasing function of the domestic interest rate and the forward exchange rate:

\[
B^F = f(Y, W, r^d, r^f c),
\] (11)

\[
f_{W}, f_{r^f c} > 0, f_{r^d} < 0.
\]

The model assumes that there is no demand by foreign residents for domestic bonds. To include such a demand in the model would further complicate it without adding any significant insight. The omission of a foreign demand for domestic bonds is equivalent to accepting the small-country assumption; that is, the country being analyzed is faced with an infinitely elastic supply of foreign bonds by the rest of the world at the prevailing foreign interest rate \( (r^F) \). In effect, the model admits the possibility of foreign demand for domestic bonds indirectly through the substitutability of domestic and foreign bonds.

Stock equilibrium is defined in the domestic bond market when total demand for domestic bonds by the public and firms, commercial banks, and the central bank equals the indebtedness the public is willing to incur.\(^2\)

---

\(^1\) The sign of the partial derivative of domestic residents' demand for foreign bonds with respect to domestic income is ambiguous, as is the sign of the change in the demand by domestic residents for domestic bonds as a function of domestic income. Wealth is held constant, and an increase in income cannot imply a positive increase in the demand for all assets (at least not a demand that will be satisfied). Since it is assumed that an increase in income induces an increase in the quantity of money demanded, it must be true that the total quantity of domestic and foreign bonds demanded by domestic residents must fall. Whether both will fall or one will rise and the other fall is not clear, and consequently the relevant income elasticities are ambiguous. At present the question is an empirical one.

\(^2\) Since there is no real capital accumulation in the model, all money is of the "inside" variety. If the model were concerned with long-run capital accumulation, it could consider "outside"
\[ R^P + R^B + R^{Gen} = B^S, \]  

(12)

where

\[ (R^P - B^S) = R^P(r^D, W^D, r^d, r^{fc}), \]  

(13)

\[ B^S = R^S(r^d, r^{fc}, i, q), \]  

(14)

\[ R^P, R^B, R^{P'}, R^{B'} > 0 \quad \text{and} \quad R^{P'}, R^B, R^{P}, R^{B}, R^q < 0. \]

I assume open market operations and changes in the discount rate to be the two principal tools of monetary policy. The use of discretionary changes in reserve requirements can be shown to have an identical impact as open market operations in such a comparative statics-portfolio balance model of monetary equilibrium. The main difference, of course, being that the smaller are reserve requirements the greater is the leverage of other monetary policies upon economic variables. It will therefore be assumed for the purposes of simplification that reserve requirements are unchanged throughout the period of analysis and that, whereas the absolute size is less than 100 percent, its actual magnitude will remain unspecified.

Discount rate policy is treated differently from that normally pursued by central bankers. It is assumed that the central bank keeps a completely open discount window to all commercial banks, and that the discount rate is used as a policy tool to actively affect monetary conditions rather than merely as a response to activity at the window. The discount rate will then lead rather than follow movements in domestic interest rates. Open market operations are treated as purchases and sales of short-term securities by the central bank. Both policy tools are then viewed as alternative means of affecting domestic short-term monetary conditions.

There are two ways that the central bank can view increased (or decreased) activity at the discount window. It can be seen as a means through which the commercial banks bypass short-run monetary policy, thereby reducing the monetary authority's ability to control the domestic money supply. Alternatively, it can be viewed as a means through which the commercial banks avoid sudden portfolio shifts imposed upon them by significant changes in central bank policy (or changes in private liquidity preference or unexpected flows through the foreign exchanges), allowing them a temporary escape valve money and the government's indebtedness. In a short-run monetary impact model such as this, however, the government's "debt" position is with respect to holdings of short-term assets for use in open market operations, exchange rate pegging operations, and in maintaining an open discount window.
until they are able to permanently shift their asset holdings in keeping with changed economic conditions. In the former case the authorities would most likely discourage discounting as much as possible, whereas a central bank with the latter viewpoint might well keep a more open discount window.

Note that international flows of short-term capital can also be viewed as a form of discounting in this context. A commercial bank in need of reserves can either rediscount a bill at the central bank discount window or sell some of its holdings of foreign bonds to foreign residents as a way of building up reserves (analogously, it could borrow from the central bank or from a foreign bank). In either case it uses the central bank's discount window or the foreign exchange market to change its short-run asset position in response to changing returns on assets or economic conditions.

2. MONETARY EQUILIBRIUM IN A CLOSED ECONOMY

Invoking the wealth constraint and taking first differences, the model presented above for a closed economy can be expressed as:

\[
\sum_{y} \Delta Y^{D} + \sum_{r} \Delta r^{d} + \sum_{d} \Delta W^{D} + \sum_{n} \Delta h - q \left( \Delta B^{Cen} + \frac{B^{N}}{r_{d} \Delta r^{d} + B^{N} \Delta d} \right) = 0, \tag{15}
\]

and

\[
\Delta M^{S} = q \left( \Delta B^{Cen} + \frac{B^{N}}{r_{d} \Delta r^{d} + B^{N} \Delta d} \right). \tag{16}
\]

The solution to this system is:

\[
\Delta r^{d} = \frac{1}{N \frac{r_{d} - qB^{N}}{r_{d}}} \left[ -N \Delta Y^{D} - \sum_{w} \Delta W^{D} - \sum_{h} \Delta h + q \Delta B^{Cen} + qB^{N} \Delta d \right] \tag{17}
\]

\[
\Delta M^{S} = \frac{q}{N \frac{r_{d} - qB^{N}}{r_{d}}} \left[ -B^{N} \Delta Y^{D} - B^{N} \Delta W^{D} - B^{N} \Delta h + \sum_{d} \Delta B^{Cen} + \sum_{r} \Delta B^{N} \Delta d \right] \tag{18}
\]

and where

\[
\frac{\partial r^{d}}{\partial B^{Cen}} = \frac{q}{N \frac{r_{d} - qB^{N}}{r_{d}}} < 0, \tag{19}
\]

\[
\frac{\partial r^{d}}{\partial \Delta d} = \frac{qB^{N}}{N \frac{r_{d} - qB^{N}}{r_{d}}} > 0, \tag{20}
\]
\[
\frac{\partial S}{\partial B_{\text{Can}}} = \frac{qN^d}{r_{-\sigma}^{B^N_{d}}} > 0, \quad \text{and}
\]

\[
\frac{\partial S}{\partial I} = \frac{qN^d B^N_{d}}{r_{-\sigma}^{B^N_{d}}} < 0.
\]

Increased open market purchases or a reduction in the discount rate by the central bank induce a fall in the domestic interest rate and a rise in the domestic money supply. The more responsive the demand for money to changes in the domestic interest rate the less effect these monetary policies will have upon interest rates and the more effect they will have upon the money stock. That is, the greater the public's portfolio shifts between interest-bearing and noninterest-bearing assets due to interest rate movements the smaller will be the fall in the interest rate necessary to induce the public to hold a larger stock of money.

On the other hand, the more responsive are commercial bank borrowings at the discount window to changes in the domestic interest rate the smaller are the central bank's powers in inducing changes in interest rates or the money supply through the use of either monetary tool. In the limiting case, if the commercial banks do not change their position at the discount window in response to changes in the domestic interest rate \(\frac{B^N_{d}}{r} = 0\), then open market purchases increase the domestic money base by the exact amount of the purchases. When this elasticity is infinite \(\frac{B^N_{d}}{r} = \infty\), then neither open market operations nor changes in the discount rate have any effect on the domestic interest rate or the money supply (i.e., any change in the interest rate induces increased activity at the discount window until both the money stock and interest rate return to their previous levels). A central bank that keeps a completely open discount window and encourages its use without limit will therefore be unable to control domestic monetary conditions through the use of either open market operations or changes in the discount rate.

On the other hand, the more responsive is commercial bank discounting to changes in the discount rate the greater is central bank control over the interest rate and money supply through discount rate changes.

Implicitly assumed up to now is the nonexistence of any relationship between commercial bank responsiveness to changes in the interest rate and changes in the discount rate. Presumably, the more responsive commercial banks are to the cost of borrowing from the central bank, the more
responsive they will be to the return they can receive on the borrowed funds. Therefore, for the remainder of the analysis we make the restrictive assumption (for the sake of convenience) that the elasticities of response of discounting to changes in the interest rate and discount rate are of equal magnitude \( \frac{E^N}{E^L} = \frac{E^N}{E^L} \). Note, however, that a central bank that can induce highly elastic responses in commercial bank discounting to changes in the discount rate, while reducing the impact of interest rate changes on commercial bank behavior at the discount window, can significantly increase the effects of both open market operations and changes in the discount rate on the money supply and the domestic interest rate.

Assuming equal responsiveness of commercial banks to changes in the discount rate or the interest rate, the more elastic the discounting the less powerful are the effects of open market operations upon either the interest rate or the nominal stock of money. In the limiting case with zero elasticity \( \frac{E^N}{E^L} = -\frac{E^N}{E^L} = 0 \), open market operations have the maximum impact, increasing the money base by the amount of the open market purchases; with infinite elasticity, open market operations have no impact on the money supply or the interest rate.

The more responsive commercial bank discounting to changes in the discount rate (and the domestic interest rate) the greater is central bank control over the interest rate and money supply through discount rate changes. Again looking at the polar cases, when discounting is completely unresponsive to changes in the discount rate and the domestic interest rate, then the effect of a change in the discount rate on domestic interest rates and the money supply is, of course, zero. If the responsiveness is infinitely elastic, then a rise in the discount rate will force the domestic interest rate higher until it is equal to the new discount rate and the money supply will fall (through a decrease in discounts and advances) until there is no longer an excess supply of money caused by the effect of the higher domestic interest rate on money demand.

The central bank, keeping a completely open discount window and not changing the discount rate in response to disturbances will then be faced with a domestic money stock that is determined in part by demand conditions in the market. Except as it can be controlled through changes in the discount rate, the domestic money supply will be endogenous.

The effects of exogenous disturbances such as changes in liquidity preference, income, wealth, etc., are also affected by the responsiveness of commercial bank discounting. As an example, the effects for changes in liquidity preference are shown below:
\[
\frac{\partial d}{\partial h} = -\frac{N_h}{\frac{N_d}{r_d} - q h r_d} > 0, \quad \text{and} \\
\frac{\partial S}{\partial h} = -\frac{q h N_d}{\frac{N_d}{r_d} - q h r_d} > 0.
\]

With an increase in liquidity preference the public sells domestic bonds for domestic money, driving up the interest rate and increasing commercial bank borrowing at the discount window; this increases the money supply and satisfies the increased demand. The more responsive is the demand for funds from the discount window by the banks the larger is the effect of the exogenous disturbance upon the domestic money supply, and the less is the effect on the domestic interest rate (this could perform a valuable smoothing role in the economy in the event the demand for money was unstable). In the limiting case of infinitely elastic demand for discounts and advances \( (B_d^N = -b_1 = \infty) \), the interest rate is pegged at the level of the discount rate and the money supply will increase by exactly the amount of the increase in liquidity preference \( (N_h) \).

The monetary authority, when faced with such a disturbance, has a choice among: (1) doing nothing so that discounting operates to allow adjustment in the nominal stock of money and/or the interest rate; (2) preventing an increase in the stock of money either by raising the discount rate to discourage the use of the discount window or by increasing open market sales by the amount of the increased activity at the discount window; or (3) preventing an increase in the interest rate (and tight short-run monetary conditions) either by lowering the discount rate to encourage discounting or by increasing open market purchases.

Thus, in a closed economy a monetary authority faced with an exogenous disturbance must choose between controlling the interest rate and allowing the nominal money stock to be determined by demand conditions, or controlling the money stock while allowing domestic monetary conditions (through the short-term interest rate) to be demand-determined. The problem is not as important in an open economy with mobile short-term capital, where the domestic interest rate is at least partially tied to the foreign interest rate, as it is in a closed economy.

The use of discount rate changes versus open market operations to control short-run domestic liquidity conditions has been discussed in the literature, especially with regard to the United States monetary policy (see, e.g., Ascheim 1961; Friedman 1959; Holmes 1969; Polakoff 1960, 1963; Smith 1963;
Since the United States policy has been to discourage a completely open discount window and to allow changes in the discount rate to follow (rather than lead) domestic interest rate changes, these discussions are not entirely relevant to my analysis. However, it is instructive to review part of their analyses.

In reference to my model, Polakoff (1963) presents some evidence to show that discounting is responsive to the difference between the rate of interest and the discount rate; however, as borrowings increase there is great reluctance by the banks to assume greater debt. This historical reluctance on the part of the banks to borrow is in part due to the administration of the discount window and plays a great role in reducing the interest elasticities of discounting \( b_1^N \) and \( b_2^N \) (Smith 1963, pp. 50-51). In fact, one opinion holds that commercial banks come to the window only out of need and that, therefore, the response to changes in the discount rate is small \( b_1^N = 0 \) (Polakoff 1963, pp. 193-95).

The facts that open market operations can just as easily provide liquidity and that discretionary changes in the discount rate can send false signals to the market have been the principal arguments against the use of discounting as a more active policy (Ascheim 1961; Friedman 1959; Polakoff 1963; Smith 1963). The former criticism neglects the fact that the discount window provides an automatic safety valve for banks with liquidity problems that would not be available with a system using only open market operations. The second argument has two major faults: (1) the discount rate in the United States is raised (except in rare cases) only under pressure from rising short-term interest rates, so that few market participants are misled into thinking that the discount rate is a leader rather than a follower (Polakoff 1963); and (2) the discount mechanism suggested in my analysis above would leave no doubt as to its signal because it would always be an accurate indicator of intended monetary policy.

3. MONETARY POLICIES IN AN OPEN ECONOMY WITH FIXED EXCHANGE RATES

In an open economy the commercial banks are presented with an additional opportunity to borrow needed reserves or lend excess reserves, namely, the foreign bond markets. In a period of tightening domestic money markets, banks can increase their reserves by borrowing from the central bank (via discounting) or from foreign money markets (through capital inflows realized, for example, by selling domestic bonds to foreign residents and cashing the proceeds into domestic currency). Similarly, when the central bank pursues an easier money policy, commercial banks can reduce excess reserves either by reducing their discounts at the central bank or increasing their holdings of foreign bonds.
The model for a fixed exchange rate regime can be shown to be:

\[ N_D \Delta X^D + N_d \Delta r^d + N_D \Delta N^D + N_d \Delta h + N_r \Delta r_r^f = q \left( \Delta b^Cen + T^D - \Delta b^P + b^N_d \Delta r_d + b^N_d \Delta t + b^N_r \Delta r_r^f \right) = 0, \]  

\( (25) \)

\[ \Delta b^P = f_D \Delta X^D - f_D \Delta N^D = f_r \Delta r^d = f_r \Delta r_r^f = 0, \]  

\( \) and

\[ \Delta b^S = q \left( \Delta b^Cen + b^N_d \Delta r_d + b^N_{t} \Delta t + b^N_r \Delta r_r^f + T^D - \Delta b^P \right), \]  

\( (27) \)

where the exogenous trade balance \( (T^D) \) and short-term capital inflows enter the money supply through official pegging operations of the central monetary authority.

With fixed exchange rates, the multipliers analogous to \( (19)-(22) \) for the closed economy are then:

\[ \frac{\partial \bar{r}}{\partial \bar{r}} = \frac{q}{N_d + q^f \bar{r}} < 0, \]  

\( (28) \)

\[ \frac{\partial \bar{r}}{\partial \bar{t}} = \frac{q^N}{N_d + q^f \bar{r}} > 0, \]  

\( (29) \)

\[ \frac{\partial \bar{b}^S}{\partial \bar{r}} = \frac{q^N}{N_d + q^f \bar{r}} > 0, \]  

\( \) and

\[ \frac{\partial \bar{b}^S}{\partial \bar{t}} = \frac{q^N}{N_d + q^f \bar{r}} < 0. \]  

\( (31) \)

The results are identical with those for a closed economy except for the inclusion of the interest-elasticity of capital flows \( f_{r_d} \). The more interest-elastic are international capital flows the less impact either domestic monetary policy has upon domestic interest rates and the domestic money supply. When capital flows are not at all responsive to domestic interest rates \( f_{r_d} = 0 \), the results are identical to those for the closed economy. On the other hand, when capital flows are infinitely elastic, \( f_{r_d} = -\infty \), domestic monetary policies have no impact at all. This latter result
is the familiar conclusion that monetary policy has no power with fixed exchange rates and perfectly mobile capital and is a result of the fact that the central bank must interfere in the foreign exchanges to offset the effect of capital flows on the exchange rate.

It is instructive to analyze the size of the short-term capital outflow resulting from an increase in open market purchases by the central bank:

\[
\frac{\Delta B^F}{\Delta B^{Gen}} = \frac{qf_d r_d}{r_d + qf_d - qB_d} > 0. 
\] (32)

If capital is perfectly mobile \( (f_d = \infty) \) then any exogenous change in the domestic money stock will be exactly offset by an equal outflow of capital and resulting decrease in the official holdings of gold and foreign exchange. On the other hand if capital flows are completely restricted \( (f_d = 0) \), then there will be no discounting by commercial banks in the foreign exchanges and all adjustments to the new stock of money must come in domestic markets.

Note that we continue to treat open market operations as an exogenous variable. To the extent that monetary authorities attempt to sterilize the effect of the balance of payments on domestic liquidity conditions, open market operations will be a function of both the current account balance and short-term capital flows. In such a case, the model above would need to be respecified to include open market operations as an endogenous variable. It would be possible to specify both of our monetary variables \( (\Delta B^{Gen} \text{ and } \Delta i) \) so that they contained both an exogenous component and a "sterilization" component that was endogenous to the system. As this would complicate the model without changing any of our basic conclusions, I have retained the exogenous nature of both of our monetary variables.

If the central bank is indifferent with respect to the composition of its assets (as between discounts to commercial banks and holdings of foreign exchange), it will be indifferent whether commercial banks discount at the central bank or in the foreign exchanges as a result of the effects of open market operations. The effectiveness of open market operations is reduced by discounting at either the discount window or in the foreign exchanges. Any attempt to restrict the openness of the discount window will presumably induce the banks to use the foreign exchanges in adjusting their portfolios during a liquidity crisis. Similarly, any restrictions on short-term capital flows will increase activity at the only other source of funds, namely the discount window.

On the other hand, the greater the interest elasticity of commercial bank borrowings the less effective are open market operations and the more effective are discretionary changes in the discount
rate. In order to retain any power at all then, the monetary authority should abandon the use of open market operations in favor of changes in the discount rate when attempting to influence short-run domestic monetary conditions with a fixed exchange rate.

To be sure, the effectiveness of discount rate changes will be reduced the more interest-elastic are capital flows, but then the effectiveness of open market operations is also reduced. The primary reason to use discount rate changes with fixed exchange rates is that this choice at least leaves an option open to the central bank, namely, in times of short-run disturbances, the central bank can wield some power over domestic monetary conditions by restricting the mobility of short-term capital. This is an option not available when open market operations are the principal tool of monetary policy because the commercial banks, when faced with restrictions on short-term capital flows, can always increase or decrease their activities at the central bank's discount window.

The effects of an exogenous change in liquidity preference are:

\[
\frac{\partial f^d}{\partial h} = \frac{-N_h}{N_d^d - qB N_d^d + qf R^d} > 0, \quad \text{and} \quad (33)
\]

\[
\frac{\partial M^d}{\partial h} = \frac{-qN_h}{N_d^d - qB N_d^d + qf R^d} \left( N_h + N_d \frac{\partial f^d}{\partial h} \right) > 0. \quad (34)
\]

As in (23) and (24) above, an exogenous upward shift in the demand for money induces a rise both in the domestic interest rate and the nominal stock of money. Because of the access of the foreign exchange market, the effect of the liquidity shift upon the interest rate is reduced (as compared to the closed economy case) while there is a greater increase in the money supply. The more elastic is the flow of international short-term capital the less is the effect upon the interest rate and the greater is the effect upon the nominal supply of money. Note in (34) that the induced change in the money supply is the increased quantity demanded as a result of the liquidity shift \(N_h\), less the quantity of money no longer demanded as result of the induced rise in the interest rate \(N_d \frac{\partial f^d}{\partial h}\). With perfectly mobile capital \(f^d = \infty\), the domestic interest rate is pegged to the foreign interest rate so that the inflow of capital fully satisfies the shift in demand \(N_h\).

Monetary policy is not as powerful a tool in reacting to exogenous disturbances as it was in the closed economy case. Attempts to achieve an interest rate that is higher than the foreign
interest rate will risk capital inflows in the short run and possible exchange crisis in the long run. A monetary authority that reacts to an increase in the money supply that has been induced by an upward shift in liquidity preference by soaking up the increased liquidity through open market sales will find that its efforts are met by even further capital inflows and continued discounting at the central bank. In order to control the nominal money stock through open market operations, then, the monetary authority must restrict access to the discount window and impose capital controls in the foreign exchanges.

Alternatively, if the monetary authority were to react to the increasing money stock by raising the discount rate, the only leakage from the short-run tight policy would be through the foreign exchanges. If the offsetting capital inflow were felt to be serious enough, then short-run capital controls could be instituted, but no restrictions on the use of the discount window would be necessary, as the banks' access to the window would be the primary source of power available to the monetary authority.

In addition, to the extent that changes in the discount rate are viewed as direct changes in policy, they will have an impact on exchange rate expectations. If changes in the discount rate are taken by speculators to be direct evidence of attempts by the monetary authority to change domestic liquidity conditions and if it is felt that the monetary authority has the power to make its policies effective, then speculative expectations will reflect confidence in the monetary authorities' policy and speculative capital flows will not reduce the effects of the policy. To the extent that a monetary authority feels it can make a positive impact on exchange rate expectations by instilling confidence in its policies, then discount rate changes as a direct signal to market participants will be that much more effective in a fixed exchange rate regime. Since the use of open market operations has a less direct impact as a market indicator, it will not have this property. This provides one additional reason for using discount rate changes rather than open market operations in determining domestic short-run monetary conditions with fixed exchange rates.

---

3It is not clear in this case that the monetary authority would necessarily want to offset the money supply increase; a preferred policy might be to allow the shift in liquidity preference to be satisfied by the market. However, the use of the liquidity preference shift variable is merely one example of an exogenous disturbance; other disturbances from which the monetary authority might well wish to insulate the domestic economy's nominal money stock include shifts in foreigners' liquidity preference, shifts in foreign residents' propensity to hold this economy's bonds, shifts in long-term capital flows, etc. By fixing the exchange rate, the monetary authority surrenders control over the short-term interest rate as long as capital is free to move across international borders. The question is: Given an exogenous disturbance, of the monetary policies available with fixed exchange rates, which gives authority the best control over the short-run nominal money stock?
This use of changes in the discount rate for "psychological effect" was discussed at length by R. G. Hawtrey (specifically in reference to the English experience with Bank Rate from 1864 to 1914) and was recently analyzed by Hicks (1969). Hicks notes that discount rate policy provides the possibility of decisive action by the monetary authority, where such policies, when perceived as being decisive by market participants, affect expectations so as to induce the intended effects upon capital markets. This decisiveness is surrendered by authorities when the discount rate is changed merely in response to changing market conditions. Their discussions of the effects on expectations were specifically in reference to domestic markets, but the effects of decisive discount rate policy would be expected to have similar effects on those market participants analyzing the expected relative rates of return on both foreign and domestic liquid assets.

In short, with fixed exchange rates, in order to exercise effective power through the use of changes in the discount rate, the monetary authority can restrict the mobility of short-term capital; but to use open market operations effectively, the monetary authority must not only restrict short-term capital mobility but must also restrict the activities of commercial banks at the discount window. With fixed exchange rates then, monetary authorities should use changes in the discount rate rather than open market operations to affect domestic short-run liquidity conditions. This choice enables monetary authorities to have as much power over the domestic money supply and interest rates as is possible with fixed exchange rates while minimizing the artificial restraints it must impose to exercise its control over domestic monetary conditions.

4. MONETARY POLICIES WITH FLEXIBLE EXCHANGE RATES

In order to complete the model when exchange rates are free to fluctuate, I must define equilibrium in both spot and forward exchange markets in what has by now become a standard representation (see Tsai 1958, 1959; Grubel 1966). It is assumed that there are three groups participating in the markets for spot and forward exchange. There are traders dealing both in the movement of goods and services and long-term capital flows, whose purchases and sales are assumed to be entirely in spot currency. There are domestic residents demanding foreign bonds (interest arbitragers) dealing in

---

4The use of discount rate changes to offset short-run liquidity conditions does not preclude the use of open market operations for longer-run goals. Since the discount window is only available to the banks as a source of short-run funds, it can only serve to offset policies in the short run. For example, if a longer-run tight monetary policy is being pursued through open market sales during a fixed exchange rate regime, my conclusions indicate that, if this policy is being temporarily thwarted through increased activities in the foreign exchanges and at the discount window, the correct short-run complementary policy is to raise the discount rate (and possibly restrict capital outflows) rather than to increase open market sales.
international short-term capital movements, and who are assumed to always cover their exchange risk in the forward exchange market. The third group is composed of those assuming an open position with respect to exchange risk—speculators. There exists then a market for spot exchange composed of traders and interest arbitragers and a forward exchange market composed of interest arbitragers and speculators.

By representing traders as dealing only in spot exchange, I am assuming that their hedging decisions in the forward market are a function of their expectations on future spot prices and not on their current account transactions. Uncovered capital flows are treated as a simultaneous arbitrage and speculative transaction (see Tsaiang 1959).

The excess demand for spot domestic currency by interest arbitragers \( (s^A) \) will be equal to in magnitude but opposite in sign to the foreign bonds demanded by domestic residents \( (B^F) \). Ignoring earnings from interest (profit remittances), the assumption that all interest arbitragers cover their exchange risk implies that the excess demand for forward domestic currency by arbitragers \( (F^A) \) will be equal in magnitude but opposite in sign to the excess demand by arbitragers for spot exchange:

\[
s^A = -F^A = -B^F. \tag{35}
\]

Note that the demands for currency by arbitragers (and later by speculators, traders, and authorities) are flow demands. These "flow" demands are envisioned to condense changes in stocks from the beginning of the period to the end into one point in time so that they are equivalent to stock demands, as expressed in (35) above. This analytical distinction between stocks and flows and the "period" of adjustment was previously used by Hicks (1939).

From (11) and (35) above, it follows that:

\[
-s^A = F^A = f(T^D, W^D, r^c, r^c). \tag{36}
\]

The short-term capital inflow in any given period is equal to the negative of the change in the equilibrium stock demand for foreign bonds by domestic residents from the previous to the present period:

\[
- (B^F - B^F_{-1}) = -\Delta B^F = s^A + F^A_{-1}. \tag{37}
\]

5Henceforth, all references to "demand" for currencies will in actuality be excess demands; a negative excess demand is, of course, an excess supply. Similarly, all references to "currency" should be read "domestic currency" unless specifically referred to as foreign currency.
This last expression in (37) above states that short-term capital inflows equal the present excess demand for spot exchange by arbitragers plus the net forward position by arbitragers in the previous period (which is identically equal in magnitude but opposite in sign to arbitragers' previous net position in the spot market, ignoring profit remittances). As an example, suppose all old bond contracts were continually renewed so that there were no capital flows (ignoring profits). Then,

\[ -B^F_{-1} = -B^F_{-l} = S^A = A_{-1} = -A = -A_{-l}, \]

and all foreign exchange contracts would be continually turned over. In this case:

\[ \Delta B^F = -B^F_{-1} \]

\[ = S^A + P^A_{l} = 0, \]

and net indebtedness would continually remain equal to \( B^F \).

Exporters and importers are assumed to operate only in the market for spot exchange. Exports (\( E \)) therefore are a decreasing function of the spot exchange rate:

\[ E = E(X), \quad E_X < 0. \] (38)

Imports (\( M \)) are specified as an increasing function of the spot rate and the domestic level of income:

\[ M = M(X, Y^D), \quad M_X, M_{Y^D} > 0. \] (39)

Speculators are assumed to hold some expectations on future spot exchange rates. It is assumed that these expectations are not held with certainty, that speculators have limited funds available for speculation, and that all speculators do not have identical expectations. Any of these assumptions by itself implies that speculative demand is not infinitely elastic at the expected future spot price.

Speculators purchase forward exchange when the spot rate they expect to prevail in the future (\( X^e \)) is greater than the present forward rate and then realize their profit (or loss) when their forward contract matures by selling spot currency to cover their foreign exchange liability. Alternatively, speculators will sell forward currency if \( X^e < X' \). Speculators' excess demand for forward currency is therefore an increasing function of the expected level of the future spot rate and a decreasing function of the forward rate:

\[ F^S = S(X', X^e), \quad S_X' < 0, \quad S_X^e > 0. \] (40)

I assume for simplification that the expected future spot rate equals the current spot price:

\[ X^e = X. \] (41)
The host of problems associated with speculation and the effects of exchange rate expectations on monetary equilibrium that this simplified expectations function ignores are not the primary concern of this analysis. (See Kohlhagen (1973) for an analysis of the problems of exchange rate expectations as they relate to the effectiveness of monetary policy.)

After invoking the wealth constraint and taking first differences, our complete model is:

\[
N_D^d \Delta Y^D = N_d^d \Delta r^d + N_d^w \Delta W^D + N_h^d \Delta h + N_r^d \Delta r^f + N_x^d \Delta X + N_x^f \Delta X' - q (\Delta \beta^C_G + b_N^d \Delta r^d + b_1^N \Delta f + b_r^N \Delta r^f \\
+ b_x^N \Delta X + b_x^N \Delta X') = 0, \quad (42)
\]

\[
\Delta B^F = f^d \Delta Y^D - f^w \Delta W^D - f^r \Delta r^d - f^r \Delta r^f - f_x \Delta X - f_x \Delta X' = 0, \quad (43)
\]

\[
\Delta H^S = q (\Delta \beta^C_G + b_N^d \Delta r^d + b_1^N \Delta f + b_r^N \Delta r^f + b_x^N \Delta X + b_x^N \Delta X'), \quad (44)
\]

\[
\Delta B^F = S_x \Delta X + S_x \Delta X', \quad \text{and} \quad (45)
\]

\[
\Delta B^F = x_x \Delta X - h_x \Delta X - M^r \Delta Y^D + \Delta X + \Delta B^{F, \text{-1}}, \quad (46)
\]

where \( K \) are exogenous long-term capital flows.

The multipliers for the monetary policy variables are:

\[
\frac{\partial r^d}{\partial \beta^C_G} = \frac{q \left( \frac{S_x^r + f_d^r}{r^d} \right)}{f^d \Delta X + \Delta X} < 0, \quad (47)
\]

\[
\frac{\partial r^d}{\partial f} = \frac{b_N^d \left( \frac{\partial r^d}{\partial \beta^C_G} \right)}{r^d \Delta X + r^d \Delta X} > 0, \quad (48)
\]

\[
\frac{\partial S^S}{\partial \beta^C_G} = \frac{-f^d \Delta X + \Delta X}{} > 0, \quad (49)
\]

\[
\frac{\partial S^S}{\partial f} = \frac{b_N^d \left( \frac{\partial S^S}{\partial \beta^C_G} \right)}{r^d \Delta X + r^d \Delta X} < 0, \quad (50)
\]

(Where \( N_x^r = N_x^r - N_x^r, \) and \( N_x^r = N_x^r - b_N^d \)).
An expansionary monetary policy (through either an increase in open market purchases or a decrease in the discount rate) induces a fall in the domestic interest rate that, in turn, induces a fall in discounting both at the central bank and in the foreign exchanges (through a short-term capital outflow). With fixed exchange rates the monetary authority was forced to intervene in the foreign exchange market and reduce somewhat the intended increase in the domestic money supply. With flexible exchange rates the induced capital outflow not only does not reduce the money supply but depreciates the exchange rate and has an expansionary effect on the domestic economy through the current account; this effect is entirely consistent with the expansionary monetary policy being pursued by the central bank. The more interest-elastic is discounting the lower will be the capital outflow and the lower will be the expansionary effect through the current account.

To the extent that there is a reduction in the domestic interest rate, there will still be some leakage of the increased money stock (from open market purchases) out of the system through reduced discounting at the open discount window. However, the greater are induced capital outflows the less will be the fall in the domestic interest rate and the less will be the reduction in discounting from the central bank. Consequently, the increase in the money stock as a result of a given amount of open market purchases will be greater the more responsive are capital flows to changes in the domestic interest rate. This is a small increase to be sure, but it is significant that, with a flexible exchange rate regime, the greater are capital flows the greater is the impact of monetary policy on the domestic economy and the domestic money supply.

Under a flexible exchange rate regime then, the central bank would increase the effectiveness of open market operations by encouraging discounting in the foreign exchanges and discouraging the use of discounting at the discount window. If capital markets are well-integrated, the monetary authority might even consider severely restricting the use of the discount window, since discounting is easily obtained in the foreign exchange markets where it reinforces central bank policy. Since all activity at the domestic discount window merely offsets central bank policy, it should not be encouraged in a flexible exchange rate regime, especially if there is easy access to foreign financial markets for commercial banks during short-term liquidity crises.

With flexible exchange rates, the effect of an exogenous shift in liquidity preference would be

\[ \frac{2r^d}{3h} = \frac{N_h(S_{x} + f_{x})}{-f_{x}^{\tau}n_{x}^{\tau} + n_{x}^{\tau}(S_{x} + f_{x})} > 0, \quad \text{and} \quad (51) \]
\[ \frac{\delta S}{\delta h} = \frac{e N \left[ B_1 \left( -f \frac{\delta X}{\delta x} \right) + f \frac{\delta X}{\delta x} \right]}{\frac{\delta d}{\delta x} \left( N + N \frac{\delta d}{\delta h} \right)} > 0. \] (52)

An upward shift induces a rise in the interest rate, capital inflows, increased discounting at the central bank, and a rise in the nominal money stock. The capital inflow induces an exchange appreciation that has a deflationary impact on domestic economic activity. Since the monetary authority does not interfere in the foreign exchange market, the capital inflow has no direct effect on the domestic money stock. That is, the interest-induced purchases by foreign residents of domestic interest-bearing assets induces a current account deficit as the exchange appreciation makes foreign goods more attractive to domestic consumers and domestic goods less attractive to foreigners. Whereas with fixed exchange rates domestic residents could exchange domestic interest-bearing assets for high-powered money (due to the monetary authority's interference into the foreign exchange markets), with flexible exchange rates the public as a whole can only exchange domestic interest-bearing assets for foreign goods. The only source for more noninterest-bearing assets (i.e., money) is through the discount window, where some of the increased demand will be satisfied when the interest rate rises.

The monetary authority can take either of two policy steps to eliminate or at least reduce the pressures resulting from such a disturbance (of which the liquidity shift is merely an example). They can lower the discount rate, thereby making discounting cheaper, or they can purchase securities in the open market to ease credit conditions. The analysis above indicates that they should choose the latter to relieve domestic deflationary pressures. The use of changes in the discount rate for such purposes would merely encourage discounting and reduce the effectiveness of open market operations as a monetary tool.

Thus, whereas with fixed exchange rates the central bank should use changes in the discount rate (while, if necessary, reducing short-term capital mobility) to control short-run monetary conditions, with flexible exchange rates the central bank should rely on open market operations, encourage short-term capital mobility, and discourage commercial bank activities at the discount window (perhaps keeping the window open for emergency liquidity needs).

5. CONCLUSIONS

The Canadian experience with fixed and flexible exchange rates is interesting in light of this discussion—the Bank of Canada uses the discount window differently in the fixed rate period than in the flexible rate period. The bank has not approached discounting as it is assumed to exist in my
analysis; it has traditionally not offered a completely open discount window and has used the discount rate essentially as a penalty rate, discouraging excessive use of the discounting privilege. During the flexible exchange rate regime from 1954 until 1962 it pursued an unusual discount rate policy. The discount rate was pegged at one-quarter of one percentage point above the average rate of tender for 90-day Treasury bills in an effort to further restrict the openness of the discount window. This flexible bank rate completely eliminated the bank’s power to use the discount rate as a tool of monetary policy or as a signal to the markets—a signal that presumably could have been misleading (O’Brien and Lerner 1969, pp. 120-21). In 1962, when the exchange rate was fixed as a result of the crisis in the foreign exchange markets, the Bank of Canada also decided to release the discount rate from its ties to the Treasury bill rate, so as to once again be able to use discretionary changes in the bank rate as a monetary tool and as a signal to the market. This policy—one that could be considered more normal—has continued up to the present time.

My analysis concludes that open market operations have a comparative advantage during a flexible regime (and that access to the discount window should therefore be restricted) and that discretionary changes in the discount rate have a potentially greater impact than do open market operations with a fixed exchange rate. The Bank of Canada therefore would be acting to maximize the impact of short-run domestic monetary policies by restricting the use of discounting with flexible exchange rates and reopening the window with a fixed rate, which is precisely what it did in May 1962.

With fixed exchange rates in the Bretton Woods system, monetary authorities found it increasingly difficult to successfully pursue independent monetary policies. These attempts to achieve monetary autonomy were incompatible with fixed rates and eventually contributed to the instability and collapse of the adjustable peg system. The recent experience with exchange rate flexibility has given those central bankers desiring autonomy (especially those attempting to insulate their domestic economies from worldwide inflation) a greater sense of control over domestic monetary conditions. Other central bankers may prefer to return to a fixed exchange rate, at least with their principal trading partners. In either case my analysis can serve as a preliminary answer to the question of which policy tools give them the most power over domestic monetary conditions.
REFERENCES


