

CURRENCY SUBSTITUTION AND THE  
DEMAND FOR MONEY: SOME EVIDENCE FOR CANADA

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## I Introduction

Recently, the possibility that foreign and domestic currencies are substitutes has received considerable attention.<sup>1</sup> Currency substitution has important implications for the working of flexible exchange rates. If the degree of currency substitution is high, small changes in the money supply would induce large changes in the exchange rate. Furthermore, currency substitution would transmit the effect of monetary disturbances from one country to another.<sup>2</sup> Indeed, significant currency substitution would seriously undermine the ability of flexible exchange rates to provide monetary independence.

This paper examines the empirical importance of currency substitution in the framework of the demand function for money. If currency substitution is important, the expected change in the exchange rate should be a significant determinant of the demand for home currency. In section II, we undertake such a test for the Canadian demand for money during the recent flexible exchange rate period. There is considerable evidence that the forward exchange rate is a good measure of the expected exchange rate.<sup>3</sup> Our own tests confirm these results for Canadian data since 1970. Using the forward rate measure, we find that the expected change

in the (U.S.-Canadian dollar) exchange rate was not a significant factor in the Canadian demand for money.

Our results are in sharp conflict with a recent study by Miles (1978) which reported a high degree of currency substitution in Canada. In section III, we re-examine Miles' evidence and show that his results are based on a mis-specified model. Indeed, estimation of what we believe to be a properly specified model using Miles data, reveals currency substitution to be insignificant.

## II The Expected Exchange Rate Change and the Demand for Money

According to the standard formulation,<sup>4</sup> the demand for money is a function of a scale variable representing income or wealth and a set of variables representing the opportunity cost of holding money. In this framework, if foreign money is a substitute for home money, the expected rate of return on foreign money would be an argument in the demand for home money.<sup>5</sup> Assuming that no interest is paid on foreign money balances, the expected rate of return on foreign money would simply equal the expected rate of appreciation of the exchange rate (defined as the price of foreign money).<sup>6</sup> Thus, the possibility of currency substitution can be tested by examining whether expected exchange rate change is a significant determinant of the demand for domestic money.

In this section we estimate the Canadian demand for domestic money with the purpose of identifying the influence of the expected exchange rate change. We use the proportional difference between the 90-day forward and the spot exchange rate to measure expected exchange rate change. We begin by briefly reviewing evidence which suggests that the forward rate is a good measure of the spot rate. We then estimate a number of alternative specifications of the Canadian demand for money to test whether the spread between the forward and spot rates is a significant determinant.

### The Forward Rate Measure

Recently, Frenkel (1977, 1978, 1980a, 1980b) has made a strong case for using the forward exchange rate as a measure of the expected exchange rate. His evidence is based on tests of the following relationship:

$$\log S_t = a + b \log F_{t-1}(1) + u_t \quad (1)$$

where  $S_t$  is the spot exchange rate and  $F_{t-1}(1)$  the 1-period forward rate prevailing in  $t-1$ . The hypothesis that the forward rate is an unbiased predictor of the future spot rate implies that  $a = 0$  and  $b = 1$ . Furthermore, the hypothesis that the forward rate measures the expected future rate without any error implies that  $u_t$  represents unanticipated changes in the spot rate and thus, it would be independent of information available in period  $t-1$ .<sup>7</sup> Frenkel finds the above hypotheses to be consistent with the evidence from the 1920's as well as the 1970's.

To test whether the above results hold for our data set, we estimated the following relationship for the U.S.-Canadian exchange rate from November 1970 to November 1979, using monthly data:

$$\log S_t = .002 + 1.015 \log F_{t-3}(3) \quad (t=1, 4, 7, \dots)$$

(.003)      (.049)

$$R^2 = .93 \quad DW = 1.61 \quad SEE = .0177 \quad \text{No. Obs.} = 37$$

$$m = 1.59 \quad (\text{critical value at 95\% confidence level} = 5.99)$$

(Note: standard errors are shown in brackets)

where  $F_{t-3}(3)$  is the 3-month forward rate available in  $t-3$ .

Since we are dealing with 3-month forward rates, we use monthly data at 3-month intervals to exclude overlapping observations.<sup>8</sup>

The above results do not reject the hypothesis that the intercept is equal to zero and the slope equal to one. Thus, we can conclude that the forward rate provides an unbiased forecast of the future exchange rate. The evidence is also consistent with several implications of the hypothesis that the forward rate measure is free of error. First, the error term is not serially correlated according to the DW statistic. Second, the  $m$  statistic shows that we cannot reject the hypothesis that the error term is uncorrelated with the forward rate.<sup>9</sup> Finally,  $F$ -tests show the error term to be independent of spot rates (and forward rates) prevailing in periods  $t-3$  or before.<sup>10</sup> Our results thus confirm Frenkel's findings that the forward rate represents an unbiased and an efficient forecast of the future spot rate. In the tests below we use the proportional spread between the 90-day forward and spot exchange rates  $((F-S)/S)$  to measure the expected rate of exchange rate appreciation.

Evidence on the Canadian Demand for Money

We estimate the Canadian demand for money for the recent flexible exchange rate period 1970 III to 1979 IV, using quarterly data. The demand function is estimated for M1 as well as M2. We considered several measures of the scale variable but ultimately decided to use the simple current income measure.<sup>11</sup> Interest rates were represented by two variables: a short rate and a long rate.<sup>12</sup> In the case of M2, we also used the interest rate on saving deposits as a measure of the own rate. The form of the function was assumed to be log-linear, double-log with respect to income and semi-log with respect to the opportunity cost variables.<sup>13</sup> The adjustment lag in the demand for money can be specified in terms of either nominal or real stocks. We let the data decide which adjustment mechanism is preferred.<sup>14</sup> Finally, we used Cochrane-Orcutt adjustment in the regression equations where serial correlation of the residual error was indicated.

In table 1, for each definition of money, we first show the best-fitting demand for money function without the expected rate of exchange rate appreciation ( $\hat{E}$ ). We then introduce  $\hat{E}$  in the equation to examine the influence of currency substitution. As the table shows, the best-fitting function for M1 is based on real adjustment mechanism and includes only the short rate. The best-fitting function for M2, on the other hand, uses nominal

adjustment mechanism and includes a long rate as well as an own rate. The table also shows the best-fitting demand function for (M2-M1) balances which represent largely personal saving deposits. The form of the demand function for these balances is the same as that for M2.<sup>15</sup> In all three cases, the effect of  $\hat{E}$  when introduced is insignificant. Thus, there is no evidence of currency substitution in the demand for M1, M2 or (M2-M1).

It may be suspected that the effect of  $\hat{E}$  is insignificant because: (a) its range of variation is small and/or (b) it is strongly correlated with other interest rates. To examine this possibility, table 2 shows standard deviations of the three interest rates and  $\hat{E}$  as well as correlation co-efficients between these variables. The table shows the variability of  $\hat{E}$  to be not much different from the three interest rates (the standard deviation of  $\hat{E}$  is somewhat smaller than that of the short and the own rate but larger than the long rate). The table also shows that while the three interest rates are strongly correlated with each other, there is little correlation between the interest rates and  $\hat{E}$ .



Table 1

Currency Substitution in the Canadian Demand for Money: Quarterly Data, 1970 IV - 1979 IV

Dependent Variable: $\log (X_t/P_t)$	Type of Regression	Coefficients of Independent Variables (t- values in brackets)										Durbin h	Rho
		Const.	$\log y$	$i_s$	$i_1$	$i_o$	$\hat{E}$	$\log \left( \frac{X_{t-1}}{P_{t-1}} \right)$	$\log \left( \frac{X_{t-1}}{P_t} \right)$	$R^2$	SEE	DW	
1. X=M1	OLSQ	-1.19 (-1.92)**	.08 (1.86)**	-.65 (-4.20)**				.87 (12.84)*		.926	.0149	2.32	-1.07
2. X=M1	OLSQ	-1.49 (-2.27)*	.11 (2.21)*	-.67 (-4.36)*			-.21 (-1.26)	.85 (12.30)*		.930	.0148	2.39	-1.31
3. X=M2	CORC	-1.39 (-1.72)**	.11 (1.75)**		-.91 (-2.71)*	.72 (4.07)*			.88 (16.34)*	.997	.0064	1.71	.224
4. X=M2	CORC	-1.58 (-1.87)**	.13 (1.89)**		-.76 (2.05)*	.65 (3.27)*	-.85 (-1.89)		.87 (15.47)*	.997	.0064	1.70	.235
5. X=M2-M1	CORC	-2.33 (-2.79)*	.19 (2.77)*		-1.01 (-2.24)*	1.11 (4.56)*			.86 (20.98)*	.998	.0084	1.79	.282
6. X=M2-M1	CORC	-2.38 (-2.73)*	.19 (2.70)*		-.96 (1.93)**	1.08 (4.04)*	-.03 (-.23)		.85 (20.20)*	.998	.0085	1.79	.295

Note: M1 = Narrowly defined money, M2 = Broadly defined money, P = Price level, y = real income,  $i_s$  = short interest rate,

$i_1$  = long interest rate,  $i_o$  = own rate,  $\hat{E}$  = expected rate of change in the exchange rate; all rates represent annual rates expressed as fractions. For further explanation and sources, see Appendix.

\* indicates significance at the 5% and \*\* at the 10% level.

Table 2

Means, Standard Deviations, and Correlation Matrix  
of the Rates of Interest and the Expected Change in the Exchange Rate

Variable	Mean	Standard Deviation	<u>Correlation Coefficients</u>			
			$i_s$	$i_l$	$i_o$	$\hat{E}$
$i_s$	8.04	2.44	1.00			
$i_l$	9.03	1.05	.903	1.00		
$i_o$	6.67	1.94	.954	.930	1.00	
$\hat{E}$	.43	1.61	.130	.362	.164	1.00

Note: For explanation of terms and sources, see Table 1 and Appendix.

### III Miles' Evidence Re-examined

In a recent study, Miles (1978) examined the influence of currency substitution in Canada using a different methodology and a different set of data than used here. In this section, we show that his evidence indicating a significant role for currency substitution can be reinterpreted to be consistent with our results discussed above.

Miles' approach is based on the assumption that domestic and foreign money balances (in real terms) are inputs in a production function, output of which is some monetary service stream. Assuming that the production function can be represented by a CES function which is homogeneous of degree one and that foreign exchange market is characterized by certainty and perfect interest arbitrage, he maximizes the monetary service flow subject to an asset constraint to derive the following relationship:

$$\log(M_d/EM_f) = \alpha_0 + \alpha_1 [\log(1 + i_f) - \log(1 + i_d)] \quad (2)$$

where  $M_d$  and  $M_f$  are stocks of money balances denominated in domestic and foreign dollars,  $E$  the exchange rate (domestic dollars per foreign dollar),  $i_d$  the domestic and  $i_f$  the foreign interest rate. In the above relationship  $\alpha_1$  equals the elasticity of substitution. Using this relationship, Miles finds the elasticity of substitution

in Canada to be significant and as high as 5.78 in the period 1970 IV to 1975 IV.

We present evidence below which suggests that the model used by Miles is incorrectly specified. Our specification test can be explained as follows. Suppose that instead of assuming a monetary service production function with domestic and foreign money balances as inputs, we consider the following utility function which includes goods as well as the two moneys as its arguments:

$$u = f(m_d, m_f, g) \quad (3)$$

where  $m_d = M_d/P_d$ ,  $m_f = EM_f/P_d$ ,  $P_d$  = the domestic price level and  $g$  = flow of goods (a unit of  $g$  equals one real dollar).<sup>16</sup> To derive the budget constraint, we assume that all income is spent in each period.<sup>17</sup> We also maintain the assumptions that certainty and perfect interest arbitrage obtain in the exchange market. Letting  $w_o$  represent financial wealth in real terms and  $r_o$  the flow of real income from sources other than financial wealth, the relevant constraint can be simplified to:

$$y = g + i_d m_d + i_f m_f \quad (4)$$

where  $y = i_d w_o + r_o$  represents real income.<sup>18</sup> In this constraint,

$i_d$  and  $i_f$  represent prices (opportunity costs) of holding  $m_d$  and  $m_f$  for one period (the price of  $g$  is assumed to be unity). Maximizing (3) subject to (4), we derive the demand for each money as a function of real income  $y$  and the two interest rates,  $i_d$  and  $i_f$ . We assume the following log-linear form for the two demand functions:

$$\log m_d = \beta_0 + \beta_1 \log y + \beta_2 i_d + \beta_3 i_f \quad (5)$$

$$\log m_f = \gamma_0 + \gamma_1 \log y + \gamma_2 i_d + \gamma_3 i_f \quad (6)$$

If there is no substitution between  $m_d$  and  $m_f$ , the terms  $\beta_3$  and  $\gamma_2$  (representing cross substitution effects) would be equal to zero.

To relate the above model to tests in the previous section, note that under conditions of arbitrage and certainty,  $i_d = i_f + \hat{E}$  (see footnote 18). Using this relation, (5) can be written as:

$$\log m_d = \beta_0 + \beta_1 \log y + (\beta_2 + \beta_3) i_d - \beta_3 \hat{E} \quad (7)$$

Thus, the test that the coefficient of  $\hat{E}$  in equation (7) equals zero is equivalent to testing the hypotheses that the coefficient of  $i_f$  in (5) is equal to zero.

To compare the above model with Miles' specification, we subtract (6) from (5) and rearrange terms to get:

$$\log (M_d/EM_f) = \delta_0 + \delta_1 \log y + \delta_2 i_d + \delta_3 (i_f - i_d) \quad (8)$$

where  $\delta_0 = \beta_0 - \gamma_0$ ,  $\delta_1 = \beta_1 - \gamma_1$ ,  $\delta_2 = \beta_2 + \beta_3 - \gamma_2 - \gamma_3$  and  $\delta_3 = \beta_3 - \gamma_3$ .

Equation (8) suggests two problems with Miles' approach. First, it is not clear whether the coefficient of the interest rate differential  $(i_f - i_d)$ <sup>19</sup> represents a measure of the elasticity of currency substitution. Indeed, it can be shown that to interpret  $\delta_3$  in equation (8) as a measure of this elasticity, one must assume that there is no substitution between foreign money and goods.<sup>20</sup> Second,  $\delta_1$  and/or  $\delta_2$  may not be equal to zero. In this case, omitting the influence of  $i_d$  and  $y$  would generally bias the estimate of  $\delta_3$ . This possibility is examined below in Table 3.

In this table we first repeat Miles' test by regressing  $\log (M_c/EM_u)$  on  $(i_u - i_c)$  where  $M_c$  and  $M_u$  are, respectively, Canadian and U.S. dollar balances held by Canadian residents,  $E$  is the (C\$/U\$) exchange rate and  $i_u$  and  $i_c$  represent the short term interest rates in the two countries.<sup>21</sup> We then introduce  $i_c$  and  $\log y$  ( $y$  represents Canadian GNP) as additional variables in the regression.<sup>22</sup>

Miles' model implies that the coefficients of both  $i_c$  and  $\log y$  would not be significantly different from zero. The results in Table 3 show that this implication is clearly rejected for the total period as well as subperiods of flexible exchange rates.<sup>23</sup> In all cases,  $i_c$  exerts a strong negative effect on the money ratio. Furthermore, the table also shows that the coefficient of the interest rate differential ( $i_u - i_c$ ) is significant only in Miles' regression equation. It becomes insignificant in the more general equation which includes  $i_c$  as a separate variable. We conclude that Miles' model is mis-specified and his evidence is not inconsistent with the result in the previous section that currency substitution is insignificant in the demand for (domestic) money in Canada.

Table 3

Miles' Estimates of Elasticity of Substitution Re-examined

<u>Period</u>	<u>Const.</u>	$\frac{i-i}{u_c}$	$i_c$	$\log y$	$R^2$	<u>DW</u>	<u>Rho</u>	<u>SEE</u>
1. 1960 IV - 1975 IV (Miles' total data period, includes fixed as well as flexible rates)	2.56 (18.34)*	4.98 (2.40)*			.78	1.47	.88	.1323
	-5.72 (-1.13)	-1.39 (.59)	-11.40 (-4.35)*	.78 (1.74)**	.83	1.70	.85	.1164
2. 1960 IV - 1962 II plus 1970 III - 1975 IV (Combines the two flexible exchange rate subperiods)	2.75 (21.15)*	6.67 (2.45)*			.76	1.45	.78	.1476
	-2.83 (-.54)	-.11 (-.03)	-10.52 (-2.71)*	.54 (1.15)	.82	1.84	.78	.1340

Note: The dependent variable is  $\log((M_c/EM_u))$ . All estimates are based on the Cochrane-Orcutt procedure. t-values are shown in brackets. See text and Appendix for further explanation of terms and sources.

\* indicates significance at the 5% and \*\* at the 10% level.



#### IV Conclusions

In this paper we tested for the influence of the (expected) return on foreign money on the demand for domestic money in Canada during the flexible exchange rate period of the 1970's and found this influence to be negligible. Thus, at least for one major country where significant amounts of foreign currency are held, currency substitution is not an important factor in the demand for money function.

As the demand for money is a key building block for the models of flexible exchange rates, our results suggest an insignificant role for currency substitution in the determination of flexible exchange rates. The evidence also does not support the view that currency substitution limits the ability of a country on flexible exchange rates to pursue an independent monetary policy.

Footnotes

- \* We wish to thank Charles Freedman and William Alexander of the Bank of Canada for providing us with data and for helpful suggestions.
1. See Calvo and Rodriguez (1977), Miles (1978), Bilson (1978), Girton and Roper (1976) and Brillembourg and Schadler (1979).
  2. Monetary disturbances could also be transmitted through capital mobility. However, with capital mobility and rational expectations, only unanticipated foreign monetary changes affect the home country (see Flood 1979). Currency substitution would also transmit the effect of anticipated foreign monetary changes.
  3. See, for instance, Frenkel (1977, 1978, 1980a and 1980b) and Hakkio (1980). Also see Levich (1979) for a survey of this issue.
  4. See, for instance, Laidler (1977).
  5. The cross elasticity of the demand for home money with respect to the rate of return on foreign money would provide a measure of the degree of currency substitution.

6. Holding of foreign money may also yield a service flow. In the next section, we discuss currency substitution in terms of a simple model where both domestic and foreign monies enter the utility function.

7. Formally, let

$$\log F_{t-1}(1) = \log \hat{S}_{t-1}(1) + v_t \quad (i)$$

where  $\hat{S}_{t-1}(1)$  is the optimal 1-period ahead forecast of the spot rate and  $v_t$  the error in the forward rate measure. We can also write:

$$\log S_t = \log \hat{S}_{t-1}(1) + w_t \quad (ii)$$

where  $w_t$  represents unanticipated changes in the exchange rate. Combining (i) and (ii), we get the text equation (1) with  $a = 0$ ,  $b = 1$  and  $u_t = w_t - v_t$ . Now if the forward rate measure is not subject to error,  $v_t = 0$  and  $u_t = w_t$ . Since  $\hat{S}_{t-1}(1)$  is the optimal forecast,  $E(w_t | I_{t-1}) = 0$  where  $I_{t-1}$  is the information set available in  $t-1$ .

8. Even if  $F_{t-3}(3)$  utilizes all information available in period  $t-3$ ,  $u_t$  may be correlated with  $u_{t-1}$  and  $u_{t-2}$  and thus may exhibit serial correlation. We drop overlapping observations to avoid this problem. For the use of alternative econometric methods to deal with this problem, see Hakkio (1980).

9. This test is due to Hausman (1978) and is used in Frenkel (1980a, 1980b). To test the hypothesis that  $\text{cov}(u_t, \log F_{t-3}(3)) = 0$ , the relevant test statistics can be written as:

$$m = (\hat{b}_I - \hat{b}_O) (\text{var } \hat{b}_I - \text{var } \hat{b}_O)^{-1} (\hat{b}_I - \hat{b}_O)$$

where  $\hat{b}_O$  is the vector of regression coefficients using OLS and  $\hat{b}_I$  the vector using the instrumental variable method (Durbin rank variable was used as an instrument for  $\log F_{t-3}(3)$ ).

$\text{Var } \hat{b}_I$  and  $\text{Var } \hat{b}_O$  represent the variance-covariance matrices of  $\hat{b}_I$  and  $\hat{b}_O$ , respectively.

10. We introduced into the regression equation,  $n$  ( $n = 4, 5, 6$ ) lagged spot rates,  $\log S_{t-3}$ ,  $\log S_{t-4}$ , ...,  $\log S_{t-n-2}$ , and found their effect to be insignificant as follows. For the test restriction that coefficients of all lagged spot rates are equal to zero, the relevant F-values are; for  $n = 4$ ,  $F_{31}^4 = .487$ , for  $n = 5$ ,  $F_{30}^5 = .377$  and for  $n = 6$ ,  $F_{29}^6 = .319$  (all of these F-values are well below the 5% critical value). Similarly  $m$  ( $m = 2, 3, 4$ ) lagged forward rates,  $\log F_{t-4}(3)$ , ...,  $\log F_{t-m-3}(3)$ , were introduced into the equation but their effect was also found to be insignificant.

11. As an alternative, a permanent income measure can be constructed using the error learning model. It is well-known, however, that such a measure is difficult to distinguish econometrically from a

specification which includes current income plus an adjustment lag (see, however, Spinelli 1980, for a recent attempt to discriminate between the two approaches). We also tried a measure of non-human wealth but found that it generally produced similar results.

12. A more general approach has recently been used by Heller and Khan (1979) who take into account the entire term structure of interest rates.
13. This form is convenient as expected exchange rate change can take both positive and negative values. One could use a double-log form by adding a positive constant to this variable before taking logs (such an approach has been used by Frenkel (1977) in estimating the demand for money under hyperinflation). However, in our case, the range of variation in the opportunity cost variables is not large and thus the choice between semi-log and double-log forms is not an important issue.
14. The question of which mechanism is more appropriate has not yet been settled. See, for instance, Goldfeld (1973), White (1978), Heller and Khan (1979) and Hafer and Hein (1980). The two mechanisms are specified as follows:

$$\text{real adjustment: } \log m_t = \lambda \log m_t^*(\dots) + (1-\lambda) \log m_{t-1}$$

$$\text{nominal adjustment: } \log M_t = \lambda \log M_t^*(\dots) + (1-\lambda) \log M_{t-1}$$

where  $m$  and  $M$  represent the stocks of real and nominal balances, starred letters represent desired stocks and  $0 < \lambda < 1$ . The nominal adjustment specification is estimated in the following form (to derive it divide both sides by the price level  $P_t$  and set  $M_t^* = P_t m_t^*$ ):

$$\log m_t = \lambda \log m_t^*(\dots) + (1-\lambda) \log M_{t-1}/P_t$$

15. The results would suggest that the demand for saving deposits is different from  $M1$  and as it accounts for a major proportion of  $M2$ , it dominates the form of the demand for  $M2$ .
16. We follow Miles in deflating both domestic and foreign money balances by the domestic price level.
17. See Klein (1974) who uses a similar constraint to derive the demand for money.
18. Assuming that financial wealth consists of domestic bonds ( $B_d$ ), foreign bonds ( $B_f$ ), as well as domestic and foreign money,

$$w_o = (B_d + EB_f + M_d + EM_f)/P_d \quad (i)$$

Since all income is spent in each period,

$$g = r_o + (i_d B_d + (i_f + \hat{E}) E B_f + (\hat{E}) E M_f) / P_d \quad (ii)$$

where because of certainty the expected rate of exchange rate appreciation  $\hat{E}$  is the same as the actual rate and it also equals the proportional difference between the forward and spot exchange rates. Arbitrage under these conditions implies that  $i_d = i_f + \hat{E}$ . Using this relation, substituting for the value of  $(B_d + E B_f) / P_d$  from (i) into (ii) and simplifying, we derive the constraint in (4).

19. Note that  $(i_f - i_d) \approx \log(1 + i_f) - \log(1 + i_d)$ .

20. Let  $\epsilon_{ij}$  represent the cross elasticity of compensated demand for good  $i$  with respect to price of good  $j$ . Since compensated demand for foreign money is homogenous of degree zero in all prices,

$$\epsilon_{fg} + \epsilon_{fd} + \epsilon_{ff} = 0 \quad (i)$$

where subscripts  $g$ ,  $d$  and  $f$  refer to goods, domestic money and foreign money, respectively. In demand functions (5) and (6), semi-elasticities  $\beta_3$  and  $\gamma_3$  can be written as:

$$\beta_3 = \epsilon_{df} / i_f \text{ and } \gamma_3 = \epsilon_{ff} / i_f \quad (ii)$$

Let  $\sigma$  be the Hicks-Allen elasticity of substitution between domestic and foreign money.  $\sigma$  can be related to cross-elasticities as follows (see Layard and Walters (1978) for a general discussion of this relationship):

$$\sigma = \epsilon_{df}(y/i_f^{m_f}) = \epsilon_{fd}(y/i_d^{m_d}) \quad (\text{iii})$$

Now if  $\epsilon_{fg} = 0$  (no substitution between foreign money and goods), (i) implies that  $\epsilon_{ff} = -\epsilon_{fd}$ . In this case,  $\delta_3 (= \beta_3 - \gamma_3)$  can be related to  $\sigma$  as follows. Substituting for  $\epsilon_{ff}$  in (ii) and using (iii), we derive

$$\delta_3 = \sigma(S_m/i_f)$$

where  $S_m = (i_d^{m_d} + i_f^{m_f})/y$ . Note that  $\delta_3$  is not an exact measure of  $\sigma$  except in the special case where  $S_m = i_f$ .

21. The series on  $M_u$  was kindly supplied to us by Marc Miles. It includes only bank deposits (the data on the holding of U.S. currency by Canadian residents is not available) and represents end-of-quarter data. For comparability, the series on  $M_c$  uses similar definition of bank deposits and end-of-quarter data (see Appendix for further details). While our measures are the same as Miles', the estimates in Table 3 differ slightly from those reported in his paper because: (a) our  $M_c$  series incorporates some recent revisions and (b) we use



$i_u - i_c$  instead of  $\log [(1 + i_u)/(1 + i_c)]$ .

22. Our definition of  $y$  in (4) includes the imputed value of the services of domestic and foreign money ( $i_{d,m_d} + i_{f,m_f}$ ). We ignore this imputation in using real GNP to measure  $y$ .
23. Miles considered the early flexible exchange rate regime (1960 IV - 1962 II) separately. However, as this subperiod only included seven observations (and our regression equation involved four independent variables) we have combined it with the recent flexible exchange rate period.

Appendix

Data Definition and Sources

Equation 1:

$S$  = Spot Exchange Rate (Canadian dollars per U.S. dollar, closing rate, monthly data)

$F$  = 90-day Forward Rate (Canadian dollars per U.S. dollar, closing rate, monthly data)

Tables 1 and 2:

$M1$  = Currency and demand deposits (seasonally adjusted, quarterly average of monthly data)

$M2$  =  $M1$  plus personal saving and non-personal notice deposits (seasonally adjusted, quarterly average of monthly data)

$P$  = GNE price deflator (1971 = 100, quarterly data)

$y$  = GNP at constant (1971) prices (quarterly data)

$i_s$  = 90-day Finance Company Paper Rate (rate per year, quarterly average of monthly data)

$i_1$  = Rate on Trust Company 5-year Guaranteed Investment Certificate  
(rate per year, quarterly average of monthly data)

$i_0$  = Rate on Non-Chequable Savings Deposits (rate per year, quarterly  
average of monthly data)

$E = 4(F-S)/S$  (quarterly average of monthly data)

Table 3:

$M_u$  = U.S. dollar deposits (all types) of Canadian residents held  
at both U.S. and Canadian banks (end of quarter data)

$M_c$  = Canadian dollar deposits (all types) and currency held by  
Canadians (equals M2 plus non-personal term deposits, end of  
quarter monthly data)

$i_c$  = 3-month Canadian Treasury Yield (per cent per year, end of  
quarter monthly data)

$i_u$  = 3-month U.S. Treasury Bill Yield (per cent per year; for  
comparability with Canadian rates, adjusted to a 365-day  
true yield bias; end of quarter monthly data)

E is the same as S defined above.

Sources: The source for P and y is Statistics Canada.  $M_u$  was supplied by Marc Miles. The Bank of Canada is the source for all other data.

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