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The Monetary Sector in an Open Economy: An Empirical Analysis for Canada and Germany

by

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I. INTRODUCTION

In recent years, national monetary authorities have experienced increasing difficulty in maintaining independent monetary policies. The greater international mobility of capital has reduced the degree of control which the authorities exercise over national interest rates. With capital responsive to relative interest rate incentives, a change in monetary conditions in any one market soon has been transmitted to other markets. The degree of foreign influence has varied among countries, depending upon the institutional structure of the individual market, as well as the policies adopted by the monetary authorities. But no major money market has been completely isolated from foreign conditions.

This study will investigate the channels through which foreign monetary conditions influence conditions in the domestic money market by estimating a model which will explain the determination of domestic interest rates as a joint function of domestic and foreign factors. Our study builds upon an extensive literature describing the determination of domestic interest rates in terms of bank behavior and the public's demand for monetary assets,[1] and a more recent literature investigating the interest rate sensitivity of international capital movements.[2]

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[1] For example, see the work of Goldfeld (1967), Hendershott and deLeeuw (1970), Modigliani, Rasche and Cooper (1970) and Teigen (1965). For additional references to the literature on the demand for money, see Laidler (1970).

[2] For example, see the work of Branson (1968), Branson and Hill, (1971), Bryant and Hendershott (1970), Herring (1973), Kouri and Porter (1972), Miller and Whitman (1970) and Willett and Forte (1970).

This study departs from the former in recognizing the importance of foreign assets for domestic monetary decisions, and from the latter in integrating the analysis of international capital movements with the determination of the supply of money.

To understand the logical structure of the model, consider the impact of an increase in foreign interest rates upon the domestic monetary sector. The net impact of the change depends upon the reactions of both private holders of wealth and the monetary authorities. Two opposing adjustments emerge:

1. In response to higher foreign rates, the public will tend to shift the composition of its portfolio away from domestic money balances and domestic securities toward foreign securities. To induce the public to maintain the existing stock of real money balances a lower domestic interest rate will be necessary.

2. The shifts in private portfolios induce a capital outflow and a loss of foreign exchange reserves. The reaction of the monetary authorities to this shift determines to what extent the loss of foreign exchange reserves leads to changes in bank reserves, and hence to changes in the domestic money supply. If the authorities do not completely sterilize the loss of foreign exchange reserves, then a higher foreign rate will result in a reduction in bank reserves and a higher domestic interest rate. Thus, even the direction of the impact on the domestic rate of a change in the foreign rate is an empirical question.

In this study we construct a structural model of the money market designed to analyze the respective decisions on the part of the public and the monetary authorities. The model will explain simultaneously the demand and supply of bank money, international capital movements, and the supply of bank reserves in such a way that we may describe explicitly the channels through which foreign interest rates affect domestic interest rates. The theoretical model is described in section II, while in Sections III and IV we present estimates of the model for Canada and Germany, respectively, based on data from periods when each country maintained fixed exchange rates. The fifth and concluding section presents a summary of our findings and a solution for each of the models showing the impact of a change in the U.S. interest rate on the Canadian and German interest rates.

II. A STRUCTURAL MODEL OF THE MONETARY SECTOR IN AN OPEN ECONOMY

The Demand for Bank Deposits

In an open economy, the public is likely to view foreign securities as well as domestic securities as alternatives to bank deposits. Thus, our study will depart from previous practice in including a foreign interest rate in the equations describing the demand for bank deposits. Real bank balances (D^d/P) are expressed as a negative function of the interest rate on domestic and foreign securities (r_d and r_f), a positive function of real or permanent income (Y/P) and a negative function of the expected rate of inflation ($\dot{P}$):

(II-1) $$D^d/P = f(r_d, r_f, Y/P, \dot{P})$$ [1]

The Supply of Bank Deposits

The supply of bank deposits is determined primarily by the level of bank reserves in the system, together with the average reserve requirement on bank deposits (q). But bank decisions may impart some interest elasticity to the supply function; banks can vary their holdings of free reserves (excess reserves less borrowed reserves) in response to relative interest rate incentives. A higher rate of return on domestic securities will lead banks to reduce their free reserves, while a higher discount rate will lead them to increase their free reserves. As in the case of the demand for bank deposits, moreover, a higher foreign interest rate will also induce a portfolio shift: banks will reduce their free

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[1] For a discussion of this formulation of the demand for money (without the inclusion of the foreign rate), see Laidler (1970).

reserves--increasing their borrowing and/or reducing their excess reserves--in order to increase their holdings of foreign assets. Thus, the desired level of free reserves is a negative function of the interest rates on domestic and foreign securities, and a positive function of the discount rate (r_{disc}):

$$RF^* = RF^* (r_d, r_f, r_{disc}).$$

This formulation of the desired stock of free reserves has been combined with a partial adjustment hypothesis in several successful applications to postwar banking data in the U.S.[—/] In this hypothesis the current change in free reserves (Δ RF) is equal to some fraction (λ) of the difference between the desired stock of free reserves and the stock of free reserves last period ($RF^* - RF_{-1}$) and to impact variables that influence free reserves only temporarily (such as the change in unborrowed reserves, Δ Ru, or an unanticipated increase in the demand for commercial loans, Δ CL):

$$\Delta RF = \lambda(RF^* - RF_{-1}) + C_1 \Delta RU - C_2 \Delta CL.$$ [—/]

Of course, the specific details of a model used to explain free reserves would depend upon the characteristics of the particular banking system under study.

[—/] For example, see Hendershott and deLeeuw (1970), Modigliani, Rasche and Cooper (1971) or the Wharton Econometric Model (1971).

[—/] Hendershott and deLeeuw (1970) have shown that this empirical specification may be derived from several different hypotheses about bank behavior.

The free reserves held by the banking system together with the level of unborrowed reserves and the reserve requirement, (q), set by the central bank determine the supply of bank deposits as in the identity:

$$\text{(II-2)} \quad D^S = \frac{RU - RF(r_d, r_f, r_{disc})}{q}$$

Thus, the supply of bank deposits is positively related to the interest rates on domestic and foreign securities, and negatively related to the discount rate and to the average reserve requirement.

The demand and supply equations for bank deposits can be solved for an equation relating the domestic interest rate to the foreign interest rate and the level of unborrowed reserves as well as other factors. This equation takes the following form if we first linearize the demand and supply equations:[1]

$$\text{II-3} \quad r_d = \frac{1}{b_1 + a_1} \left[-(b_2 + a_2)\, r_f - (RU/q) + b_3 r_{disc} + a_3 (Y/P) - a_4 \dot{P} \right]$$

where $a_i = a_i' . P$ $\qquad b_i = \frac{b_i'}{q}$ [2]

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[1] The equations can be expressed in linear form (omitting the constant term and seasonal factors) as follows:

$$D^d/P = -a_1' r_d - a_2' r_f + a_3' (Y/P) - a_4' \dot{P}, \quad a_i' \geq 0, \; i = 1,\ldots 4$$

$$D^S . q = RU - RF$$

$$D^S . q = RU + b_1' r_d + b_2' r_f - b_3' r_{disc}, \quad b_i' \geq 0, \; i = 1,..,3$$

[2] Because the Bundesbank frequently changes reserve requirements, it will be more convenient to discuss the German equations in change form. Thus, for future reference we present a parallel solution of the equations in change form:

$$\Delta D^d/P = -a_1' \Delta r_d - a_2' \Delta r_f + a_3' (\Delta Y/P) - a_4' \Delta \dot{P}$$

$$q . \Delta D^S = \Delta RUE - \Delta RF \text{ where } \Delta RUE = \Delta RU - \Delta q . D_{-1}$$

$$q . \Delta D^S = \Delta RUE + b_1' \Delta r_d + b_2' \Delta r_f - b_3' \Delta r_{disc} - b_4' \Delta RF_{-1} - b_5' \Delta(\Delta RUE) \text{ so that}$$

$$\Delta r_d = \frac{1}{b_1 + a_1} \left[-(b_2 + a_2) \Delta r_f + \frac{(b_5 - 1) \Delta(\Delta RUE)}{q} + b_3 \Delta r_{disc} + a_3 \Delta \frac{Y}{P} - a_4 \Delta \dot{P} + b_4 \Delta RF_{-1} \right]$$

From this equation, it is apparent that, with unborrowed reserves and other factors constant, a rise in the foreign interest rate requires a fall in the domestic interest for money market equilibrium to be maintained.

In most models of the money market, the level of unborrowed reserves is treated as an exogenous variable having no systematic relationship to conditions in the money market. In this study, the link between the reserve base and interest-sensitive capital movements is treated explicitly. The analysis proceeds in two stages: the first is a description of how changes in interest rates lead, through international capital flows, to changes in the central bank's holdings of foreign exchange reserves. The second is an explanation of how changes in foreign exchange reserves lead, through action (or inaction) of the monetary authority, to changes in unborrowed reserves.

In a fixed exchange rate system, movements in the central bank's holdings of foreign exchange reserves occur when the sum of current account transactions and capital account transactions differs from zero. Denoting trade flows and other current account items (which are generally insensitive to current interest rates) by CA and capital flows by CF, the current change in foreign exchange reserves (ΔRFX) may be written as:

$$\Delta RFX = CA + CF .$$

If CA is treated as exogenous, then ΔRFX is determined once CF is determined.

International Capital Flows

The portfolio theory of capital movements asserts that the stock of foreign assets held by investors at home and abroad depends on the level of expected returns on domestic and foreign assets, on the degree of risk attached to each asset, on the stock of total assets and on levels of exports and other variables. Thus, an increase in a foreign interest rate will cause a reallocation of portfolios of assets toward holding a greater proportion of foreign assets. This reallocation of portfolios both by domestic residents and foreigners will be observed as a capital outflow from the home country. Although this reallocation may extend over a considerable period of time, once it is accomplished the flow will cease until desired holdings of assets are further altered by some other change in interest rates, risks, wealth or trade.

If we denote levels of risks, wealth, trade and other factors affecting capital flows by Z, then we may describe capital flows, CF, as a function of changes in the domestic and foreign interest rate and changes in Z:

(II-4) $CF = CF(\Delta r_d, \Delta r_f, \Delta Z)$.

The Reaction Function

The policies which are adopted by the authorities in response to higher foreign interest rates and the resulting capital inflows determine to what extent foreign monetary conditions influence domestic conditions. Thus, an essential element in explaining linkages between domestic and foreign interest rates is a function explaining the reaction of the authorities to foreign conditions.

The authorities may respond to changes in foreign conditions in two essentially different ways. They may seek to control the supply of bank reserves by sterilizing at least partially inflows or outflows of foreign exchange reserves.[1] If the authorities are successful in partially offsetting changes in foreign exchange reserves, then bank reserves will not adjust fully in response to capital flows or exogenous changes in the current account of the balance of payments. The extreme case would be that in which the authorities completely insulate the domestic money supply from outside influences.

An alternative strategy, motivated by concern for the country's foreign exchange position, would be for the authorities to protect the country's foreign exchange reserves by anticipating the public's reaction to higher foreign rates; in this case, bank reserves would be reduced in response to higher foreign rates to limit the capital flows which would otherwise occur.[2]

To the extent that the authorities deliberately change domestic conditions to avert anticipated capital flows or to the extent they allow movements of private capital to effect those same changes,

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[1] The monetary authorities are viewed as controlling bank reserves rather than the monetary base (bank reserves plus currency in the hands of the public). That is, the authorities are assumed to automatically adjust the monetary base in response to changes in the public's currency holdings, since they are primarily interested in controlling bank behavior.

[2] The above description of policy is not meant to imply that the authorities can act prior to any portfolio adjustment undertaken by the public. The public and the authorities are both viewed as adjusting over time to changes in foreign monetary conditions. By changing bank reserves and thereby inducing adjustments in domestic interest rates, however, the authorities are able to limit the portfolio adjustment that would otherwise occur.

domestic interest rates will move in the same direction as foreign interest rates. Only if the authorities follow a monetary policy oriented exclusively to domestic goals (i.e. are unresponsive to foreign interest rates) combined with a policy of complete sterilization of any movements in foreign exchange reserves, will bank reserves be independent of foreign interest rates.

Apart from the above internationally-oriented operations, the authorities' control over bank reserves naturally will be guided by domestic objectives. These objectives might include providing for an orderly expansion of the money supply as the needs of internal trade expand, and controlling domestic inflation or unemployment through appropriate short term adjustments of reserves.

A reaction function will be estimated to explain the authorities' control over unborrowed reserves[1] as a function of these foreign and domestic factors.[2] The foreign factors include the level of foreign exchange reserves (RFX) and the foreign interest rate (r_f). The domestic factors, denoted by the vector H, might include the expected level of income to reflect the needs of internal trade, the inflation

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[1] The reaction function is expressed in terms of unborrowed reserves rather than total bank reserves because this is the reserve instrument that the central bank unambiguously controls (at least in a closed economy). In the estimation below, we report alternative equations where the authorities are assumed to control total reserves by offsetting increases in borrowed reserves with equivalent reductions of unborrowed reserves.

[2] Reaction functions explaining central bank behavior have been estimated in several previous studies including Dewald and Johnson (1963), Reuber (1964), Wood (1970), and Courchene and Kelly (1971). The recent study by Argy and Kouri (1972) is one of the first to analyze sterilization policy; this is done within the context of a model relating the net domestic assets of the central bank (the monetary base less net foreign assets) to the net foreign assets of the bank. For earlier work concerned with the interaction between movements in foreign exchange reserves and monetary policy, see Willms (1971) and Porter (1972).

rate, and the level of unemployment. Since the capital flow equation is expressed in flow terms, the reaction function is formulated so that the change in unborrowed reserves (Δ RU) is related to the change in the foreign and domestic factors as follows:—/

(II-5) $\Delta RU = g(\Delta RFX, \Delta r_f, \Delta H)$.

If the equation is expressed in linear form, the coefficient of Δ RFX will reflect the <u>fraction</u> of any foreign exchange inflow or outflow which remains to inflate bank reserves after the authorities have completed their sterilization operations. A coefficient of unity, for instance, would indicate no sterilization, while a coefficient of zero would indicate complete sterilization.

The reaction function and the capital flow equation together determine a functional relationship between the change in unborrowed reserves and the change in the domestic and foreign interest rates (and non-interest rate factors). To solve the two equations for Δ RU and Δr_c, we must first make use of the identity relating the change in foreign exchange reserves to the capital flow and the current account balance:

$$\Delta RFX = CF + CA$$

—/Alternatively, this function could be formulated to explain the level of unborrowed reserves (RU) as a function of thelevel of foreign exchange reserves, the foreign interest rate, and domestic factors, i.e.

(II-5') $RU = G(RFX, r_f, H)$

If the capital flow equation and reaction function are expressed in linear form and solved using the above identity, we obtain:[1]

(II-6) $\Delta RU = f_1 h_1 \Delta r_d - (h_2 f_1 + f_2) \Delta r_f + f_3 \Delta H + f_1 h_3 \Delta Z + f_1 CA$.

From this equation, it is apparent that unborrowed reserves increase with an increase in the domestic interest rate and decrease with an increase in the foreign interest rate. Holding unborrowed reserves constant, the domestic interest rate increases in response to an increase in the foreign interest rate.

The response of domestic interest rates to foreign rates depends upon the net outcome of adjustments in both bank deposits and reserves. Consider the case of an increase in foreign interest rates. To maintain equilibrium between the supply and demand for bank deposits, with unborrowed reserves held constant, the domestic rate must fall. Yet an increase in foreign rates leads to a shrinkage of bank reserves which causes the domestic rate to rise. To investigate the net impact of these adjustments, consider the relationship between unborrowed reserves and the domestic interest rate as reflected in equations II-3 and II-6.

Equation II-3 describes non-bank and bank portfolio decisions involving the supply and demand for bank deposits; according to this equation, a higher level of unborrowed reserves will reduce the domestic interest rate. Thus, in Figure II-1, the domestic interest rate is

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[1] The equations can be expressed in linear form as follows:

$CF = h_1 \Delta r_d - h_2 \Delta r_f + h_3 \Delta Z$

$\Delta RU = f_1 \Delta RFX - f_2 \Delta r_f + f_3 \Delta H$

inversely related to unborrowed reserves in what we might call a demand function for unborrowed reserves (D_{ru}). A higher foreign interest rate tends to shift this curve to the left as the demand for unborrowed reserves decreases. The non-bank public reduces its demand for bank deposits, while the banks reduce their free reserves (thereby economizing on bank reserves).

Movements in foreign exchange reserves, together with the reaction function of the authorities determine the supply of unborrowed reserves (S_{ru}).—/ Because higher domestic interest rates induce inflows of capital, and hence larger bank reserves, the supply function is positively sloped as in Figure II-1. A higher foreign interest rate induces an outflow of capital and a contraction of bank reserves as long as the authorities do not completely sterilize the outflow. A higher foreign interest rate may also induce the authorities to reduce bank reserves directly to forestall losses of foreign exchange reserves. In either case, a higher foreign interest rate will shift the supply curve to the left, raising the domestic interest rate.

The net impact of higher foreign rates on the domestic rate thus is indeterminate in the general case; the response of the domestic rate depends upon the parameters underlying each of the above functions. Consider the two interesting polar cases of immobile and perfectly mobile capital:

—/To compare equations II-3 and II-6, the latter must first be expressed in level form (i.e. RU is expressed as a function of r_f and r_d, as well as the levels of the other explanatory variables).

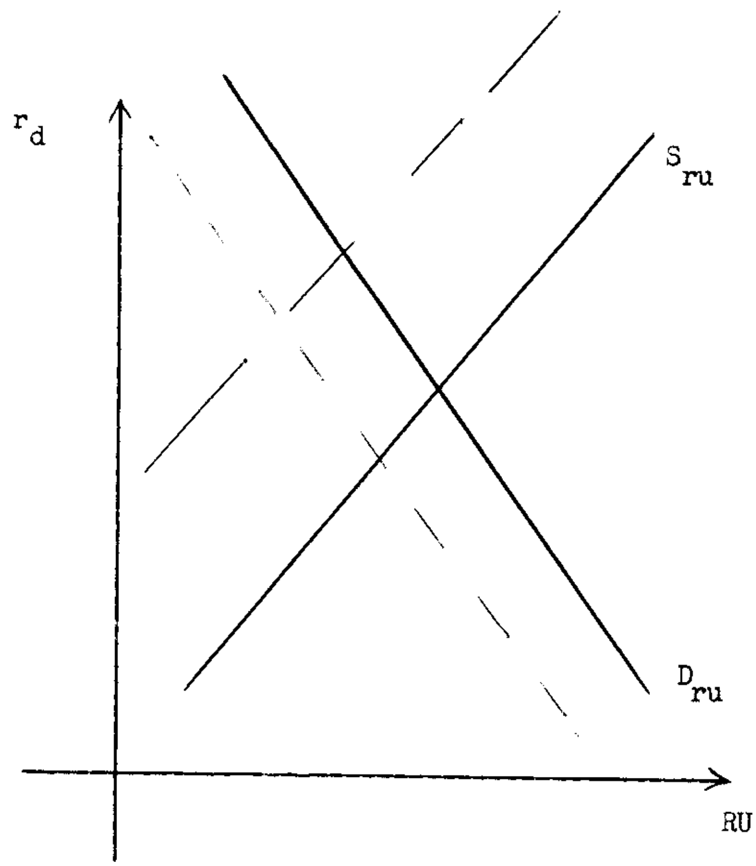

Figure II-1

1. If capital is immobile internationally (so that $h_1 = h_2 = 0$ and $f_2 = 0$), then the supply of bank reserves will be insensitive to both domestic and foreign interest rates. The S_{ru} curve will be vertical. Yet the domestic rate will still not be independent of foreign influences. A current account imbalance or an autonomous capital flow can still affect bank reserves (shifting the S_{ru} curve) unless the authorities completely sterilize all movements in foreign exchange reserves ($f_1 = 0$). In that case, the domestic interest rate will be determined solely by the parameters of the bank deposit supply and demand functions (and a domestically-oriented reaction function), as in any closed economy model.

2. If capital is perfectly mobile internationally (so that h_1, $h_2 = \infty$, and $f_1 = 1$ since sterilization operations will be ineffective), then S_{ru} will be horizontal at the prevailing world interest rate ($r_d = r_f$).

The impact of foreign on domestic rates can be seen more clearly by solving the two equations (II-3 and II-6) explicitly for the domestic and foreign interest rates. Consider the coefficient of the foreign interest rate in the reduced form expression obtained by eliminating RU from the two equations:

$$r_d = \frac{-q(a_2 + b_2) + (f_2 + h_2 f_1)}{q(b_1 + a_1) + f_1 h_1} r_f + \ldots.$$

Denote the coefficient of r_f by K. K measures <u>the responsiveness of the domestic interest rate to the foreign rate</u>, and will be positive if the two rates are positively correlated, and negative (or zero) otherwise.

From this expression, it can be established that:

III. THE CANADIAN MONETARY SECTOR [1]

In the case of Canada, we have chosen to analyze the relationship between the Canadian market and the U.S. money market because of the traditionally close links between these two markets. The principal Canadian and U.S. interest rates included in the model are both short-term rates--the rates of interest on Canadian and U.S. Treasury bills. All the equations of the model are estimated over the period of a fixed exchange rate for the Canadian dollar, 1962III-1970I. The equations are estimated by a 2SLS procedure except where otherwise indicated.

Demand for Bank Deposits

Equations for demand deposits and time deposits (both personal and corporate notice deposits) were estimated separately. For purposes of estimation, the general demand equation described in Part II was specified both in ratio and simple linear form.[2] In the ratio form,

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[1] For previous analyses of the Canadian monetary sector, see especially: the RDX2 Model in Helliwell et al. (1971) which includes an extensive set of non-bank asset demand equations, a complete banking sector, and foreign exchange equations explaining long term capital flows and foreign exchange demand (both private and official); Courchene and Kelly (1971) who present disaggregated money demand equations, a single supply equation relating deposits to the reserve base, and a reaction function to explain the monetary base as a function of domestic variables, as well as the U.S. interest rate; Ford and Tower (1968) who examine the free reserve hypothesis in the Canadian context; and Smith and Winder (1971) who analyze the demand for money under alternative hypotheses regarding price and interest rate expectations.

[2] Modigliani, Rasche, and Cooper (1970), for example, employ the ratio form in their study of U.S. banking. When the equation is estimated in log linear form, the income and interest rate elasticities are only marginally smaller. The linear form of the equation was selected to simplify the solution of the system of equations.

the ratio of demand deposits to income is expressed as a function of real income as well as the other determinants of demand.

The principal determinants of demand deposits include:—/

r_c: Canadian Treasury bill rate

r_{us}: U.S. Treasury bill rate

Y^p/P: Canadian permanent real income

$\dot{P}$: the rate of change of the GNP deflator.

In Table III-A we present four forms of the estimated equation, together with the implied elasticities (calculated at the sample means). In equations (1) and (3), both the Canadian and U.S. interest rates are included; the coefficients of both variables are of right sign, implying a decrease in money demand in response to a rise in either interest rate. The elasticity of money demand with respect to the Canadian interest rate is approximately -.2, while the elasticity with respect to the U.S. interest rate is somewhat less than -.15. The domestic interest rate coefficient is significant (at the five percent level) in all versions of the equation, but the U.S. interest rate coefficient has a low t-statistic in both equations (1) and (3).—/ Equations (2) and (4) present estimates of the equation with the U.S. interest rate omitted. The elasticities with respect to the Canadian rate are somewhat

—/Seasonal factors (S1, S2, S3) are included in all equations since none of the monetary series used are seasonally adjusted. For more complete definition of the variables, see the Data Appendix.

—/The low Durbin-Watson statistic, moreover, suggests that the residuals are serially correlated; if that is the case, then the t-statistics will be upwardly biased. Note that serial correlation is often encountered in U.S. money demand equations; see, for example, the above-cited Modigliani, Rasche, and Cooper (1970).

TABLE III.A

THE DEMAND FOR DEMAND DEPOSITS: CANADA, 1962III-1970I

											Elasticities		
		$\hat{r}_c$ *	Y^p/P	r_{us}	$\dot{P}$	C	S_1	S_2	S_3	R^2/D-W	Income	Domestic Int.	Foreign Int.
(1)	D/Y^p	-.0027	.000316	-.00204	-.0984	.0969	-.0059	-.0040	-.0027	.891	1.20	-.162	-.108
		(-2.11)[b]	(1.68)	(1.24)	(-1.24)	(16.67)	(-5.36)	(-3.31)	(-2.32)	1.390			
(2)	D/Y^p	-.0041	.000242		-.147	.0995	-.0058	-.0035	-.0023	.856	1.15	-.238	
		(-5.03)	(1.21)		(-1.90)	(16.37)	(-4.66)	(-2.73)	(-1.83)	1.05			
(3)	D/P	-.181	.110	-.130	-5.26	.449	-.308	-.206	-.131	.921	1.30	-.202	-.131
		(-2.44)	(10.15)	(-1.37)	(-1.16)	(1.35)	(-4.81)	(-2.93)	(-1.99)	1.16			
(4)	D/P	-.266	.105		-8.34	.617	-.296	-.172	-.106	.890	1.25	-.296	
		(-5.60)	(8.90)		(-1.83)	(1.72)	(-4.05)	(-2.27)	(-1.45)	.837			

[a] R^2 is the coefficient of determination not adjusted for degrees of freedom used up in estimating the regression equation; D-W is the Durbin-Watson statistic.

[b] Numbers in parentheses are the t-ratios of the estimated coefficients.

*A circumflex, ^, denotes variables treated endogenously for purposes of estimation. All equations in which such a variable appears were estimated by two-stage least squares.

higher in these versions of the equation. The elasticity with respect to income is approximately 1.2 in both ratio and simple linear form.

The demand for time deposits is a function of r_c, r_{us}, $\dot{P}$, as well as the following determinants:[1]

r_n: the interest rate on corporate notice deposits

Y/P: Canadian real income

$(T/P)_{-1}$: Real time deposits lagged one period

Again, the equation was estimated both in ratio and simple linear form. The results are reported in Table III-B.

The lagged adjustment form of the equation proved superior in fit to the non-lagged form. The coefficient of the lagged time deposit term implies a relatively slow speed of adjustment to changes in the rates of return and in income. The domestic interest rate variables were entered in difference form because of the high colinearity of the three interest rates. Even in this form, however, the domestic and foreign rates have very low t-statistics. Only when the U.S. rate is omitted from the equation (as in (2) and (4)) do the domestic interest rates prove significant. As expected, the domestic interest rate elasticities are higher than for demand deposits. The foreign interest rate elasticity, however, is smaller for time deposits than for demand deposits, suggesting lower substitutibility between Canadian time deposits and U.S. investments, contrary to expectation. The foreign interest rate effect may prove larger once we incorporate the rate on

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[1] Note that we also included r_n in the demand deposit equation (as a substitute for Canadian or U.S. Treasury bills), but its coefficient proved quite insignificant.

TABLE III.B

THE DEMAND FOR TIME DEPOSITS: CANADA, 1962III-1970I

	$\hat{r}_c - r_n$	Y/P	r_{us}	$\dot{P}$	$\frac{(T/P)_{-1}}{Y-P}$	C	S_1	S_2	S_3	R^2/D-W	Long-run Elasticities: Income	Long-run Elasticities: Domestic Int.	Long-run Elasticities: Foreign Int.
(1) $\frac{(T/P)}{(Y/P)}$	-.00328 (-.886)	.00138 (3.12)	-.00087 (-.481)	-.571 (-5.44)	.706 (9.06)	.00799 (.720)	.0088 (7.52)	.0065 (5.39)	.0094 (8.78)	.981 (1.69)	2.16	-.256	-.062
(2) $\frac{(T/P)}{(Y/P)}$	-.00475 (-2.32)	.0012 (5.35)		-.558 (-5.56)	.715 (9.57)	.011 (1.20)	.0089 (7.75)	.0068 (6.13)	.0096 (9.01)	.980 (1.60)	2.04	-.389	
					$(T/P)_{-1}$								
(3) T/P	-.178 (-.902)	.143 (4.21)	-.046 (-.472)	-33.5 (-6.02)	.707 (10.16)	-3.17 (-4.58)	.465 (7.49)	.348 (5.31)	.511 (8.73)	.998 (1.78)	2.26	-.263	-.062
(4) T/P	-.254 (-2.28)	.133 (5.23)		-32.9 (-6.12)	.712 (10.5)	-2.93 (-6.48)	.468 (7.67)	.359 (6.03)	.514 (8.95)	.998 (1.64)	2.16	-.382	

Canadian swap deposits in our model, since swap deposits are a closer substitute for time deposits than are U.S. instruments.[1] The coefficients of Y/P, $\dot{P}$, and the lagged adjustment term are all significant at the five percent level. The high income elasticities reflect the rapid growth of time deposits (particularly corporate notice deposits) throughout the 1960's.

The Supply of Bank Deposits

Banks in Canada are subject to a complex set of reserve requirements which relate bank reserves to the previous month's deposits. More specifically, this month's required bank reserves in the form of Bank of Canada deposits (R^r_{dep}) are related to the average reserve requirement (q), last month's chartered bank deposits (defined on a statutory basis, STD),[2] and last month's cash reserves (SR_{cash}) by the relation:

$$R^r_{dep} = -SR_{cash} + STD \cdot q$$

The deposit supply equation estimated in the model departs from the statutory relationship by substituting bank reserves[3] at the end of

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[1] Swap deposits are U.S. dollar deposits at chartered (commercial) banks covered for exchange risk. In a future version of this model, we intend to develop an equation linking the swap deposit rate to the U.S. interest rate and determinants of the U.S./Canadian dollar forward premium, and to enter the swap rate in the time deposit equation. We also intend to develop an equation to explain the rate on corporate notice deposits.

[2] Bank deposits and cash reserves are defined as an average over the four Wednesdays ending on the second last Wednesday of the preceding month.

[3] Note that actual Bank of Canada deposits (R_{dep}) are equal to required Bank deposits (R^r_{dep}) plus excess reserves.

the quarter ($TR = R_{dep} + R_{cash}$) for reserves defined on a statutory basis ($R_{dep} + SR_{cash}$). Bank reserves, in turn, are related to either statutory deposits (STD), or to end of quarter deposits (TD); when statutory deposits are explained, an equation linking statutory deposits to end of quarter deposits must be added to the model since the demand equations explain end of quarter deposits (i.e. TD = D + T). Equation (7) of Table III-C is a simple linkage equation relating the two forms of deposits (and allowing for seasonal variation in that relationship).—/

While the Canadian reserve regulations are complex, other institutional factors considerably simplify analysis of the deposit supply relationship. The authorities have changed reserve requirement ratios only once during the period; in mid-1967, the 8% ratio common to both demand and time deposits was raised to 12% for demand deposits and lowered to 4% for time deposits.—/ Thus, the Canadian authorities have not followed the German practice (to be discussed below) of using frequent changes in reserve requirements as a means of controlling the money supply.

Borrowing at the discount window also has not been an important element in deposit supply. Direct borrowing by banks from the Bank of Canada at most times has been negligible; over the sample period,

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—/This linkage equation is similar to one estimated for the RDX2 model (see Helliwell et al. (1971)).

—/The ratios were changed each month by 0.5% beginning in July 1967 until the full change was effected. Since the value of time deposits exceeds that of demand deposits, the effect of the change was to relax average reserve requirements (which fell from 8% to approximately 6.2%).

direct borrowing averaged C$0.3 million, while the level of bank reserves averaged C$1,354.5 million. Indirect borrowing through money market brokers (who in turn borrow from the Bank of Canada at the money market rate, r_{mm}) has been more important. But even this form of borrowing is limited compared with the experience of other countries; over the sample period, Bank of Canada advances to the money market brokers averaged only C$7.7 million.

Since advances to the money market brokers dominate direct lending to commercial banks by the Bank of Canada, the rate of interest relevant to the reserve management of chartered banks is, in fact, the money market rate. Throughout the sample period, however, this rate was tied at 0.25% above the Treasury bill rate. The only times when the money market rate deviated from this relationshipwere when the discount rate set by the Bank of Canada (the rate charged on direct borrowing by the chartered banks) was lowered below r_c + .25%; at such times, the money market rate was tied to the discount rate so that both forms of borrowing from the Bank of Canada were encouraged. Because of the normally fixed relationship between r_c and r_{mm}, it makes little sense to enter the money market rate along with the Treasury bill rate in the deposit supply equation. Instead, we include only r_c in the equation, and then enter a special variable (DEV) defined only for those periods when the Bank of Canada lowered the discount rate below r_c + 0.25%; DEV will measure the deviation of the money market rate relative to its normal relationship with r_c.[1]

The deposit supply equation relates required reserves (STD.q or TD.q) to:

(a) the level of unborrowed reserves, RU = R - RB where RB includes both direct borrowing of the chartered banks from the Bank of Canada and advances by the Bank to the money market brokers, and

(b) the determinants of free reserves, RF(.):

$$STD \cdot q \text{ (or } TD \cdot q) = RU - RF(.)$$

Because of the modifications we have made to the statutory relationships between reserves and deposits, we have chosen to estimate a stochastic equation linking required reserves and RU (and RF) rather than estimate a separate equation for RF and employ the deposit supply identity expressed in equation II-2.

In Table II, we present two alternative forms of the deposit supply relationship, one (equations 1-2) employing the complex form of the free reserve hypothesis outlined in Section II, the other (equations 3-6) relying on a simple hypothesis relating free reserves to DEV and r_c. The variables appearing in these equations include (in addition to those defined above):

RF_{-1}: Free reserves defined on a statutory basis for the last month of the previous quarter.

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[1] DEV is defined to be positive when r_{mm} is below its normally fixed relationship with r_c, and zero otherwise. Thus, a higher DEV reflects a lower discount rate; this should induce an increase in deposit supply.

TABLE III-C

THE SUPPLY OF BANK DEPOSITS - CANADA 1962III - 1970I

		$\hat{R}U$	$\hat{r}_c$	DEV	RF_{-1}	$\Delta\hat{R}U$	RRE	C	S1	S2	S3	R^2/DW
(1)	STD.q	1.082 (11.97)	-.0084 (-.735)	.218 (.864)	-1.36 (-1.14)	-.746 (-2.18)	.677 (1.58)	.059 (.599)	-.047 (-.698)	.071 (2.33)	.056 (2.36)	.955 1.41
(2)	STD.q	1.034 (17.14)		.284 (1.22)	-1.42 (-1.22)	-.716 (-2.15)	.672 (1.60)	.098 (1.19)	-.048 (-.730)	.071 (2.37)	.054 (2.33)	.955 1.33
(3)	STD.q	.931 (8.85)	.0056 (.376)	.772 (1.78)				.226 (1.52)	.080 (2.57)	.126 (3.76)	.063 (2.05)	.915 2.19
(4)	STD.q	.964 (16.44)		.696 (1.85)				.193 (1.64)	.083 (2.82)	.126 (3.84)	.064 (2.16)	.915 2.22
(5)	TD.q	.941 (8.26)	-.0030 (-.186)	.727 (1.54)				.224 (1.39)	.073 (2.14)	.114 (3.14)	.034 (1.02)	.894 2.40
(6)	TD.q	.923 (14.47)		.768 (1.87)				.242 (1.89)	.071 (2.20)	.114 (3.18)	.033 (1.02)	.893 2.37
		RD	TD_{-1}	S1.TD	S2.TD	S3.TD	C					
(7)	STD	.625 (9.37)	.393 (5.71)	-.0150 (-4.31)	-.0044 (-1.28)	.0009 (.275)	.269 (2.54)					.999 1.86

ΔRU: The change in unborrowed reserves defined from the end of the previous quarter to the end of the current quarter.

$\Delta RRE \approx STD_{-1} \cdot \Delta q$: The change in reserves required as a result of a change in the average reserve requirement where STD_{-1} is defined for the previous quarter, and Δq is the change over the current quarter.

Equation (1) relates required reserves to unborrowed reserves and to the determinants of free reserves: r_c, DEV, RF_{-1}, ΔRU, and ΔRRE. The level of unborrowed reserves has a coefficient that is insignificantly different from its appropriate value of unity, but free reserves lagged one period has a coefficient of -1.36, compared with its maximum appropriate value within the context of the free reserve hypothesis of minus one.[1] All the remaining coefficients are of correct sign with the exception of r_c (which is statistically insignificant). A change in unborrowed reserves (ΔRU) leads to an increase in free reserves while a tightening of reserve requirements (ΔRRE) leads to a fall in free reserves; as free reserves rise, the level of deposits that can be maintained on the basis of a given level of unborrowed reserves falls. In all versions of the equation, the coefficient of the Treasury bill rate proved to be statistically insignificant, and of negative sign in most instances.[2] Thus, we report alternative equations which omit the Treasury bill rate.

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[1] Note that the coefficient is within one standard error of its maximum value.

[2] The supply of deposits also proved to be insensitive to the U.S. Treasury bill rate despite the active dealings of Canadian banks in the New York money market.

As an alternative to the above free reserve hypothesis, we present a second set of equations based on the hypothesis of an immediate adjustment of free reserves to money market conditions. Equations (3) and (4) relate statutory deposits to RU and the determinants of free reserves, while equations (5) and (6) relate deposits at the end of the quarter to these same variables. The coefficient of RU in each equation is within one standard error of unity, but the coefficient of r_c is again insignificant. The failure to detect significant interest rate sensitivity (except in response to deliberate discount policy as reflected in the coefficient of DEV) is disappointing, but not unexpected given the characteristics of the Canadian banking system. With reserve requirements for the current month known because they are based on the previous month's deposits, chartered banks can maintain a much lower level of free reserves than U.S. banks. Movements of free reserves that do occur around this small base are more likely to originate in unexpected changes in bank reserves (Δ RU) than in conscious adjustment of free reserves in response to interest rate incentives. With so little interest rate sensitivity, the deposit supply relationship is reduced almost to an identity.[/]

[/] Note that the simple form of the deposit supply relationship (equations 3-6) is similar to the equation estimated for an earlier period by Courchene and Kelly (1971) except that the equations above take into account the change in reserve requirements which occurred in 1967-68, as well as any marginal interest-rate sensitivity.

International Capital Flows

To close the model of the Canadian monetary sector, we must develop equations to explain movements in bank reserves. In the next subsection we discuss the control of bank reserves by the authorities, including their sterilization policy. In this subsection, we discuss movements in foreign exchange reserves; since we treat the current account of the balance of payments as exogenous to the monetary sector, our analysis is confined to (private) capital movements.

The basic form of the equation to be estimated relates net capital flows to:[1]

- Δr_c: the change in the Canadian Treasury bill rate
- Δr_{us}: the change in the U.S. Treasury bill rate
- ΔGRDCN: the change in the differential growth rate in permanent income between Canada and the rest of the world
- ΔTB: the change in the Canadian trade balance
- SPECCN: a speculative dummy variable constructed to reflect unusual disturbances in the capital account, most notably the speculative attack on the Canadian dollar set off by the announcement of the U.S. direct investment control program in the first quarter of 1968.[2]

In Table III-D, we report the results of estimating the capital flow equations both by ordinary least squares (OLS) and by two-stage

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[1] For previous estimates of net capital flows for Canada, see Branson (1971) and Herring (1973, Ch. 4). Herring's equations, estimated over a longer period than in this study, differ from those reported here in relating net capital flows to the Canadian long term rate and a weighted average of foreign long term rates.

[2] For further definition of ΔGRDCN and SPECCN, see Herring (1973, Ch. 4).

TABLE III-D

INTERNATIONAL CAPITAL FLOWS - CANADA 1962III - 1970I

	Δr_c	Δr_{us}	ΔGRDCN	SPECCN	ΔTB	C	S1	S2	S3	R^2/DW
OLS (1) CF	.081 (1.32)	-.057 (-.703)	.052 (2.20)	.608 (6.01)	-1.37 (-2.66)	.279 (6.83)	.011 (.197)	.007 (.119)	-.349 (-6.89)	.862 1.55
2SLS (2) CF	$\Delta\hat{r}$ .125 (1.49)	-.101 (-1.02)	.049 (2.03)	.652 (5.65)	-1.49 (-2.79)	.291 (6.70)	.002 (.030)	-.012 (-.178)	-.350 (-6.98)	.865 1.84
OLS (3) CF	$\Delta(r_c - r_{us})$ .081 (1.34)		.054 (2.36)	.606 (6.11)	-1.43 (-2.79)	.283 (7.31)	.009 (.173)	.002 (.039)	-.347 (-7.00)	.861 1.58
2SLS (4) CF	$\Delta(\widehat{r_c - r_{us}})$ .124 (1.50)		.051 (2.19)	.649 (5.74)	-1.42 (-2.92)	.295 (7.12)	.0002 (.004)	-.017 (-.262)	-.348 (-7.09)	.864 1.89

least squares (2SLS) treating the domestic interest rate as endogenous. In equations (1) and (2), the Canadian and U.S. interest rates are entered separately, while in equations (3) and (4), the coefficients of the two interest rates are constrained to be equal but opposite in sign. In all versions of the equation, the t-statistics of the interest rate coefficients are low, and the coefficients themselves imply a relatively low interest rate sensitivity for the net capital account. A one percent rise in the Canadian Treasury bill rate induces only a C$ 80 to 125 million capital inflow (compared with a bank reserve base of C$ 1300 million). Comparing the OLS and 2SLS results, we find a noticeable improvement in the interest rate coefficients when the equation is estimated by consistent methods. Estimation by 2SLS raises both the size of the coefficients and their associated t-statistics. This is in accordance with our expectations, since OLS estimates of the interest rate coefficients should be downward biased.

The remaining coefficients in the capital flow equations are of appropriate sign and significant at the 5% level. The differential growth rate in permanent income between Canada and the rest of the world (GRDCN) is designed to reflect some of the factors determining direct investment flows. The underlying notion is that the expected growth of income in a market area helps determine the expected return from investment. An increase in the growth rate in Canada relative to the rest of the world should signal greater returns to investment and induce capital inflows--hence a positive coefficient for Δ GRDCN. The speculative variable, SPECCN, should have a positive coefficient (a positive value indicating a speculative inflow of capital). The change in the trade balance, Δ TB, is expected to have a negative sign if increases in exports relative to imports require additional domestic financing (a capital outflow). The coefficient of Δ TB, however, is greater than unity, suggesting that a C$1 million increase in net exports leads to a C$1.3 or 1.4 million outflow of capital.[1] The coefficient of Δ TB, therefore, probably reflects additional factors unrelated to trade financing.

In general, the capital flow equations yield sensible results in accord with theoretical expectations. The low interest rate sensitivity remains puzzling, however, suggesting the need for further investigation. In future work we intend to disaggregate the capital account into direct investment and the presumably more interest-sensitive financial capital flows, and estimate separate equations for each category.

The Reaction Function

The level of unborrowed reserves (RU) available to Canadian chartered banks is treated within our system as an endogenous variable subject to control by the authorities. The authorities have maintained control of RU primarily through open market operations.[2] A reaction function describing their control of unborrowed reserves will relate RU to the domestic and foreign factors influencing official policy.

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[1] Equations fitted with distributed lags on Δ TB resulted in even larger coefficients for the sum of the terms, often as large as -2, yet with no noticeable improvement in the equation as a whole.

[2] As discussed above, reserve requirements were changed only once during the period.

The domestic factors might include the following:

Y: the level of activity in the economy (to represent transactions requirements)

Y_{cy}: a measure of cyclical income ($Y - \bar{Y}$, where $\bar{Y}$ is the trend value of income)

$\bar{U}$: the recent level of unemployment ($\bar{U} = (U_t + U_{t-1})/2$)

p^e: the expected inflation rate (i.e., the expected rate of change of the consumer price index)[1]

The coefficients of Y and $\bar{U}$ are expected to be positive, while those of Y_{cy} and p^e should be negative (if the authorities pursue anticyclical or anti-inflation policies, respectively).

Foreign factors influence policy in two different ways. The authorities may react defensively in response to developments in the dominant U.S. money market. If the authorities are concerned about the level of foreign exchange reserves, they may respond to higher U.S. interest rates, for instance, by reducing bank reserves in order to prevent an outflow of capital and a loss of reserves. The authorities also have an opportunity to guide domestic monetary conditions through their sterilization policy. When fluctuations in foreign exchange reserves occur, the authorities can offset to a greater or lesser extent the impact of these foreign exchange fluctuations upon the reserve base. To reflect these two different effects, we include both the U.S. interest rate and the level of foreign exchange reserves (RFX) in the reaction function (treating the latter variable as endogenous since foreign

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[1] This variable, obtained from the RDX2 model, is a weighted average of past rates of change of the consumer price index. The weights are derived from the estimation of an equation for the market value of the capital stock. (See Helliwell <u>et al.</u>, 1971, Part 2, p. 114).

exchange reserves are determined in part by interest-sensitive capital movements). The coefficient of r_{us} is expected to have a negative value, while the coefficient of RFX should lie between zero and one, with a zero coefficient reflecting complete sterilization.

Table III presents several versions of the reaction function. Equation (1) relates unborrowed reserves to foreign exchange reserves, the U.S. interest rate, Canadian income, the expected inflation rate, and the recent level of unemployment. All the coefficients have the expected signs with the exception of the unemployment rate: reserves are decreased in response to a higher U.S. interest rate or a higher expected rate of inflation, while reserves are increased as the level of activity in the economy rises. Reserves also increase in response to increases in foreign exchange reserves, but by only a fraction of the initial increase as the authorities sterilize a large proportion of any increase in foreign exchange. The level of reserves varies inversely with the unemployment rate, suggesting that the authorities do not follow a consistent anticyclical policy. When the cyclical income variable replaces the unemployment rate (equation 2), the coefficient of this variable is positive rather than negative, again indicating a procyclical movement of bank reserves. Equations (3-5) omit the unemployment rate and cyclical income. Equation (4) substitutes the trend value of income ($\overline{Y}$) for the actual value, while equation (5) relates total bank reserves (TR) to the same variables as in (3). In all three equations, reserves increase in response to higher income or inflows of foreign exchange reserves, and decrease in response to a higher U.S. interest rate or a higher expected inflation rate.

TABLE III-E

THE REACTION FUNCTION - CANADA 1962III - 1970I

		$\hat{RFX}$	r_{us}	Y	P^e	$\bar{U}$	Y_{cy}	C	S1	S2	S3	R^2/DW
(1)	RU	.137 (1.37)	-.075 (-2.07)	.024 (5.96)	-.066 (-1.44)	-.0091 (-2.62)		-.010 (-.047)	-.103 (-3.31)	-.118 (-3.60)	-.049 (-1.58)	.926 2.14
(2)	RU	.158 (1.41)	-.078 (-2.00)	.025 (5.80)	-.073 (-1.48)		.037 (1.90)	-.065 (-.268)	-.108 (-3.23)	-.114 (-3.24)	-.042 (-1.24)	.915 2.02
(3)	RU	.164 (1.38)	-.080 (-1.93)	.025 (5.37)	-.066 (-1.27)			-.063 (-.244)	-.103 (-2.90)	-.112 -3.00	-.046 -1.28	.901 1.60
(4)	RU	.192 (1.44)	-.075 (-1.61)	$\bar{Y}$ .022 (4.31)	-.039 (-.681)			-.044 (-.153)	-.097 (-2.44)	-.106 (-2.53)	-.047 (-1.16)	.874 1.29
(5)	TR	.171 (1.73)	-.071 (-2.03)	.025 (6.53)	-.084 (-1.94)			-.085 (-.397)	-.124 (-4.20)	-.128 (-4.11)	-.068 (-2.27)	.930 1.50

Equation (5) seems to be superior in fit to (3), suggesting that the authorities control total reserves, offsetting any increases in borrowing with a reduction in unborrowed reserves.[1] In any case, the coefficients of the independent variables vary little whichever reserve series is explained.

In all versions of the equation, the coefficient of RFX proved to be surprisingly small, indicating that less than twenty percent of any fluctuation in foreign exchange reserves was reflected in variations of the domestic reserve base. Thus, in this eight year period of fixed exchange rates, the Canadian authorities seem to have enjoyed considerable success in sterilizing movements in bank reserves originating in balance of payments fluctuations. The results for Canada are in marked contrast with those for Germany to be discussed below where the absence of a large securities market inhibits sterilization operations.

The above results must be regarded as tentative, however, since the low coefficient for RFX is combined with a significant (and stable) negative coefficient for r_{us}. A significant coefficient for r_{us} suggests that balance of payments fluctuations were kept to a minimum by a conscious policy of adjusting bank reserves in response to variations in U.S. interest rates. Consider the case of a rise in U.S. interest rates. The authorities, in effect, seem to have anticipated market reactions by contracting the reserve base and forcing up domestic interest

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[1] This result must be regarded as tentative, however, since the series for borrowed reserves, though on average of small mean, is dominated by a (relatively) high level of borrowing in several quarters. Thus, RB could be a proxy for other money market disturbances occurring in those selected quarters.

rates to forestall those international portfolio adjustments that would otherwise occur. Their motivation for doing so is evident, at least through much of the period, since the authorities were under an obligation to maintain foreign exchange reserves close to a given level. Canada, in return for its exemption from the U.S. interest equalization tax, had agreed to limit movements in foreign exchange reserves away from a mutually acceptable target level.[1] But if the Canadian authorities pursued a conscious policy of at least partially adjusting domestic to U.S. monetary conditions, it is difficult to understand why they did not limit their sterilization operations when foreign exchange reserves did change. The answer may be that the authorities pursued a more sophisticated sterilization policy than can be captured in the present specification. For example, the degree of sterilization may have varied depending upon whether foreign exchange reserves were increasing or decreasing, or whether reserves were above or below the target prevailing at the time. Alternative specifications embodying such behavior will be tested in future work.

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[1] Beginning in mid-1963, Canadian policy was guided by understandings between the U.S. and Canadian governments about the level of foreign exchange reserves consistent with the continued exemption of Canadian securities issues from the interest equalization tax. Helliwell (1969) developed a series for this target level of foreign exchange reserves (based on information provided in the Bank of Canada's Annual Reports) which he used in a study of the foreign exchange market.

Despite doubts about the size of the RFX coefficient, this coefficient proves to be quite stable when the specification of the rest of the equation is varied. The same can be said for the coefficient of r_{us}. When the entire model is solved for the reduced form coefficients (see Section V), moreover, the coefficients of RFX and r_{us} (together with the coefficient of r_{us} in the capital flow equation) lead to estimates of the impact of U.S. rates on the reserve base which seem eminently reasonable.

IV. THE GERMAN MONETARY SECTOR[1]

Demand for Bank Deposits

Because we have not yet been able to obtain the appropriate data to estimate equations for time and savings deposits, the equations in Table IV.A describe the demand for sight deposits alone.[2] Four forms of the relationship, along with the implied elasticities (calculated at the sample means) are presented in Table IV.A. Although the equation was estimated under several different specifications, the interest and income elasticities varied to only a limited extent: the elasticity of the demand for sight deposits with respect to the German interest rate is approximately -.2, while the elasticity with respect to real income is within a range from 1.3 to 1.7.[3]

Equations IV.A.1 and 2 were estimated in simple linear form, while in equations IV.A.3 and 4 the interest rates and the rate of inflation were multiplied by the sum of demand deposits in the preceding year, B, in an attempt to compensate for the impact of trend in demand deposits on the coefficients of the interest rates and the rate of inflation.

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[1] All the German equations were estimated over a period from 1960I through 1969II, the latter date preceding the abnormal capital flows which occurred in late 1969 when the DM was temporarily floated.

[2] Equations for time and savings deposits will be presented in future versions of this paper.

[3] Although the results for the traditional log specification are not reported in Table IV.A, the elasticities are similar.

TABLE IV.A

THE DEMAND FOR DEMAND DEPOSITS: GERMANY, 1960I - 1969II

		C	r_g	r_{us}	$\dot{P}$	Y/P	S1	S2	S4	R^2/DW	Elasticities: income	Elasticities: domestic interest rate
(1)	D/P	-.03 (-1.7)	-.013 (-3.3)		-.19 (-1.7)	.47 (25.8)	.01 (3.9)	.00 (0)	-.003 (-1.0)	.977 1.84	1.36	-.25
			$\hat{r}_g$									
(2)	D/P	-.06 (-2.0)	-.012 (-2.3)		-.12 (-1.0)	.48 (23.9)	.01 (3.9)	.00 (0)	-.004 (-1.2)	.976 1.69	1.38	-.23
			$B.\hat{r}_g$	$B.r_{us}$	$B.\dot{P}$							
(3)	D/P	-.15 (-5.5)	-.0084 (-2.2)		-.15 (-1.6)	.58 (9.8)	.02 (3.9)	.00 (0)	.01 (-2.1)	.971 1.67	1.67	-.21
(4)	D/P	.13 (-3.2)	-.0087 (-2.3)	.0018 (0.6)	-.15 (-1.7)	.55 (8.5)	.01 (3.1)	.00 (0)	-.01 (-1.6)	.975 1.79	1.59	-.22

The principal determinants of the demand for sight deposits include:

r_G[1]: the German mortgage bond yield

r_{US}[2]: the U.S. Treasury bill rate

Y/P: German GNP deflated by the consumer price index

$\dot{P}$: the annual rate of change of the GNP deflator.

We were not able to measure any significant sensitivity of the demand for sight deposits to the U.S. rate or the Eurodollar rate; the signs of the foreign rate usually were positive rather than the theoretically appropriate negative, and the coefficients were generally insignificantly different from zero. Equation IV.A.4 is typical; the coefficient of the U.S. rate is positive, but not significantly different from zero at even the 90% level of confidence.

Equations IV.A.2-4 were estimated by two-stage least squares, while equation IV.A.1 was estimated by ordinary least squares. The coefficient of the German interest rate is virtually identical, no matter which estimation technique is employed.[3]

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[1] The inter-bank rate, the principal German short-term rate, was employed in several specifications, but the long-term, mortgage bond rate yielded consistently better results. This may have been due to the fact that the inter-bank rate is not a return which is available to non-bank holders of wealth (it does not represent a return on a possible substitute asset).

[2] Although the Eurodollar rate and other major European interest rates should also be included in these equations, we have not yet developed equations to explain these rates.

[3] In this connection note that we find below that the supply of deposits is insensitive to the interest rate.

The Supply of Bank Deposits

The Bundesbank regulates bank liquidity both through influencing the total level of bank reserves and by determining the minimum ratio of reserves to deposit liabilities.-/ Several different policy instruments are employed.

In order to affect the level of unborrowed reserves, the Bundesbank can initiate open market operations, shift government balances between the Central Bank and private banks, or engage in swap operations in the forward exchange market. Open market operations are of limited significance in Germany as compared to the practice of monetary policy in Canada or the United States--in part, because of the limited size and distribution of marketable government debt in Germany.-/ On the other hand the German monetary authorities make much greater use of shifts in Federal and State government balances between the Central bank and private banks than do their North American counterparts.-/ In addition, the

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-/Useful discussions of the German monetary system are contained in Hodgman (1974), in Deutsche Bundesbank (1971), and in the appendix to Porter (1972).

-/An additional important difference is that the Bundesbank initiates open market operations by varying the rates at which it will sell or buy government debt from the banks, rather than by directly issuing orders to buy or sell a particular quantity of government securities.

-/This instrument was strengthened in the Stabilization Law of 1967 by extending Bundesbank influence to placement of special anticyclical deposits of the Federal Government and the State Governments and to placement of deposits related to an anticyclical surtax on income.

Bundesbank has occasionally made extensive use of swap operations in the forward exchange market, in effect, employing foreign capital markets (especially the New York market) to influence domestic bank liquidity.-/

The Bundesbank can control the volume of borrowed reserves in three ways: by setting the cost of discount borrowing, the discount rate; by fixing the maximum amount which each credit institution may borrow, the discount quotas; and, at times by excluding certain kinds of credit instruments from the list of bills eligible for discounting. In the period under study the Bundesbank changed the discount rate fourteen times. In addition, there were several changes in discount quotas.-/ Banks are usually heavily in debt to the Bundesbank; borrowed reserves averaged 28% of total bank reserves over the period studied.

The Bundesbank has made exceptionally vigorous use of variations in reserve requirements. Over the last decade reserve requirement ratios have been changed 27 times. Minimum reserve

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-/The Bundesbank initiates a swap by offering to repurchase a foreign currency, usually dollars, from banks at some point in the future at a more attractive exchange rate than that available on the forward market. In response to the consequent increase in the covered return, banks may be induced to hold some of their assets in dollar denominated assets rather than as D-market reserves. Often the Bundesbank has required that the official swap rate be used only to cover purchases of U.S. Treasury bills.

-/Although the discount quota may never be exceeded, once its discount quota is exhausted, a credit institution has recourse to Lombard credit, borrowing from the Central Bank in which securities are used as collateral. The rate on Lombard credit is usually 1% above the discount rate.

requirements are calculated on a monthly formula and are differentiated by kind of deposit-- demand, time or saving-- by whether the bank is one of four sizes and by whether the deposit liability is to a resident or a non-resident. Excess reserves are generally quite small since no interest is paid on reserves and the method of calculating required reserves allows considerable flexibility in managing required reserves.-/

This wide diversity of policy instruments through which the Bundesbank can influence the behavior of German banks complicates the task of describing the behavior of German banks. The desired level of free reserves-/ may depend not only on the levels of the discount rate, the open market rate, the foreign and domestic interest rates, and the swap rate, but also on the levels of discount borrowing relative to the discount quotas. Furthermore, the actual level of reserves may well be buffeted by unanticipated changes in reserve requirements as well as changes in unborrowed reserves and exogenous shifts in the demand for loans.

-/Banks have the option of calculating their average liabilities subject to the reserve requirement over the month either on the basis of the figures at the end of each day from the 16th of the previous month to the 16th of the current month or on the basis of the position at the 23rd and last day of the previous month and the 7th and 15th of the current month. Reserves are the monthly average of the daily balances maintained with the Bundesbank. Failure to maintain the appropriate level of required reserves is met with an interest charge on the shortfall at a rate usually 4% above the discount rate.

-/This analysis in terms of free reserves is in contrast to the standard Bundesbank analysis in terms of free <u>liquid</u> reserves which includes in addition to free reserves (excess reserves less borrowed reserves) potential claims against the Bundesbank in the form of unused discount quotas, open market paper and liquid foreign assets. The justification is that all of these potential claims could be readily converted into reserves. This broader concept, however, obscures precisely the behavior on which we wish to focus: given the values of the Bundesbank's policy instruments, how much will the banks borrow?

In Table IV.B we present four versions of the free reserve equation. In addition to the variables defined above, the following variables appear in the free reserve equation:

r_{disc}: the discount rate.

FR_{-1}: free reserves at the end of the preceding quarter.

ΔRUE: the change in effective unborrowed reserves (the change in unborrowed reserves minus the change in required reserves attributable to a change in the required reserve ratio).

ΔBL: the change in bank loans to the private sector.

We would expect the coefficient of the r_{disc} to be positive since an increase in r_{disc} would increase the cost of borrowing and thus lead to a reduction in borrowed reserves or an increase in free reserves. Similarly, r_G and r_{US} should have negative coefficients since an increase in either rate would make it more attractive to borrow from the Bundesbank in order to purchase domestic or foreign assets and less attractive to hold excess reserves. The lagged adjustment hypothesis implies that one minus the coefficient of RF_{-1} would equal the proportion of the gap between desired and actual free reserves eliminated each quarter; thus, the value of the coefficient should be between zero and one. An increase in RUE may be expected to increase free reserves because some part of the increase may be used to reduce indebtedness to the central bank or, if there is insufficient time to adjust the bank's portfolio, some part of it may temporarily become

TABLE IV.B

THE DEMAND FOR FREE RESERVES: GERMANY, 1960I - 1969II

	C	r_{disc}	$\hat{r}_g$	r_{us}	RF_{-1}	$\Delta R\hat{U}\hat{E}$	ΔBL	S1	S2	S4	R^2/DW	
(1) RF	-5.16 (-.9)	-.41 (-1.0)	1.40 (1.2)	-.95 (-2.7)	.81 (3.7)	.33 (2.4)	.006 (.23)	.54 (1.0)	-.09 (-.3)	-.42 (-.8)	.891 2.58	
(2) RF	1.20 (.3)	.20 (.6)	-3.7 (-.5)		.90 (6.3)	.42 (5.2)	-.026 (-1.3)	.48 (1.2)	-.19 (.17)	-.46 (-1.1)	.891 2.78	
(3) RF	-.32 (-1.1)				.96 (14.4)	.46 (3.7)	-.028 (-1.5)	.60 (1.2)	-.18 (-.7)	-.61 (-1.2)	.889 2.86	
(4) RF Cochrane-Orcutt Technique	-4.48 (-2.0)	-.11 (-.6)	.93 (2.1)	-.35 (-2.0)	1.08 (9.0)	.55 (5.4)		1.27 (2.3)	-.34 (-1.0)	-1.18 (-2.3)	.944 2.10	ρ =-.60 (-4.6)

an increase in excess reserves. On the other hand, an increase in the demand for commercial loans may be expected to temporarily decrease free reserves since it generally takes some time for banks to respond to an increase in the demand for loans by raising the lending rate and/or by increasing the stringency of credit standards.

Not all of the coefficients presented in Table IV.B have the expected signs. The interest rate coefficients, in particular, are quite unstable, changing sign in response to slight shifts in the specification. In equation IV.B.1 neither r_{disc} nor r_G has the appropriate sign, while the coefficient of r_{US} is significantly different from zero and has the expected negative sign; however, when, as in equation IV.B.2, r_{US} is dropped, r_{disc} and r_G assume appropriate, if insignificant signs and the goodness of fit of the equation scarcely declines. This may indicate that multicollinearity among the interest rates is at least partially responsible for the instability of the estimated coefficients.

Since it was not possible to develop equations which displayed persuasive evidence of interest sensitivity in bank free reserve behavior, the relationship was also estimated without the r_{disc}, r_G and r_{US}. The resulting equation (see IV.B.3) was little different except that the negative serial correlation worsened. Serial correlation is a serious problem in each of these equations.[/]

[/] When the relationship is estimated by means of the Cochrane-Orcutt technique (see IV.B.4), the value of C, the coefficient, of first order serial correlation is a highly significant -.6, and the value of the coefficient of the lagged stock of free reserves--which was implausibly large in each of the preceding estimates--exceeds one; in terms of the lagged adjustment hypothesis, this would imply that banks actually adjust their portfolios away from the desired stock of free reserves.

It is often a sign that some important variable has been omitted from the relationship and, indeed, two important policy instruments have been omitted from the free reserve equation: swaps and changes in discount quotas. Thus far we have not been able to obtain data to represent either adequately.[1]

Despite the defects in the free reserves equation, the variable representing effective unborrowed reserves performed quite well. As expected, the coefficient was positive and highly significant and the value of the coefficient seemed relatively insensitive to changes in specification. The results indicate that roughly 40% of an effective increase in unborrowed reserves will become an increase in free reserves--either a temporary increase in excess reserves or, more likely, a reduction in borrowed reserves.

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[1] Several attempts were made to construct a dummy variable to represent the impact of official swaps from data published by the Bundesbank. Unfortunately, data on actual swap commitments are available for but part of the period and, while data for the official discount or premium on forward dollars are available throughout the period, the Bundesbank did not necessarily conclude swaps at these rates. Neither variables representing the difference between the official and market rate, nor variables representing actual swap commitments proved to be of any explanatory value. The tendency of the U.S. Treasury bill rate to dominate both the German discount rate and the German interest rate in the free reserve equation may be due to the fact that r_{US} also represents swap incentives--especially during those periods in which swaps were tied specifically to investments in U.S. Treasury bills.

The Bundesbank has published changes in rediscount quotas only since 1968. Although Willms (1971, p. 16) has argued that the quotas are unimportant in that actual borrowing is well within quota limits, the existence of excess quotas in the system as a whole need not imply that no bank is constrained nor that a reduction in quotas has no impact on bank behavior. That the Bundesbank has reduced quotas eight times between 1969 and 1972--once by DM 4 billion--suggests that policy-makers may perceive quota reductions as a countercyclical device.

International Capital Flows

In Table IV.C we present three equations explaining total net capital flows to Germany from 1960I through 1969II. The principal explanatory variables include:

- $\Delta(r_G - r_{US})$: the change in the interest differential between Germany and the United States.
- ΔTB: the change in the trade balance.
- SPECGR: a dummy variable representing some of the unusual factors affecting German capital flows--principally speculative movements.
- $\Delta GRGRD$: the change in the differential growth rate of permanent income between Germany and the rest of the world.

The change in the trade balance was introduced in the equation to reflect the impact of changes in trade finance on capital flows. If exports are generally financed by the exporting country, then one would expect an increase in net exports to be accompanied by a net capital outflow. The coefficient of ΔTB has the expected negative sign, but the value of the coefficient is greater than one in absolute value, implying that a $1 billion increase in net exports will lead to a $1.5 billion net capital outflow; however, the coefficient is not significantly different from one.[*]

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[*] If patterns of trade finance were constant over the period, one might also expect to observe a return inflow associated with that same increase in net exports as export lending is repaid. However, inasmuch as leads and lags in payments are notoriously sensitive to expected changes in exchange rates, it is not surprising that it was not possible to estimate a statistically significant pay-back pattern for German data; it is likely that the average time pattern of German trade financing has shifted several times in response to exchange rate crises over the past decade.

TABLE IV.C

CAPITAL FLOWS: GERMANY, 1960I - 1969II

		C	$\Delta (r_g - r_{us})^1$	ΔTB^1	SPECGR	Δ GRGRD	S1	S2	S4	R^2	DW
(1)	CF	-.77 (-2.2)	3.87 (2.5)	-1.56 (-2.5)	-14.33 (-7.5)	2.32 (3.4)	-.91 (-3.0)	.77 (2.7)	-.77 (-2.5)	.821	1.66
(2)	CF	.24 (1.2)	6.84 (4.7)	-2.59 (-4.2)	-12.72 (-5.9)		-.73 (-2.1)	.79 (2.3)	-.76 (-2.1)	.749	1.49
(3)	CF	.04 (.2)	5.82 (3.1) $(r_g - r_{us})$		-11.72 (4.2)		-.90 (-2.0)	.78 (1.8)	-.53 (-1.2)	.552	.98
(4)	CF	-1.24 (-3.8)	.27 (.4)	-1.02 (-1.7)	-13.57 (-6.4)	3.18 (4.8)	-1.13 (-3.5)	.75 (2.2)	-.66 (-1.7)	.783	1.38
(5)	CF	.02 (.1)	1.44 (1.9)	-2.24 (-2.9)	-9.36 (-3.7)		-1.05 (-2.5)	.60 (1.4)	-.28 (-.6)	.614	1.40

Coefficients of Selected Lagged Variables

a. $\Delta (r_g - r_{us})^1$ in equation IV.D.1*

Lag	Coefficient	t-statistic
0	.86	2.5
1	.75	2.5
2	.65	2.5
3	.54	2.5
4	.43	2.5
5	.32	2.5
6	.22	2.5
7	.11	2.5
8	0	

*The best fitting lag pattern was obtained by requiring that the weights follow a linear pattern constrained to approach zero in the most distant period.

b. ΔTB^1 in equation IV.D.1*

Lag	Coefficient	t-statistic
0	.1216	.9
1	-.0691	-.7
2	-.2097	-2.2
3	-.3002	-3.0
4	-.3405	-3.4
5	-.3306	-3.6
6	-.2706	-3.7
7	-.1604	-3.7
8	0	

*The best fitting lag pattern was obtained by requiring that the weights follow the pattern of a second degree polynomial constrained to approach zero in the most distant period.

The change in the differential growth in permanent income between Germany and the rest of the world is entered in the equation as an attempt to represent some of the factors that determine flows of direct investment, the same role played by ΔGRDCN in the Canadian capital flow equation.—/ The value of the coefficient of Δ GRGRD in equation IV.C.1 implies that an increase of 1% in the growth rate of permanent income in Germany vis-a-vis the rest of the world will lead to a DM2.32 billion capital inflow in the same quarter.

Insofar as the mark has played a central role in most of the major exchange rate crises of the last decade--either as a safe refuge from a currency that was expected to be devalued or as a currency expected to be revalued--it is important to account for speculative flows in analyzing the systematic determinants of capital flows to Germany. SPECGR was constructed from estimates of disturbances to the German capital account made by various official and private analysts.—/

—/ GRGRD appears to compete with $\Delta(r_G - r_{US})$; whenever they both appear in the same equation, the coefficient of the change in the interest differential is much smaller (e.g. compare equations IV.C.1 and 2 or 4 and). However, this is not surprising given the procyclical nature of interest rate movements in both Germany and the United States.

—/For precise details see Herring (1973, pp. 84-105). The data appendix contains a list of the precise estimates and of the sources from which they are derived. These estimates were normalized on the value of the largest estimate and entered as a dummy variable with values ranging from zero to one in absolute value--one being the proxy for the largest disturbance. If the estimated coefficient is approximately equal to the value of the largest disturbance, we have a crude confirmation that the dummy variable is performing the function intended. The value of the coefficient is SPECGR is DM14.33 billion in equation IV.C.1 while the absolute value of the largest flow was DM14.64 billion.

While the change in the cost of forward cover is a reasonably good indicator of incentives for speculative flows of capital into Germany, its effectiveness in this regard is dominated by SPECGR. Whenever both appear in the same equation the cost of forward cover is insignificant. When the cost of cover appears alone, it is strongly significant.

The sign and magnitude of the coefficient of SPECGR are in accord with our _a priori_ expectations.

The coefficients of the change in the interest differential[1] all have the expected positive sign and are significantly different from zero at the 95% level of confidence. The coefficient of $\Delta(r_G - r_{US})$ in equation IV.C.1 indicates that a one percent change in the differential in Germany's favor will lead, over time, to roughly a DM3.9 billion net capital inflow. The interpolation of the Almon coefficients at the foot of the table indicates that DM.9 billion of the inflow will occur during the quarter in which the change in the interest differential occurs; the flow will continue, if other things remain equal, constantly diminishing in magnitude, until eight quarters after the change. It is unclear whether this continuing flow is a reflection of lags in portfolio adjustment and/or of the impact of a change in interest rates on expectations of future changes in interest rates. Nonetheless, it is clear that representation of lagged values of the change in the differential improves the fit of the equation. When only the current change in the differential is included, as in equations IV.C.4 or 5, the percentage of the total variation in capital flows explained by the regression equation declines markedly, as does the value of the Durbin-Watson statistic.

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[1] Coefficients for Δr_G and Δr_{US} were also estimated in unconstrained form. Best results were achieved, however, when the coefficients of the two interest rates were constrained to be equal in magnitude but opposite in sign. This result corresponds with Herring's (1973) earlier finding, based on analysis of similar capital flow data for six nations, that the international financial system is homogeneous in the sense that an equal increase in interest rates everywhere has no effect on capital flows.

Because r_G has not been treated as an endogenous variable in the estimation of equations in Table IV.C, the coefficients of the change in the differential must be regarded as low estimates of the true coefficients.[1] Nonetheless, the estimated value of the change in the interest differential is relatively large, implying that an exogenous increase of 1% in r_G would lead to a capital inflow amounting to roughly 27% of the average of total bank reserves over the last decade. The magnitude of interest-sensitive capital flows combined with the Bundesbank's relative lack of success in offsetting the monetary impact of changes in foreign exchange reserves (which we shall demonstrate in the next section) may explain why Germany has been one of the most enthusiastic European supporters of greater exchange rate flexibility.

Reaction Function

Changes in effective unborrowed reserves are treated as an endogenous variable subject to control by the Bundesbank. As noted above, effective unborrowed reserves include, in addition to unborrowed reserves, the change in reserves attributable to a change in reserve

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[1] This follows from the fact that German capital flows are likely to influence the German interest rate at the same time that the German interest rate influences capital flows. Kouri and Porter (1972,), Porter (1972, pp. 402-403) and Herring (1973, pp. 106-107) have presented expressions for the probability limits of the downward bias in the ordinary least squares estimate of the coefficient of the domestic interest rate. Several attempts were made to apply two-stage-least-squares to the German capital flow equation, but consistent estimation did not increase the value of the contemporaneous coefficient of $\Delta(r_G - r_{US})$.

requirements.[/] Since the German monetary authority frequently employs changes in reserve requirements in addition to changes in Government balances at the Bundesbank, and open market operations, effective unborrowed reserves seem more appropriate as an instrument of Bundesbank policy than unborrowed reserves alone.

We assume that the Bundesbank's control of effective unborrowed reserves is influenced by both domestic and foreign objectives. The reaction function attempts to link changes in effective unborrowed reserves to the most important of these objectives. Because of the legal and institutional obstacles to an effective discretionary fiscal policy, the Bundesbank assumes principal responsibility for meeting macroeconomic objectives such as full employment, a low rate of inflation, a high rate of growth, and balance of payments equilibrium. We have included variables representing several of these objectives in the

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[/] The change in required reserves may be decomposed in the following way:

$$\Delta RR = q_{-1}\,\Delta TD + \Delta q\,TD_{-1}$$

where RR is required reserves, TD is total bank deposits and q is the average reserve ratio. Part of ΔRR may be attributable to changes in the level of deposits, $q_{-1}\,\Delta TD$, and part may be attributable to changes in the reserve requirement ratio, $\Delta q\,TD_{-1}$. It is the latter component which we use to depict Bundesbank policy since it is the change in required reserves caused by changes in the reserve ratio.

In this way changes in reserve requirements may be depicted in terms equivalent to open market purchases or shifts in government deposits between commercial banks and the central bank.

In future work, we intend to test an alternative hypothesis that the authorities seek to control deposit expansion rather than bank reserves. The two objectives are equivalent if the average reserve ratio (q) is constant, but the two objectives diverge if q changes, since the expansionary impact of a given change in reserves varies as q changes.

reaction function, but only two proved to be significant.

In Table IV.D we present three versions of the reaction function. In addition to the variables defined above, the following variables appear:

ΔY: the change in nominal income

ΔCU: the change in capacity utilization

ΔRFX: the change in foreign exchange reserves

The change in nominal income is intended to represent the needs of trade. If nominal GNP is expected to increase and the velocity of circulation is expected to remain constant, then effective unborrowed reserves must also increase if deflationary pressures are to be avoided. The estimates in Table IV.D indicate that effective unborrowed reserves increase by roughly DM80 million in response to an increase in nominal income of DM 1 billion.[/]

The change in capacity utilization is intended to represent the trade-off between unemployment and excess demand inflation. If the Bundesbank leans against the wind, it will react to a decrease in capacity utilization by increasing effective unborrowed reserves and to an increase in capacity utilization by decreasing them. The coefficients of ΔCU are significantly negative, indicating that on

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[/] The shift in the text between "expected" and "actual" changes in income is indicative of an awkward problem in timing. In most cases the monetary authority is reacting to its expectations about the values of particular variables since in many cases the actual values may not be known until after the quarter is over. Thus, in employing actual current values we have made the assumption that policy-makers' expectations are perfect or, at least, not systematically biased.

TABLE IV.D

THE REACTION FUNCTION: GERMANY, 1960I - 1969II

	C	ΔY	Δ CU	Δ RFX	S1	S2	S4	Δr_{us}		R^2/DW
(1) Δ RUE	-.72	.08	-42.00	.80	-2.84	.20	3.22			.861
	(-2.2)	(2.9)	(-2.4)	(5.6)	(-6.6)	(.5)	(7.9)			1.48
(2) Δ RUE	-.95	.09	-33.19	.83	-3.00	.27	3.30		ρ =.26	.896
(Cochrane-Orcutt Technique	(-2.9)	(4.1)	(-2.0)	(7.0)	(-8.1)	(.7)	(10.1)		(1.6)	1.75
(3) Δ RUE	-.71	.08	-40.94	.79	-2.84	.14	3.28	-.37		.852
	(-2.2)	(2.9)	(-2.3)	(5.4)	(-6.5)	(.3)	(7.8)	(-.5)		1.50

the average the Bundesbank reacts to a 1% increase in capacity utilization by decreasing effective unborrowed reserves by DM .42 billion.[1]

Changes in foreign exchange reserves are entered in the reaction function to determine to what extent the Bundesbank succeeds in offsetting the impact of external transactions on the domestic money supply. If the Bundesbank is completely successful in offsetting ΔRFX, the coefficient will be zero; on the other hand, if the Bundesbank does not succeed in sterilizing any of ΔRFX, the coefficient will be one. The estimated coefficient of ΔRFX is roughly .8, indicating that, on the average, the German authorities have sterilized only about 20% of changes in foreign exchange reserves.[2]

The change in the U.S. rate was entered in equation IV.D.3 to determine whether the Bundesbank has attempted to alter domestic bank liquidity to counter incentives for international capital flows. A negative coefficient is consistent with a policy of offsetting capital flows by reducing incentives before portfolio adjustments are completed. Although the coefficient of Δr_{US} is negative, it is not significantly different from zero.

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[1] Inasmuch as a 1% increase in capacity utilization must surely have a qualitatively different impact at the 98% level than at the 70% level of capacity utilization, we would expect the relationship between changes in effective unborrowed reserves and changes in capacity utilization to be nonlinear. However, our attempts to introduce a nonlinear form of the variable in the equation were not successful.

[2] In future work we plan to test whether the Bundesbank may react differently to increases in RFX than to decreases in RFX.

Because the Durbin-Watson statistic indicates that equation IV.D.1 may suffer from positive serial correlation, the equation was re-estimated using the Cochrane-Orcutt technique. The resulting equation is presented as equation IV.D.2. The coefficients differ but little from those in equation IV.D.1.[1]

The empirical estimates of the German reaction function present strong evidence that the Bundesbank has managed effective unborrowed reserves with regard for both domestic and foreign objectives. The most striking result is the apparent failure of the Bundesbank to sterilize more than 20% of the changes in foreign exchange reserves through offsetting changes in effective unborrowed reserves.

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[1] There is a strong pattern of seasonal variation in ΔRUE with large increases in the fourth quarter almost matched by decreases in the first quarter of each year.

V. CONCLUSION

Our goal in this study has been to specify and estimate a set of equations depicting the monetary sector in an open economy in order to determine the impact on the domestic interest rate of a change in the foreign rate. In sections III and IV we presented provisional estimates of the model for the Canadian and German economies respectively. In this section we briefly present solutions of the estimated equations showing the net impact of the U.S. rate on the Canadian and German rates.

For Canada, the solution of the system of equations is particularly sensitive to the parameters of the capital flow equation and the reaction function. Thus we have solved the system for alternative forms of these equations. Table V.A. provides a set of alternative estimates for K, the coefficient of r_{US} in the reduced form expression for r_C. Also provided is the list of equations employed in each reduced form solution. The estimates of K vary within a relatively limited range from .679 to .782. That is, the long-run impact of a 1% rise in the U.S. interest rate is to raise the Canadian rate by approximately .7%. This result is not unexpected given the close dependence of the Canadian economy upon the U.S. economy.

The uniformity of these estimates, however, should not obscure the several questions which remain to be resolved about the specific structural equations on which they are based. The parameters of the reaction function are particularly crucial in determining the size

Table V.A

Estimates of K

(The net impact of a 1% increase in the U.S. interest rate on the Canadian rate)

Alternative Solutions	(1)	(2)	(3)	(4)
K	.782	.738	.679	.740
Equations Solved/ Table				
Demand Deposits / III.A.	(3)-/	(3)	(3)	(3)
Time Deposits / III.B.	(3)	(3)	(3)	(3)
Deposit Supply /III.C.	(6)	(6)	(6)	(6)
Capital Flows / III.D.	(4)	(4)	(4)	(2)
Reaction Function / III.E.	(3)	(4)	(5)	(3)

-/ In solving the deposit supply and demand equations, government demand deposits (which are excluded from D), were treated as exogenous. Note also that in solving the equations, the variables P and q (which entered the reduced form expression in multiplicative form) were held constant at their sample means. P was set equal to 1.15; q at .075.

of K; alternative specifications of this function may lead to significantly different results, at least with regard to the breakdown between sterilization and the direct reaction of the authorities to higher foreign rates.

Table V.B. displays a set of alternative estimates for K',[/] the coefficient of r_{US} in the reduced form expression for r_G along with references to the equations used in computing each estimate.

Although the estimates vary somewhat, they are all quite large implying that an increase of 1% in the U.S. interest rate will lead to roughly a .97% increase in the German rate. In view of the Bundesbanks' lack of success in sterilizing changes in foreign exchange reserves and the high sensitivity of German capital flows to changes in interest differentials, these results are not surprising.

Both short- and long-run values of K' are estimated (see IV.B.1.). The former takes into account the temporary impact of ΔRUE on bank holdings of free reserves and the initial impact on capital flows of a change in interest rates, while the latter represents the total impact after all portfolio adjustments have taken place. Although the long-run value is larger, the difference between the two estimates

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[/] Because the German equations were solved in change form, the expression for K' differs slightly from that reported for K:

$$K' = \frac{[-(a_2+b_2)q - (b_5' - 1)(f_2 + h_2 f_1)]}{[\; q(a_1 + b_1) - (\; b_5' - 1\;)\; f_1 h_1 \;]}$$

In particular, K' has an extra term, b_5', which represents the temporary increase in free reserves in response to a change in effective unborrowed reserves, ΔRUE. Because this impact is temporary and because German capital flows appear to respond with a lag with respect to interest rate changes

Table V.B

Estimates of K'

(The net impact of a 1% increase in the U.S. interest rate on the German rate.)

Alternative Solutions	(1)	(2)	(3)	(4)
$K'_{long-run}$	.968	.982	.918	.874
$K'_{short-run}$	.870	--	--	--
Equations Solved/ Table				
Demand Deposits / IV.A.	(2)—/	(2)	(2)	(2)—/
Free Reserves / IV.B.	(3)	--	--	--
Capital Flows / IV.C.	(1)	(2)	(5)	(1)
Reaction Function / IV.D.	(1)	(1)	(1)	(1)

—/ In solving the deposit supply and demand equations, time deposits and government demand deposits (which are excluded from D), were treated as exogenous. In addition, the variables P and q (which enter the reduced form expression in multiplicative form) were held constant at their sample means. P was set equal to 106.2; q to .0805.

—/ In this estimate we assume that time deposits have the same interest sensitivity as demand deposits. Thus the coefficient of r_G in equation IV.A.2. is multiplied by three since time deposits are twice as large as demand deposits. Furthermore we assume that time deposits are sensitive to r_{US} with a coefficient roughly 60% the size of that of r_G. In effect, this is a crude attempt to assess the probable bias to our estimates of K' due to the omission of equations explaining time deposits.

is rather small because even the initial induced change in the supply of bank reserves, and hence bank deposits, is large relative to the interest sensitivity of the demand for bank deposits.

These estimates of K' should be considered somewhat higher than the true value of K' due to the absence of estimates of the interest sensitivity of time deposits; an experiment with some assumed values for the interest rate coefficients in the time deposit equation indicates that the resulting bias may not be too severe. (See V.B.4).

As the case of the Canadian estimates for K, the near uniformity of the estimates of K' is encouraging, though not an indication in itself that the structural models should be accepted as economic truth. The considerable advantage of estimating a full set of structural equations, as we have done in this study, is that it allows us to judge each equation on its own merits based on what knowledge we have of the specific economic relationship involved. The results of estimating the various structural equations to date are somewhat mixed, but this approach to investigating international interest rate interactions appears to be promising.

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both a short- and long-run value are calculated for K'. In the short-run solution b_5' is given the value it assumes in equation IV.B.3. and h_2 and h_1 are assigned the value of the contemporaneous coefficient in the Almon lag on $\Delta(r_G - r_{US})$. In the long-run solution, b_5' equals zero and h_2 and h_1 are assigned the value of the sum of the coefficients in the Almon lag.

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