JOHN H. ROGERS

The Currency Substitution Hypothesis and Relative Money Demand in Mexico and Canada

1. INTRODUCTION

THE DEGREE TO WHICH AN ECONOMY'S TOTAL TRANSACTIONS are conducted in U.S. dollars rather than domestic currency is referred to as "dollarization," a phenomenon that may be important for several reasons. When demand for dollars grows beyond the requirements of tourism and international trade, it is difficult for the monetary authority to find an appropriate definition of money and to control domestic liquidity. The dollarization ratio (domestic holdings of dollar deposits divided by domestic currency deposits) is closely watched by the monetary authority of small open economies close to the United States.

I estimate models of the dollarization ratio in both Mexico and Canada in order to test hypotheses concerning currency substitution. Two plots in Figure 1 display these ratios: the series MM (Mexico) and MC (Canada). This ratio is the log of U.S. dollar demand deposits held in domestic banks to domestic currency demand deposits, both in units of domestic currency. In the numerator of MM is Mexdollars, U.S. dollar-denominated demand deposits held in Mexican banks. Beginning in March 1977, the monetary authority took several steps designed to encourage residents to hold Mexdollars, which were partially backed by central bank reserves. From mid-1980 to 1982, Mexdollar demand deposits accounted for nearly 10 percent of total M2. As the government intended, Mexdollars initially were an insulation from

The author thanks Shaghil Ahmed, Charles Engel, Jim Fackler, Jim Hamilton, Venda Nowak, Steve Poloz, Carlos Silva, Fernando Solis-Soberon, Sam Yoo, participants at Penn State's International Economics workshop, and especially Luis de la Calle for their input into this paper.

JOHN H. ROGERS *is assistant professor of economics at the Pennsylvania State University.*

Journal of Money, Credit, and Banking, Vol. 24, No. 3 (August 1992)

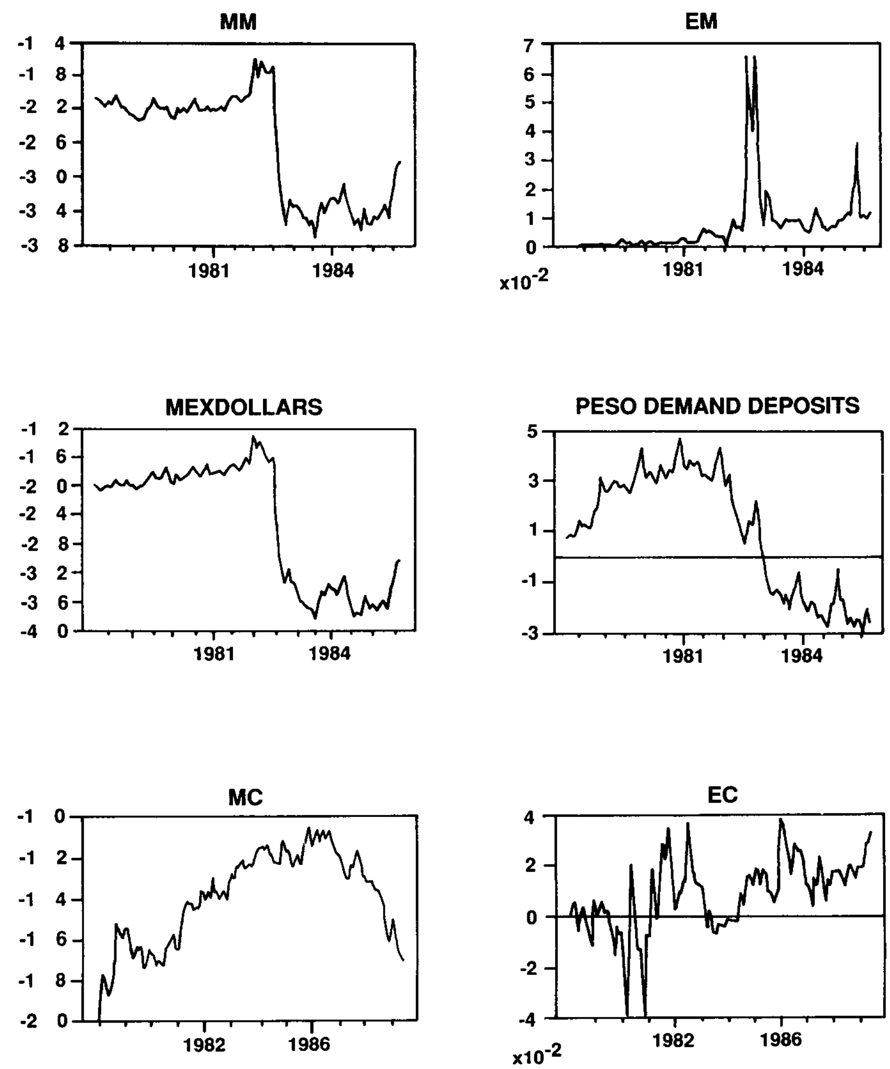

FIG. 1. Plots of the Series, Mexico and Canada

the outflow of short-term capital, absorbing much of the pressure that otherwise would have affected the foreign exchange market.[1]

[1]Concerning the importance of dollarization, see Ortiz and Solis (1982), Ortiz (1983), Ize and Ortiz (1984), and Ramirez-Rojas (1985). The first two papers also describe the evolution of the Mexdollar system. Dornbusch (1987) notes, "These Mexdollar accounts absorbed a good deal of the speculation, although their holders ultimately did much worse than those who bought the real thing." The importance of Mexdollars is also noted by Blanco and Garber's (1986) discussion of their decision to use the monetary base, because "a sizeable stock of domestic liabilities was denominated in dollars (mexdollars) during the sample period."

Note that in mid-1982 the ratio MM drops sharply. An interpretation of this drop in terms of currency or exchange rate risk would suggest it is associated with the expectation of an appreciation of the peso. The relative money demand function in Calvo and Rodriquez (1977) is consistent with the conventional interpretation [see their equation (11)]. Also, in their model a higher rate of domestic money growth, which produces a higher expected steady-state rate of depreciation, leads to a relative rise in foreign real balances. However, the sharp rise in EM (a measure of expected peso depreciation) seen in Figure 1, suggests that movements in the dollarization ratio, at least in mid-1982, are anomalous with conventional interpretation. This may be inferred from the actual numbers: EM averaged 12.4 percent per month from 3/82 to 7/82, up from 6.3 percent the previous four months, while MM *fell* 16.3 percent (the mean change is −0.8 percent).

I explain movements in the dollarization ratio using a general-to-specific modeling strategy. First I estimate a general-equilibrium model whose centerpiece is a relative money demand function. By embedding this equation in a multivariate model, I circumvent the problem of simultaneity between the dollarization ratio and expected depreciation. Next, I reduce the general model to estimate sparsely parameterized models of relative money demand. Evidence found consistently confirms the "figure 1 Rorschach test" results: the correlation between MM and EM is negative and significant.

My explanation of the anomalous movements in MM and EM is that holding Mexdollars was associated with "convertibility risk"—the possibility that full convertibility between Mexdollars and actual dollars would no longer be maintained. This risk was rising during 1981 and mid-1982 when, on August 12, 1982, with the Mexican economy on the verge of collapse and the ratio of Mexdollar demand deposits to foreign reserves near unity, the central bank converted all dollar-denominated debts to pesos at seventy to the dollar. This was below market exchange rates and the official rate soon after—above one hundred by the end of August. New Mexdollar accounts were permitted after August 1982 in special circumstances only, such as for use in vital international trade.

According to my convertibility risk hypothesis, when the central bank runs low on foreign reserves and expected peso depreciation is high, investors and the central bank realize that holders of Mexdollars may be unable to convert all of their Mexdollars into real dollars if they wanted. As a consequence, when reserves approach a critical level and investors consider withdrawing Mexdollars to buy true dollars, the government reacts by converting Mexdollars into pesos. However, investors know that the central bank may take this action, and so precipitate a run on Mexdollars as reserves run low. Because this corresponds to periods in which the peso is expected to be devalued, the anomaly that higher expected depreciation is associated with a lower relative demand for dollars is found in the data. The absence of such risk in Canada provides a benchmark case.[2]

[2]A key assertion is that Mexdollars were substituted for "real" dollars. Into which assets did Mexdollar holders "run"? U.S. dollar currency is one answer. I am unable to test this because there is no data on Mexican holdings of dollar currency (I use the most liquid of the appropriate measures). One would

Because I test an hypothesis from the empirical literature, this paper is empirical in nature. I note the implications of my results for existing theoretical models. Explanation of my results in models that formally analyze the properties of money demand is an important challenge to theory which awaits further research. Also, I leave some discussion of the estimation techniques to an appendix which is available on request.

2. THE GENERAL SPECIFICATION: A VECTOR AUTOREGRESSION (VAR) MODEL

I use monthly observations on the following:

e (*EM* or *EC*) = expected rate of depreciation; percentage difference between the three-month forward exchange rate and the spot rate (domestic currency per U.S. dollar),
y (*YM* or *YC*) = (log of) industrial production (Mexico or Canada),
p (*PM* or *PC*) = (log of) consumer price index (Mexico or Canada),
i (*IM* or *IC*) = three-month (Mexican or Canadian) Treasury bill rate,
m (*MM* or *MC*) = (log of) ratio of U.S. dollar-denominated deposits to domestic currency-denominated deposits; both in domestic currency units.

My measure of the expected rate of depreciation is the three-month forward premium.[3] In the case of Mexico, this was determined in the market that existed in New York until November 1985. The ratio *m* is nominal dollar deposits divided by domestic currency deposits, both denominated in domestic currency. My measure of *MM* is the same as that used by Ortiz (1983) and Ramirez-Rojas (1985).[4] The Mexican and Canadian data are from their central bank publications *Indicadores* and *Review*, respectively.

I focus on the final equation from the following innovation model:

$$y_t = b_{14} i_t + u_{1t} , \tag{1a}$$

also think of U.S. dollar deposits abroad, U.S. T-bills, and/or real estate in California. I focus on the Mexdollars because they (i) were important to Mexican policymakers, (ii) fit the definition of money more closely than do available alternatives, and (iii) are used by others who estimate currency substitution in Mexico. I avoid formal use of figures on capital flight; however, an often-used proxy reveals a strong correlation with the drop in Mexdollars in 1982, as the errors and omissions of the balance of payments are (in hundreds of thousands of pesos):

1981: IV −3757.7 1982:I 235.9 1982:II −1216.0 1982:III −2225.3

[3]One reason that I use this proxy is because Bordo and Choudri (1982), Daniel and Fried (1983), Cuddington (1983), and Ramirez-Rojas (1985) do also. It may be a biased predictor of the future change in the spot rate [see Hodrick's (1987) survey] because of (i) a failure of rational expectations, (ii) a risk premium, (iii) the peso problem, or (iv) nonstationarities due to a change in the process governing the spot rate. If there is a risk premium, my conclusions are only strengthened. Finally, it is reasonable to assert that the large forward discounts on the peso reflect nearly entirely expected exchange rate changes, as Cumby and Obstfeld (1983) argue.

[4]*MC* is the ratio of U.S. dollar deposits held by Canadians at both U.S. and Canadian banks to Canadian dollar deposits held by Canadians. The numerator is identical to that of Miles (1978) and Bordo and Choudri (1982), while the others also include in the denominator holdings of Canadian dollar currency.

$$P_t = b_{21}y_t + u_{2t}\,, \tag{1b}$$

$$e_t = b_{34}i_t + u_{3t}\,, \tag{1c}$$

$$i_t = b_{41}y_t + b_{42}P_t + b_{43}e_t + b_{45}m_t + u_{4t}\,, \tag{1d}$$

$$m_t = b_{51}y_t + b_{52}p_t + b_{53}e_t + u_{5t}\,. \tag{1e}$$

The model is conventional: IS and aggregate supply equations, an equation relating expected depreciation to the domestic interest rate (motivated by interest rate parity), and an equation for relative money supply and demand. In the Mexican case I include in each equation of the reduced form (the first-step, unrestricted VAR) the variables *DUMEM* and *DUMMM*, which are respectively *DUM*(*t*)**EM*(*t*) and *DUM*(*t*)**MM*(*t*), where *DUM* is unity in each month up to 1982, and zero for each month after January 1982. This is in order to account for possible structural changes which occurred in 1982.

I reproduce the equations of interest in (2M) and (2C), where standard errors are reported in parenthesis. The estimate of the entire model is given in Table 1. Note that the right-hand-side variables are independent of u_{it} by construction, so the estimates are unbiased and consistent. Available on request are details of the estimator, which follows Bernanke (1986).

Mexico

$$\underset{}{m_t} = \underset{(0.67)}{-0.38y_t} - \underset{(3.06)}{0.69p_t} - \underset{(3.56)}{18.6e_t} + u_{5t}\,. \tag{2M}$$

Canada

$$m_t = \underset{(0.12)}{1.02y_t} - \underset{(0.06)}{0.15p_t} + \underset{(0.54)}{1.66e_t} + u_{5t}\,. \tag{2C}$$

The model estimates generally well. Notably, the negative coefficient on e_t in the equation for m_t in (2M) implies that a rise in the expected rate of peso depreciation is associated with a *drop* in relative holdings of U.S. dollar deposits. This contradicts

TABLE 1

COEFFICIENT ESTIMATES (equations 1)

Mexico Coeff:	b_{14}	b_{21}	b_{34}	b_{41}	b_{42}	b_{43}	b_{45}	b_{51}	b_{52}	b_{53}
	−6.51	1.28	−0.01	4.07	0.46	3.47	0.06	−0.38	−0.69	−18.6
	(3.46)	(1.49)	(0.05)	(2.85)	(0.42)	(1.33)	(0.13)	(0.67)	(3.06)	(3.56)
Canada Coeff:	b_{14}	b_{21}	b_{34}	b_{41}	b_{42}	b_{43}	b_{45}	b_{51}	b_{52}	b_{53}
	0.34	−0.05	−0.32	0.34	0.25	0.11	0.09	1.02	−0.15	1.66
	(1.76)	(0.10)	(2.17)	(1.76)	(0.50)	(1.00)	(0.14)	(0.12)	(0.06)	(0.54)

NOTE: Standard errors are reported in parenthesis. See equations (1) in the text for interpretation of the coefficients.

findings in the literature on currency substitution in other countries and episodes. On the other hand, the Canadian case supports the conventional currency substitution hypothesis.

3. SPARSELY PARAMETERIZED MODELS

Estimating relative money demand as above produces an estimate with the explanatory variables independent of the error term by construction. This has its advantages, but no estimator is problem-free, so I provide evidence using the "specific" modeling strategy. The VAR is not to be discounted, however, because the general and specific methodologies lead to the same conclusion.

Unit Roots and Cointegration

Tests for unit roots and a deterministic time trend in each series most strongly indicate that each series contains one unit root (see Table 2). I also implement two tests for cointegration. The results in Tables 3 and 4 indicate the presence of some cointegration among the variables. Hence, the sparse parameterizations are based upon specifications with each series in first differences, and an error correction representation is examined.[5]

TABLE 2

TESTS FOR UNIT ROOTS

var	$q_t[z]$	$q_\mu[z]$	$q_t[Dz]$	$q_\mu[Dz]$	$t_t[z]$	$t_\mu[z]$	$t_t[Dz]$	$t_\mu k[dz]$
MM	−9.80	−5.01	−82.80**	−82.72**	−2.12	−1.63	−3.96**	−3.99**
MC	0.22	−4.00	−119.1**	−113.7**	0.60	−1.73	−5.75**	−4.86**
EM	−36.29**	−28.58**	−114.0**	−114.0**	−2.73	−2.25	−5.71**	−5.75**
EC	−35.85**	−20.02*	−127.0**	−126.9**	−3.49*	−2.35	−6.72**	−6.73**
YM	−11.41	−7.48	−133.8**	−133.4**	−1.98	−2.51	−2.94	−2.76
YC	−7.96	−1.35	−143.4**	−142.8**	−2.39	−0.68	−3.23*	−3.18*
PM	−4.13	0.41	−35.38**	−23.53**	−2.21	0.39	2.08	−1.87
PC	−31.84**	−30.9**	−112.0**	652.5	1.11	−0.86	−0.39	0.92
IM	−12.19	−1.78	−61.73**	−61.70**	−2.63	−0.97	−6.62**	−6.67**
IC	−11.44	−8.50	−84.05**	−83.96**	−2.58	−2.11	−5.05**	−5.07**
IUS	−13.10	−5.59	−82.36**	−81.44**	−2.91	−1.48	−4.94**	−4.89**
IMP	−7.66	−7.73	−115.3**	−114.0**				
OILP	−4.78	−5.95	−94.75**	−90.09**				
FR	−9.52	−7.02	−125.3**	−125.2**				

NOTE: * (**) denotes significant at the 5 percent (1 percent level. I use a fourth-order autoregressive correction in all tests. The q (t) test statistics are for the Stock-Watson (Dickey-Fuller) tests. Critical values are in Stock and Watson (1988) and Fuller (1976).

Model Estimates

I derive the single-equation models by using the information from tests for unit roots and cointegration to reduce the money demand equation from the first-stage

[5]The cointegration tests imply that estimating the VAR in levels (as I do) is preferable to first differences, although a vector error-correction system as in King, Plosser, Stock, and Watson (1989) would be preferable to either *if* the desire were to keep the analysis multivariate. However, my results are better understood using the following single-equation approach—certainly the results are more readily compared to the existing literature this way.

TABLE 3

JOHANSEN TESTS FOR COINTEGRATION

r	$-2\ln Q_r$ Mexico	$-2\ln Q_r$ Canada	Quantiles 90%	95%	97.5%	99%
4	2.19	0.27	7.6	9.1	10.7	12.7
3	17.3	13.1	18.0	20.2	22.2	25.0
2	63.9	37.9	32.1	35.1	37.6	40.2
1	139.8	65.8	49.9	53.3	56.4	60.1
0	245.8	96.2	71.5	75.3	78.9	83.0

NOTE: The test statistic $-2\ln Q_r$ is explained in Johansen and Juselius (1990). Critical values are taken from their table A3. The null hypothesis is that there are at most r cointegration vectors, or equivalently, $(5 - r)$ distinct unit roots.

VAR. The only additional variables are dummies whose importance is assumed a priori. The dummy variables *DUM*1 and *DUM*2, equal to unity from 1982:1–3 and 1982:7–9, respectively, and zero all other months, are used interactively with MM_t and EM_t to capture the 1982 devaluations and events of August 1982. I consolidate *all* single-equation estimates in Table 5.

A Preliminary Parsimonious Model for Mexico (5.1M)

I present an estimate of a single-equation model of relative money demand in Mexico in equation (5.1M) of Table 5. This preliminary model is chosen for its similarity to conventional specifications and simplicity. However, (5.1M) ultimately is used to demonstrate that, when confronting problems posed by nonstationary series, simply taking first differences and "re-estimating the conventional model" is not a solution. This is useful for comparisons with other models in section 5.

The model seems promising—R^2 is high, all coefficients are reasonably significant and the standard error of the estimated model is less than the standard deviation of *DMM*: 0.109 versus 0.176. The admission of a lag structure only for the depen-

TABLE 4

ADF TESTS: COINTEGRATION BETWEEN m AND OTHER VARIABLES

Cointegrating Regression	D–W[a]	t-stat[b]	Cointegrating Regression	t-stat[b]
$MM_t = \mu + \alpha EM_t$	0.14	-1.54^d	$MM_t = \mu + \alpha_2 IM + \alpha_3 YM_t$	-3.23^c
$MM_t = \mu + \alpha FRM_t$	0.09	-1.84^e	$MM_t = \mu + \alpha_2 IM + \alpha_3 EM_t$	-1.81^c
$MM_t = \mu + \alpha IM_t$	0.21	-2.10^c	$MM_t = \mu + \alpha_2 EM + \alpha_3 FRM_t$	-1.85^d
$MM_t = \mu + \alpha IUS_t$	0.13	-2.13^e	$MC_t = \mu + \alpha_2 IC_t + \alpha_3 EC_t$	-3.31^c
$EM_t = \mu + \alpha MM_t$	0.80	-3.42^d	$MC_t = \mu + \alpha_2 IC_t + \alpha_3 YC_t$	-1.83^c
$FRM_t = \mu + \alpha MM_t$	0.14	-2.32^e	*Critical values [Engle and Yoo (1987); n = 100]*	
$MC_t = \mu + \alpha EC_t$	0.12	-1.54^e	D − W (n = 2): 0.46(1%), 0.28(5%), 0.21(10%)	
$MC_t = \mu + \alpha IC_t$	0.06	-2.57^c	t-stat (n = 2): −3.73(1%), −3.17(5%), −2.91(10%)	
$MC_t = \mu + \alpha IUS_t$	0.50	-1.96^c	(n = 3): −4.22(1%), −3.62(5%), −3.32(10%)	
			(n = 4): −4.61(1%), −4.02(5%), −3.71(10%)	
			(n = 5): −4.98(1%), −4.36(5%), −4.06(10%)	

NOTES: a = Durbin-Watson statistics in the cointegrating regression.
b = t-stat. on p, lagged residual from the cointegrating regression.
c = the number of lags used in the ADF test, q, is 0.
d = the number of lags used in the ADF test, q, is 1.
e = the number of lags used in the ADF test, q, is 4.
n = number of variables in the regression; n = 5 is the maximum computed.
The null is that the residuals are I(1), that is, no cointegration.

TABLE 5: PART 1

MEXICAN SINGLE-EQUATION MODELS[a]

Equation	(5.1M)	(5.2M)[b]	(5.3M)[b]	(5.4M)[b]	(5.5M)[b]	(5.6M)[b]	(5.7M)[c]
$Dm(t-1)$	0.15 (0.07)	....	......	......	......	......	0.22[c] (0.11)
$Dm(t-2)$	0.17 (0.07)	....	......	......	......	......	0.08[c] (0.10)
$De(t)$	−4.38 (1.61)	....	......	......	......	......	
$De(t-1)$	....	−4.49 (2.08)	−4.47 (1.95)	−4.47 (2.09)	−4.10 (2.41)	......	−4.84 (2.03)
$De(t-2)$	....	−7.15 (1.23)	−6.64 (1.17)	−7.04 (1.26)	−6.80 (1.50)	−4.43 (1.01)	−7.30 (1.21)
$Di(t)$	−0.98 (0.53)	....	......	......	......	......	......
$Di(t-3)$	....	−1.99 (0.41)	−1.99 (0.38)	−1.99 (0.40)	−1.88 (0.43)	−1.54 (0.40)	−2.03 (0.40)
$Di(t-4)$	....	2.32 (0.67)	2.29 (0.66)	2.34 (0.64)	2.46 (0.57)	1.83 (0.69)	2.41 (0.67)
$DIMP(t-2)$	....	....	0.13 (0.07)	......	......	......	......
$DOILP(t-1)$	....	....	......	0.32 (0.14)	......	0.41 (0.15)	......
$DFR(t-1)$	....	....	......	......	−0.23 (0.09)	−0.31 (0.09)	......
$DFR(t-2)$	....	....	......	......	−0.21 (0.10)	−0.27 (0.11)	......
$ERRCM(t-1)$	....	....	......	......	......	−0.06 (0.02)	......
T	90	88	88	88	88	88	88
R^2	.63	.66	.67	.67	.69	.69	.67
SEE	0.109	0.105	0.105	0.105	0.100	0.100	0.105
$n_{1,1}$	4.93	0.13	0.04	0.01	2.74	3.50	
$n_{1,4}$	11.2	4.32	3.61	3.67	9.11	8.02	
$n_{1,12}$	13.3	10.2	11.4	10.0	15.3	15.2	
$n_{2,1}$	12.1	2.10	3.96	1.91	0.18	0.02	
$n_{2,4}$	12.5	2.40	4.05	2.25	2.59	0.26	
$n_{2,12}$	24.0	14.6	12.8	14.1	17.8	9.74	
n_3(80:12/1)	....	0.31 (.874)	......	......	.....	......	
n_3(81:11/12)	....	0.23 (.920)	......	......	.....	......	
n_3(82:4/5)	2.48 (.068)	0.89 (.475)	......	......	.....	......	
n_3(82:5/6)	3.42 (.021)	0.64 (.634)	......	......	.....	......	
n_3(82:10/11)	6.90 (.35–03)	1.37 (.251)	......	......	.....	......	
n_3(82:11/12)	5.70 (.0013)	1.52 (.205)	......	......	.....	......	

(a) The dependent variable is $Dm(t)$, standard errors are in parenthesis. Interaction dummy variables $[DUM1(t)^*e(t)]$, $[DUMJ2(t)^*e(t)]$, $[DUM1(t)^*m(t)]$ and $[DUM2(t)^*m(t)]$ are included in each regression; the negative and highly significant estimates are not reported.
(b) Standard errors have been corrected for heteroskedasticity, using White's (1980) technique.
(c) The first reported coefficients in (5.7M) are $DUM3DE1 = DUM3(t)^*DEM(t-1)$, and $DUM3DE2 = DUM3(t)^*DEM(t-2)$, where $DUM3$ = unity for all months up to and including 1982:4, and is zero elsewhere.

dent variable gives rise to the problems, however, as shown by the diagnostic tests. The Breusch and Pagan (1980) Lagrange multiplier (LM) tests suggest first- or fourth-order autocorrelation, according to $n_{1,i}$, while the $n_{2,i}$, coefficients strongly indicate the presence of autoregressive conditional heteroskedasticity (ARCH) [see Engle (1982)]. This suggests the need for a more completely specified dynamic

TABLE 5, PART 2

CANADIAN SINGLE-EQUATION MODELS, ESTIMATES OF THE COMPONENTS OF *MM*, AND COINTEGRATING REGRESSIONS

Equation	(5.2C)[a]	(5.6C)[a]	(*NUM*)[b]	(*DEN*)[b]	Equation	(*COINM*)[c]	(*COINC*)[c]
constant	0.05	0.06	......	......	const	−2.42	−45.9
	(0.02)	(0.01)				(0.07)	(4.29)
trend	−.42–03	−.42–03	......	......	EM(t)	−26.0	....
	(.12–03)	(.12–03)				(5.36)	
$Dm(t-1)$	0.13	0.16	......	......	EC(t)	....	1.83
	(0.07)	(0.07)					(0.78)
$Dm(t-2)$	−0.15	....	......	......	trend	....	−.029
	(0.07)						(.002)
$De(t-1)$	6.86	....	−3.26	0.86	IC(t)	....	−3.04
	(4.48)		(1.58)	(0.79)			(0.35)
$De(t-2)$	7.15	6.97	−5.80	1.16	YC(t)	....	2.02
	(3.63)	(3.32)	(1.48)	(0.75)			(0.26)
$Di(t)$	2.68	1.72	......	......	PC(t)	....	5.04
	(0.49)	(0.42)					(0.34)
$Di(t-1)$	−1.30	....	......	......			
	(0.58)						
$Di(t-3)$	....	....	−1.37	0.49			
			(0.58)	(0.28)			
$Di(t-4)$	....	....	1.64	−0.47			
			(0.67)	(0.34)			
$Di(t-6)$	1.00	0.74	......	......			
	(0.35)	(0.31)					
$Dy(t-2)$	0.77	....	......	......			
	(0.30)						
$Dy(t-5)$	−1.08	−0.81	......	......			
	(0.30)	(0.25)					
$Dp(t-2)$	−3.58	−4.60	......	......			
	(1.30)	(1.11)					
$ERRCC(t-1)$	....	−0.14	......	......			
		(0.03)					
T	133	133	88	88			
R^2	.32	.32	.62	.09			
SEE	0.390	.0338	0.108	0.054			
$n_{1,1}$	0.16	1.97	.007	1.03			
$n_{1,4}$	3.26	3.14	3.58	4.41			
$n_{1,12}$	15.7	18.6	11.7	30.4			
$n_{2,1}$	1.64	0.96	0.06	0.83			
$n_{2,4}$	3.33	1.77	1.10	2.83			
$n_{2,12}$	11.5	9.97	14.9	18.0			
n_3(81:11/12)	1.75	....	......	.....			
	(.066)						
n_3(85:12/1)	0.69	....	......	.....			
	(.758)						
n_3(86:1/2)	0.73	....	......	.....			
	(.718)						
n_3(86:2/3)	0.70	....	......	.....			
	(.746)						

(a) The dependent variable is $Dm(t)$; the corresponding column variables are the Canadian figures. All standard errors reported in parenthesis have been corrected for heteroskedasticity, using White's (1980) technique.
The dependent variable is: (b) $DNUM(t)$ [$DDEN(t)$], the numerator [denominator] of the Mexican dollarization ratio (see text); the corresponding column variables are the Mexican figures, and (c) $MM(t)$ and $MC(t)$, respectively.

structure. Finally, parameter constancy across three of four sample splits is rejected by a Chow (1960) test at 5 percent (and at 10 percent for the fourth split), as seen by the n_3 statistics.

Robust Sparse Parameterizations: Mexico (5.2M) and Canada (5.2C)

In equations (5.2M) and (5.2C) I present a robust model for Mexico and Canada.[6] Notice in (5.2M) that lagged expected depreciation terms are negative and significant, while in (5.2C) they are positive. Taking Hendry's (1986) view that "the model is the message," I perform several diagnostic tests. The residuals, RESM and RESC in Figure 2, are well behaved: LM tests for up to twelfth-order autocorrelation and ARCH are not significant at 5 percent, as the results given by $n_{1,i}$ and $n_{2,i}$ for $i = 1, 4, 12$ indicate. The distribution of the residuals is not much different from the normal distribution in either case.[7] In addition, Chow tests fail to reject parameter constancy over several break dates. Finally, I estimate the identical equation over a sample period ending two (three) years earlier in the case of Mexico (Canada) and find the fitted values track the actual series closely (see Figure 2).

Considering the instability in Mexico over the period—especially with regard to the exchange rate and Mexdollar market, the absence of this in Canada, and the *positive* relationship between dollarization and expected depreciation in the Canadian models, (5.2M) is evidence of convertibility risk associated with holding Mexdollars. This explanation, introduced above, is consistent with the anomalous relationship between MM and EM.

4. POTENTIAL ALTERNATIVE EXPLANATIONS AND ERROR-CORRECTION MODEL

It is useful to examine alternative explanations and methodological criticisms to see if this may reverse my conclusion above. Note first that because (5.2M) is derived from a particular VAR model, there may be an omitted variables problem. Also, tests indicating the presence of cointegration suggest that an error-correction model can improve the specification.

Adding Import Demand, Oil Prices, and Foreign Reserves

Consider four new variables. In logs, *IMP* = Mexican imports (in millions of dollars), *OILP* = oil prices (in dollars), and *FR* = foreign reserves (in billions of dollars), and in levels, *IUS* = three-month U.S. Treasury bill rate. I use their first differences because Stock-Watson tests (Table 2) indicate each contains a unit root in the level. Alternative explanations of the anomalous results are assessed by adding one of the four (in turn) to (5.2M).

One explanation for the demonstrated relationship between *EM* and *MM* has nothing to do with fear over full Mexdollar convertibility. Consider that Mexican firms

[6]I also examine a postal strike dummy variable in the Canadian models, but my results are unaffected by it. Daniel and Fried (1983) show that including this dummy reconciles Miles' (1978) and Choudri's (1982) results. I also consider lagged changes in U.S. T-bill rates in all models, but find no significance from them (see section 5).

[7]For example, in the Mexican case, twenty-seven of the residuals are larger than one standard error and four are greater than twice the standard error—precisely the numbers expected if the residuals were normally distributed. For RESC, the actual numbers are forty-one and seven; the expected numbers are forty-two and six.

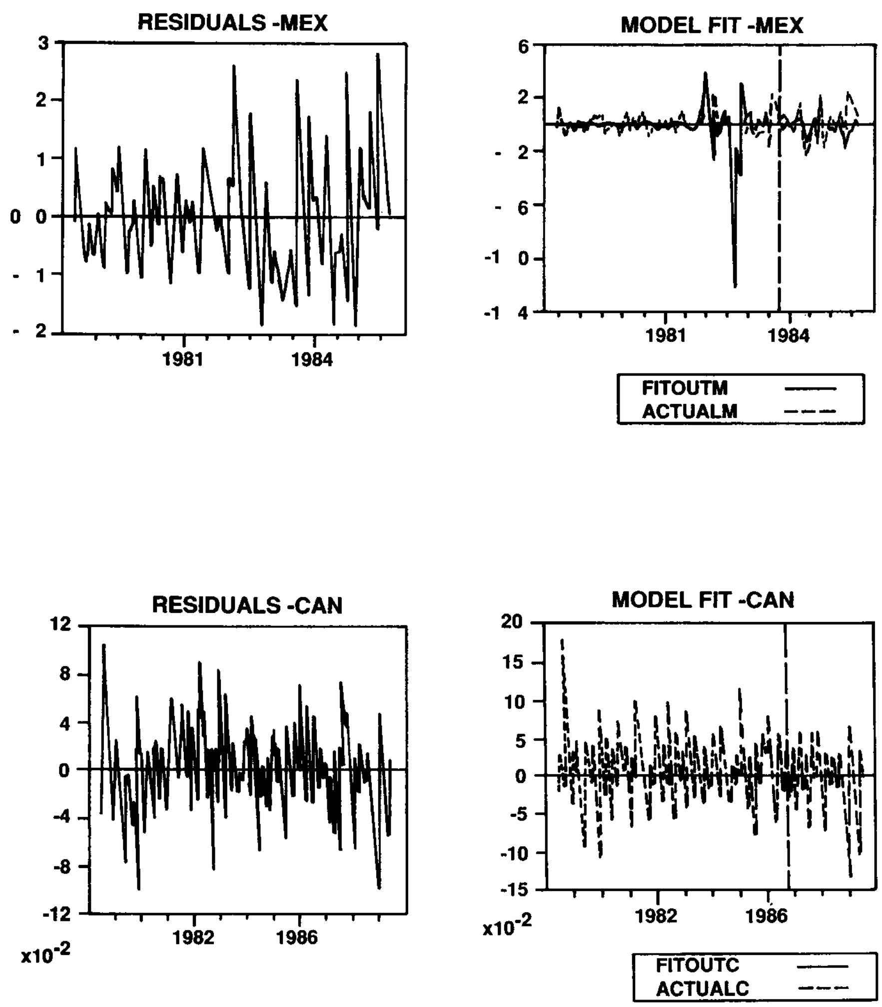

FIG. 2. Residuals and a Plot of Actual versus Fitted Values. Mexican and Canadian Sparse Parameterizations (5.2M and 5.2C)

relying on imports had to use all available dollars to continue operating despite a sharp drop in foreign borrowing beginning in 1981. Thus an external borrowing constraint that forced firms to run down their Mexdollar accounts perhaps caused *MM* to fall while *EM* was rising, implying that the results above are due to spurious correlation. After considering up to six lags of *DIMP* in (5.2M), I find the most significant result to be equation (5.3M). This reveals that lagged changes of imports are not very significant, and their inclusion in (5.2M) does not significantly affect the coefficients on lagged expected depreciation. Furthermore, adding lagged *DIUS* (which are always insignificant) has no effect on the results.

I next consider *OILP* and *FR*, whose movements reflect the strain on the government's ability to maintain the exchange rate system. Changes in oil prices affect the profitability of the state-owned PEMEX and so the receipts of the Mexican Treasury. The latter is a measure of the government's ability to defend the fixed exchange rate and preserve the value of the Mexdollars. The importance of movements in foreign reserves is noted in the introduction.

First, after adding lags of *DOILP*, I find (5.4M) fits best. All estimates have the same sign as in (5.2M) and remain significant, and the equation standard error is unchanged. Thus, the conclusion from the VAR and (5.2) is not reversed.[8] Second, in testing up to six lags of *DFR*, I find [see (5.5M)] the first two lags are highly significant and the standard error of the estimate falls by 5 percent from (5.2M). Note that the coefficients on De_{t-1} and De_{t-2} remain negative and only slightly less significant than in (5.2M). This indicates that lagged *De* and *DFR* are not highly collinear, and suggests that the convertibility risk hypothesis remains valid.[9]

Interpretations from an Error-Correction Specification

Engle-Granger (1987) tests for cointegration between *m*, *e*, and other variables provide mixed evidence (see Table 4), in light of which and the Johansen tests it is warranted to examine an error-correction model.[10] The error-correction models (5.6M) and (5.6C) are used with the cointegration regressions [(*COINM*) or (*COINC*) in Table 5] to test an implication of the conventional currency substitution hypothesis: *m* should fall when expected home-currency depreciation is high.

Consider a case in which the error term in (*COINM*), *ERRCM*, is positive. This occurs when expected peso depreciation is greater than the value of relative money demand implied by the long-run relationship. In this case, the negative coefficient on $ERRCM_{t-1}$ in (5.6M) indicates that *m* falls next period. Thus when last period's expected rate of peso depreciation is "high," there is a drop in the relative demand for Mexdollars between last period and this one. This result supports the convertibility risk hypothesis: higher expected peso depreciation coincides with an erosion of faith in the full convertibility of Mexdollars, and a drop in *m*. However, (*COINC*) and (5.6C) indicate support for the conventional currency substitution hypothesis in the Canadian case.

[8]One interpretation of the new coefficients is that falling oil prices signal additional strain on the exchange rate system, and lead to a drop in *m* because of the implied risk to the full convertibility of the Mexdollars. However, it is equally plausible to assert that Mexdollar balances move positively with changes in oil prices because international oil transactions are carried out in U.S. dollars. My conclusion holds under either.

[9]Estimating (5.5M) without De_{t-1} and De_{t-2} also indicates that lagged *De* and *DFR* are not highly collinear because the coefficients on lagged *DFR* below are essentially the same as they are in (5.5M):

$$Dm_t = \underset{(0.70)}{-0.85Di_{t-3}} \ \underset{(0.96)}{+0.93Di_{t-4}} \ \underset{(0.09)}{-0.24DFR_{t-1}} \ \underset{(0.13)}{-0.26DFR_{t-2}}; \ T = 88 \ \bar{R}^2 = .61 \ SEE = 0.113 \ .$$

[10]A discussion of error-correction models is in Hendry, Pagan, and Sargan (1984). Several papers employ the error-correction specification to model domestic money demand, including Rose (1985) and Domowitz and Hakkio (1990).

A "Final" Attempt to Invalidate the Convertibility Risk Hypothesis

Another explanation for the relationship between *EM* and *MM* that has nothing to do with fear over full Mexdollar convertibility might rely on credit controls and interest rate ceilings. Now, because dollar deposits had a 75 percent reserve requirement, banks often encouraged firms to hold peso-denominated checking accounts. Banks provided many services (such as payroll management) to firms with "reasonable" balances. In this way banks could "pay" market rates and not the ceiling imposed by the central bank. The negative relationship between *EM* and *MM* could be explained as a rise in *EM* that raises market interest rates, and thus the non-pecuniary services provided by banks, and leads to a rise in the *denominator* of *MM* as more firms try to acquire the "reasonable" level of peso demand deposits. Similarly, to "charge" market rates on loans, banks would ask firms to hold large sums of peso demand deposits as "collateral" (in some cases up to one-third of the loan). A rise in e results in a drop in m, according to the story, as more firms seek to borrow funds in the presence of interest rate ceilings.

These alternative explanations are quite plausible a priori. A testable implication is that movements in *MM* should be dominated by changes in peso deposits. The convertibility risk hypothesis suggests dominance by movements in Mexdollars. The individual components of *MM* are displayed in Figure 1 as "Mexdollars" (*NUM*) and "peso demand deposits" (*DEN*), both in real peso terms. I reestimate (5.2M) with the first difference of *NUM* and *DEN* as the dependent variable. Judging by the coefficients on lagged expected depreciation in equation (*NUM*) versus (*DEN*) in Table 5, the alternative explanations are not sufficient to explain the sharp drop in the dollarization ratio. Rather, these estimates support the convertibility risk hypothesis.

Additional Evidence Supporting the Convertibility Risk Hypothesis (5.7M)

The Chow tests reveal that when (5.2M) is estimated over the "early" subperiod(s) the coefficients on lagged expected depreciation are sometimes negative and sometimes positive (although in none of the six cases examined is the t-statistic larger than 2.0). When (5.2M) is estimated up to the break date of 1982:4, the first lag of *DEM* is positive with a t-statistic of 1.66 (and slightly higher when the second lag of *DEM* is excluded).

This suggests that Mexico's relative money demand equation looks more like that of Canada in periods when there is low convertibility risk. To test this I estimate (5.2M) with two interaction dummy variables, $DUM3DE1 = DUM3(t)*DEM(t-1)$ and $DUM3DE2 = DUM3(t)*DEM(t-2)$, where $DUM3$ = unity for all months up to and including 1982:4 and zero elsewhere. I use the first and second lags of *DEM* because these appear in (5.2M). It is seen from equation (5.7M) that the coefficient on *DUM3DE*1 is positive and significant, while adding these interaction dummies does not substantially influence either the negative coefficients on lagged *DEM* or the equation standard error. This provides supporting evidence for this paper, because the coefficient on *DUM3DE*1 shows that Mexico's relative money demand equation looks more like that of Canada in a period when there is low convertibility risk.

5. MODEL SELECTION AND ENCOMPASSING

It is important to examine how well my models approximate the true data-generating process relative to others in the literature. I focus on Mexico because of the anomalous results, but also comment on Canadian models.

A. Mexico

I estimate Ramirez-Rojas (1985) model with my data, and assess the roles of the (i) lag structure of the explanatory variables, (ii) preprocessing of the series, and (iii) estimation period, in producing our different results.

In column 1 of Table 6A I reproduce Ramirez-Rojas' equation (16), in which he finds evidence for the conventional currency substitution hypothesis employing quarterly data from 1977:I–1980:IV.[11] Column 2 shows that estimating Ramirez-Rojas' model with my monthly data from 1978:2–1980:12 produces nearly identical results: e_t is positive and significant, and the R^2 values are about the same. In columns 3 and 4 I display estimates of the same model over the periods 1981:1–1985:10 and 1978:2–1985:10, respectively. Most striking about columns 2–4 is the change in sign and significance of the coefficient on e_t across the two periods. In light of the unit roots tests, which suggest the results are from spurious regressions (Granger and Newbold 1974), I estimate the model in first differences (from 1978:2–1980:12), and display the results in the next column. The coefficient on De_t is positive and significant. However, the model is a restricted version of (5.1M), which I rejected due to dynamic misspecification. Thus, reestimating in first differences is not a fruitful approach to improving the rival specification.

Table 6A suggests that each of the three factors helps explain why my results differ from those of Ramirez-Rojas. Note that potential problems of spurious correlation, dynamic misspecification, and simultaneity bias are present in the rival model, unlike the Mexican sparse parameterizations which employ stationary time series, include only lagged terms as explanatory variables, and have serially uncorrelated residuals.

Concerning model selection and encompassing, notice the last four columns of table 6A—an estimate of my error-correction model using Ramirez-Rojas' estimation period. The equation standard error of my model is lower than that of Ramirez-Rojas. Also, my two-equation model predicts that relative demand for Mexdollars rises when expected peso depreciation is "high." Thus my error-correction model robustly predicts Ramirez-Rojas' results but the reverse is not true.

[11] Note that Ramirez-Rojas uses wholesale prices and forward exchange rates obtained from the Chicago Mercantile Exchange. Also, his money demand ratio includes savings and time deposits. Thus our data is not identical. Finally, relative money demand in Ramirez-Rojas is pesos over dollars, so to facilitate comparison I switch coefficient signs when reporting his results. For this reason I divide my estimate of e (and standard errors) by 100 in Table 6A.

TABLE 6A

MODEL COMPARISON: RAMIREZ-ROJAS

Dep. Var.	m^a	m^b	m^c	m^d	Chow Test
constant	−1.11(0.29)	−0.67(0.26)	−0.18(0.60)	−0.10(0.09)	
$m(-1)$	0.46(0.15)	0.71(0.12)	0.90(0.02)	0.92(0.03)	
e	0.03(0.01)	0.36(0.13)	−0.11(0.13)	−0.12(0.17)	
SEE	0.08	0.05	0.14	0.16	
R^2	.530	.542	.956	.946	$F(3,86) = 1.82$
DW	....	1.89	2.00	2.06	$p = 0.15$
H	−1.40	0.45	−0.03	−0.24	

Dep. Var.	Dm^e	m^f	Dm^g	Dm^h	Diagnostics^{g,h}
constant	....	−2.20(0.02)	....	....	Model (g):
$Dm(-1)$	0.08(0.17)	....	....	....	$n_1(1) = 0.49$
De	0.40(0.14)	....	....	....	$n_1(4) = 2.55$
EM	....	12.0(18.8)	....	....	$n_2(1) = 2.02$
$ERRC(-1)$	....	....	−0.31(0.12)	−0.35(0.11)	$n_2(4) = 12.6$
$De(-2)$	....	....	1.45(1.50)	....	
$Di(-3)$	....	....	0.14(0.16)	....	
$Di(-4)$	....	....	0.27(0.21)	0.31(0.18)	Model (h):
$DFR(-1)$	....	....	−0.77(0.31)	−0.66(0.32)	$n_1(1) = 0.32$
$DFR(-2)$	....	....	−0.67(0.29)	−0.68(0.31)	$n_1(4) = 1.13$
$DOILP(-1)$	....	....	0.19(0.11)	0.26(0.15)	$n_2(1) = 0.53$
SEE	0.06	0.08	0.05	0.05	$n_2(4) = 2.93$
R^2	.206	.011	.452	.432	
DW	2.07	0.60	2.20	2.11	

NOTES: Notation is as in the text; standard errors are in parentheses. (a) Taken from equation (16) of Ramirez-Rojas; data is quarterly from 1977:I–80:IV, with differences in data noted in text. (b) Model estimated with my monthly data, over 78:2–80:12. (c) As in note b, estimated over 78:2–85:10. (d) Model run for the subperiod 81:1–85:10; results of Chow (1960) test for parameter constancy are given in the next column. (e) Ramirez-Rojas' model estimated in first differences, over 78:2–80:12. (f) The cointegration regression used with (g) and (h). (g) My error correction model estimated over 78:2–80:12; robust standard errors are reported. (h) A reduced version of (g) [Autocorrelation and ARCH test statistics for (g) and (h) are in the last column].

B. Canada

Bordo and Choudri (1982) and Cuddington (1983) put forth evidence that currency substitution is insignificant in Canada, in contrast to Miles (1978). First, Bordo-Choudri and Cuddington find that estimates of Canadian money demand from 1970:IV–1979:IV are not improved by adding the forward premium. I find essentially the same when estimating the rival models over their sample period, as seen in the first four columns of Table 6B. However, the adjacent columns indicate significant fourth-order autocorrelation. Estimating the model in first differences removes much of the significance of the estimates, while autocorrelation remains present, as is true of a very similar model, (5.1M).[12]

The second piece of evidence relates to Cuddington's insight that it is difficult to distinguish currency substitution from capital mobility due to multicollinearity. Cuddington examines the effects on a conventional money demand equation of adding (i) the adjusted U.S. interest rate ($i^* + EC$) or i^* to represent capital mobili-

[12]In order to compare models, I add to my data set Canadian M1 and real GDP, extend the sample back to 1970, and switch to quarterly intervals. Because I use real GDP and deflate M1 by the CPI rather than the GNP deflator our data differs slightly. Daniel and Fried (1983) reconcile the conflicting results of Miles and Bordo-Choudri by emphasizing the effect of postal strikes (they do not discuss the role of nonstationarities). My Canadian models are offered in a similar spirit—as models robust to the potential problems of spurious correlation induced by regressing I(1) variables on each other.

TABLE 6B

MODEL COMPARISON: BORDO AND CHOUDRI, CUDDINGTON, AND MILES

Dep. Var.	*ml*[a]	*ml*[a]	*ml*[b]	*ml*[b]	Diagnostics	
					Model 1:	Model 2:
const	−1.19(−1.93)	−1.49(−2.27)	0.39(1.67)	0.39(1.63)		
y	.083(1.86)	0.11(2.21)	.065(2.10)	0.66(2.04)	$n_1(1)$ = 0.59	= 0.59
i	−0.65(−4.20)	−0.67(−4.36)	−.707(−3.18)	−.708(−3.13)	(.44)	(.44)
ml(−1)	0.87(12.8)	0.85(12.3)	0.89(16.7)	0.89(16.5)	$n_1(4)$ = 13.1	= 15.6
e	....	−0.21(−1.27)	....	−.008(−0.04)	(.01)	(.004)
SEE	.0149	.0148	.0162	.0164	$n_2(1)$ = 1.21	= 1.14
R^2	.926	.930	.964	.964	(.27)	(.28)
DW	2.32	2.39	2.19	2.19	$n_2(4)$ = 1.59	=1.56
h	−1.07	−1.31	−0.66	−0.63	(.81)	(1.82)
T	37	37	39	39		

Dep. Var.	*Dml*[b]	*Dml*[b]	Diagnostics	
Dy	0.24(1.42)	0.24(1.45)	$n_1(1)$ = 2.53	= 1.72
Di	−0.77(−1.74)	−0.79(−1.76)	(.11)	(.19)
Dml(−1)	0.28(1.64)	0.28(1.65)	$n_1(4)$ = 13.0	= 12.2
De	....	−0.23(−0.65)	(.01)	(.016)
SEE	.020	.020	$n_2(1)$ = 1.16	= 1.14
R^2	.048	.060	(.28)	(.29)
DW	2.11	2.08	$n_2(4)$ = 1.87	= 1.69
			(.76)	(.79)

NOTES: These are models by Cuddington (1983) and Bordo and Choudri (1982); *t*-stats are in parentheses. (a) From table 1 of Bordo and Choudri, quarterly from 70:IV–79:IV; the same results are found by Cuddington [regressions 1 and 4 of his table 1]. (b) My estimates of the Bordo and Choudri/Cuddington models in (a), using quarterly data from 1970:I–79:IV, as noted in the text.

ty, and (ii) *EC* to reflect currency substitution. He finds evidence of high capital mobility rather than currency substitution.

Evidence on this point is mixed, however. First, Daniel and Fried (1983, p. 621) carefully distinguish the effect of the forward premium from that of the covered foreign interest rate. They stress that ignoring the influence of postal strikes is the only modification that eliminates the significance of currency substitution. I add that it is desirable to require of these models an accounting for the nonstationarities in the individual series. Estimating in levels gives rise to potential spurious correlation, while a similar estimation strategy using first differences alters Cuddington's findings (and opens up the problems seen in (5.1M); results are available on request).[13]

The final point, made by Bordo and Choudri, is that Miles' (1978) model of Canadian relative money demand is misspecified due to omission of domestic interest rates and income, which are significantly different from zero and render insignificant the coefficient on the interest rate differential (Bordo and Choudri, table 2). I have shown in an earlier version of this paper that Bordo and Choudri's results are highly sensitive to the estimation period chosen (results are available on request); this is in addition to issues involving nonstationary time series. Also, Daniel and Fried's results are relevant here even though they do not estimate *relative* money demand.

[13]Cuddington is careful to consider first-order serial correlation in the estimates in all of his estimates, and finds none for the Canadian models.

6. CONCLUSION

I estimate models of the demand for U.S. dollars relative to domestic currency for both Mexico and Canada. In the Mexican case I find a *negative* and significant correlation between the ratio of Mexdollars to pesos and the expected rate of depreciation of the peso. This result is found in both multi-equation and single-equation models: reexamine (2M), (5.2M), (5.5M), and (*COINM*) with (5.6M). In the Canadian models the relationship is positive, as is inconsistent with the conventional currency substitution hypothesis.

Considering the policies directed at the Mexdollar accounts by the Mexican government, the timing and magnitude of the capital flight from Mexico, and the absence of such shocks in Canada, I conclude that holding Mexdollars was associated with convertibility risk. That is, when the central bank runs low on foreign reserves, all parties realize that it may not be possible to convert all Mexdollars into real dollars if desired. Hence, when dollar reserves approach a critical level and investors consider withdrawing from their Mexdollar accounts, the government reacts by converting Mexdollars into pesos. However, investors understand that the central bank may take this action, and so precipitate a run on Mexdollars as central bank reserves run low. Because this corresponds to periods in which the peso is expected to be devalued, higher expected depreciation is associated with a lower relative demand for Mexdollars. The opposite is true in estimates of relative money demand in Canada, where the absence of such risk provides a benchmark case.

My evidence has implications for applying speculative attack models [see Cumby and Van Wijnbergen (1989) and references] to the Mexican case. The models capture most of the salient features: excessive fiscal deficits and domestic credit growth, dwindling foreign reserves, and capital flight. However, three months before August 1982 there was a speculative run on the Mexdollars. The usual scenario in the literature on speculative attacks on a fixed exchange rate admits no role for assets like Mexdollars. However, because the Mexdollars played an important role in policy-making at the time of the attack, some account should be taken of them in the theoretical models.

There is an interesting question concerning generality. Is Mexico unique or does the convertibility risk hypothesis arise for other countries? This likely depends on whether dollar deposits are liabilities of the central bank and exchange rate policy is credible. Interesting cases would be Argentina, which recently reintroduced dollar-denominated accounts, and Israel.

In Israel, the counterpart asset to the Mexdollars is the Patam, which played an important role in monetary policy-making when Israel implemented a very successful heterodox stabilization program in July 1985. The large devaluation implemented at the outset of the plan and the declared policy of stabilizing the exchange rate sharply depressed the expected yields on foreign currency assets, while shekel interest rates were kept very high. This and some regulatory changes stimulated massive conversions of Patam into shekels. In the first few weeks of the plan, such conversions totaled NIS 1.25 billion, which was 2.5 times larger than the total monetary base in June 1985, according to the Bank of Israel. Such conversions were extremely worrisome to the Bank of Israel, which put forth an intensive effort to neutralize the effects of the conversions in order to avoid excessive credit growth at the outset of the stabilization. At this time, the black market premium on foreign exchange, which had been almost 30 percent in May, fell to near zero. Therefore, around the time of the stabilization at least, one would not expect to see the anomalous sign on the expected depreciation term. The crucial difference between Mexico and Israel is that exchange rate policy was credible (after the stabilization) in the latter. Many authors have attributed the success of the entire stabilization program to the fact that the exchange rate freeze credibly established a nominal anchor around which lower inflationary expectations rallied. I leave such extensions to further research.

LITERATURE CITED

Bernanke, Ben S. "Alternative Explanations of the Money-Income Correlation." *Carnegie-Rochester Series on Public Policy* 25 (1986), 49–100.

Blanco, Herminio, and Peter M. Garber. "Recurrent Devaluation and Speculative Attacks on the Mexican Peso." *Journal of Political Economy* 94 (February 1986), 148–66.

Bordo, Michael D., and Ehsan U. Choudri. "Currency Substitution and the Demand for Money: Some Evidence for Canada." *Journal of Money, Credit, and Banking* 14 (February 1982), 48–57.

Breusch, Trevor S., and Adrian R. Pagan. "The Lagrange Multiplier Test and Its Application to Model Specification in Econometrics." *Review of Economic Studies* 47 (1980), 239–54.

Calvo, Guillermo A., and Carlos A. Rodriquez. "A Model of Exchange Rate Determination under Currency Substitution and Rational Expectations." *Journal of Political Economy* 85 (June 1977), 617–25.

Chow, Gregory C. "Tests of Equality between Subsets of Coefficients in Two Linear Regressions." *Econometrica* 28 (1960), 591–605.

Cuddington, John T. "Currency Substitution, Capital Mobility and Money Demand." *Journal of International Money and Finance* (August 1983), 111–33.

Cumby, Robert E., and Sweder van Wijnbergen. "Fiscal Policy and Speculative Runs with a Crawling Peg: Argentina 1979–1981." *Journal of International Economics* 27 (1989), 111–27.

Cumby, Robert E., and Maurice Obstfeld. "Capital Mobility and the Scope for Sterilization: Mexico in the 1970s." In *Financial Policies and the World Capital Market,* edited by P. Aspe, R. Dornbusch, and M. Obstfeld. University of Chicago Press, 1983.

Daniel, Betty C., and Harold O. Fried. "Currency Substitution, Postal Strikes, and Canadian Money Demand." *Canadian Journal of Economics* 16 (November 1983), 612–24.

Domowitz, Ian, and Craig S. Hakkio. "Interpreting an Error Correction Model: Partial Adjustment, Forward-Looking Behaviour, and Dynamic International Money Demand." *Journal of Applied Econometrics* 5 (1990), 29–46.

Dornbusch, Rudiger. "Debt Problems and the World Macroeconomy." In *Developing Country Debt and Economic Performance,* edited by Jeffrey Sachs. National Bureau of Economic Research, 1987.

Engle, Robert F. "Autoregression Conditional Heteroscedasticity with Estimates of the Variance of U.K. Inflation." *Econometrica* 50 (1982), 987–1007.

Engle, Robert F., and Clive W. J. Granger. "Co-integration and Error Correction: Representation, Estimation, and Testing." *Econometrica* 55 (March 1987), 257–76.

Engle, Robert F., and Byung Sam Yoo. "Forecasting and Testing in Co-integrated Systems." *Journal of Econometrics* (May 1987), 143–59.

Fuller, Wayne A. *Introduction to Statistical Time Series*. New York: John Wiley, 1976.

Granger, Clive W. J., and P. Newbold. "Spurious Regressions in Econometrics." *Journal of Econometrics* 2 (1974), 111–20.

Hendry, David F. "Econometric Methodology: A Personal Perspective." Invited Address, 5th World Congress of the Econometric Society, January 1986.

Hendry, David F., Adrian R. Pagan, and J. D. Sargan. "Dynamic Specification." In *Handbook of Econometrics*, vol. 2, edited by Z. Grilliches and M. D. Intriligator. North Holland: Amsterdam, 1984.

Hodrick, Robert. "The Empirical Evidence on the Efficiency of Forward and Futures Foreign Exchange Markets." In *Fundamentals of Pure and Applied Economics*. Chur, Switzerland: Harwood Academic Publishers, 1987.

Ize, Alain, and Guillermo Ortiz. "Political Risk, Asset Substitution, and Exchange Rate Dynamics: The Mexican Financial Crisis of 1982." Mimeographed, August 1984.

Johansen, Soren, and Katarina Juselius. "Maximum Likelihood Estimation and Inference on Cointegration—with Applications to the Demand for Money." *Oxford Bulletin of Economics and Statistics* 52 (1990), 169–210.

King, Robert, Charles Plosser, James Stock, and Mark Watson. "Stochastic Trends and Economic Fluctuations." University of Rochester, November 1989.

Miles, Marc A. "Currency Substitution, Flexible Exchange Rates, and Monetary Independence." *American Economic Review* 68 (June 1978), 428–36.

Ortiz, Guillermo. "Currency Substitution in Mexico: The Dollarization Problem." *Journal of Money, Credit, and Banking* 15 (May 1983), 174–85.

Ortiz, Guillermo, and L. Solis. "Currency Substitution and Monetary Independence: The Case of Mexico." In *The International Monetary System under Flexible Exchange Rates: Global, Regional and National*, edited by R. Cooper, P. Kenen, J. De Macedo, and S. Ypersele, ch. 14, 1982.

Ramirez-Rojas, Carlos L. "Currency Substitution in Argentina, Mexico, and Uruguay." *International Monetary Fund Staff Papers* 32 (December 1985), 629–67.

Rose, Andrew K. "An Alternative Approach to the American Demand for Money." *Journal of Money, Credit, and Banking* 17 (November 1985), 439–55.

Stock, James, and Mark Watson. "Testing for Common Trends." *Journal of the American Statistical Association* 83 (December 1988), 1097–1107.

White, Halbert. "A Heteroscedasticity Consistent Covariance Matrix and a Direct Test for Heteroscedasticity." *Econometrica* 48 (May 1980), 817–38.