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Testing the Efficiency of the Canadian-U.S. Exchange Market under the Assumption of no Risk Premium

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ABSTRACT

The efficiency of the Canadian-U.S. exchange market for the current float is examined more extensively than previously. Semi-strong-form tests which admit the lagged spot rate as a predictor are considered in addition to the standard weak-form test. These stronger tests reject the joint null hypothesis of an efficient exchange market and no risk premium for the period ending in October 1976, although not for the entire period. For almost every year the current spot rate provided a better forecast of the future spot rate than did the current forward rate.

THERE IS NOW AN extensive empirical literature on testing the efficiency of various foreign exchange markets (see [16] for a survey). Yet almost all of these tests are weak-form tests or tests of the bias of the forward exchange rate as a predictor of the future spot rate. Such tests in the Canadian-U.S. exchange market can be found in the work of Porter [20], Eastman [5], Kaserman [10], Kohlhagen [11], Cornell [3], and Levich [14]. For the Canadian float of the 1950s, Porter [20] and Kaserman [10] found that one could not reject the unbiasedness of the forward rate. Eastman [5] and Kohlhagen [11] rejected the unbiasedness of the forward rate for the floating period, although not for the subsequent fixed period, but their use of overlapping contracts means that their standard errors are biased. Cornell [3] and Levich [14] found that in terms of the root-mean-squared error criterion the lagged spot rate and the lagged forward rate predicted the current spot rate equally well for more recent periods.

This paper examines the efficiency of the Canadian-U.S. exchange market for the current float (July 1970 to December 1978) in a more extensive way than it has been previously examined. From the weak-form test the paper proceeds to two semi-strong-form tests which admit the lagged spot rate as a possible predictor. Throughout the paper various subperiods are considered in addition to the period as a whole.

I. Tests of Exchange Market Efficiency

London [17] has shown that for the Canadian-U.S. exchange market the 30-day forward rate is an unbiased predictor of the 30-day future spot rate using end of month data. Table I presents the results of regressions of the form $s_t = a_1 + a_2 f_{t-1}$

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Table I

$$s_t = a_1 + a_2 f_{t-1}$$

Period	a_1	a_2	D.W.	S.E.R.	F^a
70.7–78.12	.0004	1.0227	2.17	.0111	.63
	(.0012)	(.0233)			
71.1–78.12	.0006	1.0231	2.20	.0114	.79
	(.0013)	(.0238)			
71.1–72.12	−.0006	.9221	1.58	.0054	.53
	(.0011)	(.0933)			
73.1–74.12	−.0008	.8767	1.48	.0074	.71
	(.0020)	(.1129)			
75.1–76.12	−.0006	.7293	1.97	.0159	1.69
	(.0033)	(.1531)			
77.1–78.12	.0097	.9597	2.24	.0120	3.19
	(.0060)	(.0587)			
71.1–76.10	−.0012	.9225	1.33	.0070	1.69
	(.0009)	(.0521)			

[a] For null hypothesis $a_1 = 0$, $a_2 = 1$. None is significant. Standard errors in brackets.

where s_t is the logarithm of the spot rate and f_t is the logarithm of 30-day forward rate, with end of month data for the entire period 1970.7 to 1978.12 and for various subperiods.[1]

For the period as a whole one cannot reject the hypothesis that the forward rate is an unbiased predictor of the future spot rate (a weak-form test), although on average the future spot rate is above the forward rate. The Durbin-Watson statistic indicates that there is no information to be found in first-order autocorrelation.

There are no two-year subperiods for which the null hypothesis can be rejected. However, for the period of little variation in the spot rate (71.1 to 76.10), the Durbin-Watson statistic is low, and the spot rate was consistently below the prediction made by the forward rate.

One semi-strong form test for efficiency tests whether the change in the spot rate is on average equal to the lagged forward premium. Such a test is performed by Porter [20] for earlier Canadian data and by Tryon [23] for several other countries. Table II presents the results of logarithmic regressions of the form

$$s_t - s_{t-1} = a_1 + a_2(f_{t-1} - s_{t-1}).$$

For the period as a whole one cannot statistically reject the hypothesis that

[1] The periods looked at were chosen for the following reasons:

(a) 1970.7–1978.12 includes all of the data which is relevant to the floating period.

(b) 1971.1–1978.12 omits the first six months, when the exchange rate might have been "settling down."

(c) 1971.1–1972.12, 1973.1–1974.12, 1975.1–1976.12, and 1977.1–1978.12 are the four two-year subperiods within (b) which allow one to examine whether things which were true for long-period of time also prevailed for lengthy subperiods.

(d) 1971.1–1976.10 includes the period when the exchange rate fluctuated in a fairly narrow range. The election of a separatist-leaning party in the Quebec election of 1976.11 might be considered the event which sparked a reappraisal of the underlying determinants of the value of the Canadian dollar.

Table II

$(s_t - s_{t-1}) = a_1 + a_2 (f_{t-1} - s_{t-1})$

Period	a_1	a_2	t for $a_2 = 1$	D.W.
70.7–78.12	.0013	.0521	−1.371	2.13
	(.0012)	(.6916)		
71.1–78.12	.0017	−.0937	−1.525	2.17
	(.0012)	(.7172)		
71.1–72.12	−.0007	−1.1908	−1.860[a]	1.92
	(.0010)	(1.1868)		
73.1–74.12	−.0014	−1.3377	−1.570	2.00
	(.0020)	(1.4892)		
75.1–76.12	.0037	−1.3071	−1.025	2.34
	(.0061)	(2.2500)		
77.1–78.12	.0063	.5094	− .21	2.27
	(.0031)	(2.3330)		
71.1–76.10	−.0002	−.9470	−4.158[b]	1.84
	(.0008)	(.4683)		

[a] Significantly different from zero at 90 percent in a two-tailed test.

[b] Significantly different from zero at 95 percent in a two-tailed test. The F-statistic for the null hypothesis ($a_1 = 0$, $a_2 = 1$) for this period is 9.35, significant at 99 percent. All other time periods have Fs which are not significant at 95 percent.

the forward premium is an unbiased predictor of the change in the spot rate, but it is clear that the evidence *in favor* of the forward premium being unbiased is very weak. Indeed, it seems that the exchange rate itself being modeled as a martingale is more in keeping with the data. (That is, $E(s_t \mid f_{t-n}, s_{t-n}) = s_{t-n}$: the current spot rate is an unbiased predictor of the future spot rate).

In the first three two-year subperiods the forward premium consistently takes the wrong sign and for the period preceding 76.10 the coefficient a_2 is significantly less than *zero*.[2] For the last two-year subperiod the coefficient on the forward premium is positive, but the constant is significantly different from zero at about a 95 percent level of significance.

As the forward premium seems to have little to do with the change in the spot rate, perhaps the current spot rate itself is a better predictor of the future spot rate than is the forward rate. To test whether use of the spot rate would significantly lower the forecast error variance the following regression was run, representing the spot rate as a weighted average of the lagged forward rate and lagged spot rate:

$$s_t = a_1 + a_2 f_{t-1} + a_3 s_{t-1}.$$

[2] The coefficient is surprisingly close to −1 and thus is analogous to the findings of Hamburger and Platt [9] for the U.S. Treasury bill market that the change in the 3-month Treasury bill rate is negatively correlated with the lagged difference between the forward rate (implicit in the 6-month Treasury bill rate) and 3-month Treasury bill rate, with a coefficient close to −1. This result is also analogous to that found by Shiller [21] for the U.S. and British bond markets and by Freedman [8] for the Canadian bond market. In order to equate holding period yields for long-term and one-period bonds, if the current long rate differs from the current short rate a capital gain (or loss) must be expected. Thus the change in the long rate (under efficient markets) should be positively related to the lagged interest rate differential. Shiller and Freedman both find a significant *negative* impact.

If the market is efficient, then a_2 will not be significantly different from 1 and a_3 will not be significantly different from 0. On the other hand if expectations are static, a_2 will be near 0 and a_3 will be near 1. (A similar classification is to be found in Bilson [1]). Regression results are found in Table III.

Again, for the period as a whole, one cannot reject the hypothesis that the forward rate is an unbiased predictor of the future spot rate, but the more reasonable hypothesis might be that the current spot rate is an unbiased predictor of the future spot rate, and that the forward rate adds nothing. Indeed for the period prior to the Quebec election the null hypothesis $a_3 = 0$ is strongly rejected, as it is for the two first two-year subperiods at 95 percent and for the third two-year subperiod at 90 percent. Although for the final two-year subperiod one cannot reject $a_3 = 0$, the constant term is again significant.

Further evidence that for much of the time period the current spot rate does just as well as the forward rate at forecasting the future spot rate may be found in Table IV, where root mean square errors of the two types of forecasts are compared. It is clear from the table that with the exception of 1977, the current spot rate has been a better predictor of the future spot rate than has the forward rate. One might argue that interest-rate differentials between Canada and the U.S. have traditionally been small and so forward and spot rates have not differed by much and thus the results in Table IV are essentially meaningless. But interest-rate differentials exceeded 1 percent from 1975.8–1977.9 (they peaked at over 4½ percent in 1976.3). For this period the spot rate still did better than the forward rate.

If the spot rate was a better predictor of the future spot rate than was the forward rate, then there must have been a way to sell forward and buy future spot or vice versa so that over the period, on average, one would make money. The pure speculator who bought Canadian dollars forward (and sold them at the maturity of his forward contract) when the current forward rate was above the current spot rate, and who sold Canadian dollars forward (buying them at maturity of his forward contract) when the current forward rate was below the current spot rate, would have made profits in all but one of the 2-year subperiods.

II. Conclusion

Statistical tests reject the joint null hypothesis of an efficient exchange market and no risk premium for the period of relative stability in the exchange rate up to October 1976. The addition of the next 26 months of increased exchange-rate volatility makes it impossible to reject the null hypothesis for the period as a whole. With the exception of 1977, the current spot rate was found to provide a better forecast of the future spot rate (in terms of root mean square error) than the current forward rate.[3] The Canadian–U.S. exchange market remains a puzzle.

[3] Cornell [3] found that for the sample period April 1973 through January 1977, the lagged spot rate was a better forecaster than the forward rate for five of seven currencies (relative to the U.S. dollar). For the Canadian dollar the lagged spot and forward rates did equally well over that period, he found. Cornell fails to discuss the significance of these results for market efficiency, however. Levich [14] found that for the 1967–75 period the lagged spot rate did better than the one-month forward rate for seven of nine currencies including the Canadian dollar.

Table III

$$s_t = a_1 + a_2 f_{t-1} + a_3 s_{t-1}$$

Period	a_1	a_2	a_3	t on $a_3 = 0$
70.7–78.12	.0008	.0990	.9224	1.332
	(.0013)	(.6940)	(.6926)	
71.1–78.12	.0012	−.0461	1.0678	1.4866
	(.0013)	(.7196)	(.7183)	
71.1–72.12	−.0005	−2.3480	3.1723	2.576[b]
	(.0010)	(1.2722)	(1.2315)	
73.1–74.12	−.0047	−2.5342	3.3252	2.210[b]
	(.0026)	(1.5468)	(1.5046)	
75.1–76.12	.0089	−3.4531	4.0833	1.881[a]
	(.0059)	(2.2283)	(2.170)	
77.1–78.12	.0289[b]	−6.0048	6.8165	1.587
	(.0134)	(4.3899)	(4.2963)	
71.1–76.10	−.0005	−1.0508	1.9682	4.2672[b]
	(.0008)	(.4648)	(.4612)	

[a] Significantly different from zero at 90 percent in a two-tailed test.

[b] Significantly different from zero at 95 percent in a two-tailed test.

Table IV

Root Mean Square Errors of Forecasts of S_t by S_{t-1} and F_{t-1}

Period	RMSE BY S_{t-1}	RMSE BY F_{t-1}
70.7–78.12	.011507[a]	.011562
71.1–78.12	.011774[a]	.011844
71.1–72.12	.005015[a]	.005263
73.1–74.12	.006847[a]	.007125
75.1–76.12	.016119[a]	.016448
77.1–78.12	.014922	.014564[a]
71.1–76.10	.006634[a]	.007251
77.1–77.12	.014163	.013333[a]
78.1–78.12	.015644[a]	.015699
75.8–77.9	.016348[a]	.016374

[a] Lower RMSE. (RMSEs were calculated from levels, not logs).

Speculators looking at economic variables such as deviations from purchasing power parity and relative money supplies could have made extraordinary profits in the case of the Canadian dollar, as those two variables indicated that it was overvalued in 1976.[4] This is the type of apparent inefficiency that is of direct concern to policy makers. In the absence of sufficient speculative funds with a

[4] As Mussa [19] has pointed out, speculators in the Canadian-U.S. foreign exchange market had for a long time a firm anchor for expectations—the exchange rate did not vary much from parity with the U.S. dollar. Perhaps the market continued to believe that the long-run exchange rate was parity even though normal unit labor costs were growing more rapidly in Canada than in the United States (1973–76).

long-term horizon, a case can be made for official intervention in the foreign exchange market.[5]

REFERENCES

1. John F. O. Bilson. "The 'Speculative Efficiency' Hypothesis." NBER Working Paper No. 474, April 1980.
2. John F. O. Bilson and Richard M. Levich. "A Test of the Forecasting Efficiency of the Foreward Exchange Rate." Mimeo: January 1978.
3. W. Bradford Cornell. "Spot Rates, Forward Rates and Exchange Market Efficiency." *Journal of Financial Economics* (August 1977), pp. 55–66.
4. W. Bradford Cornell and J. Kimball Dietrich. "The Efficiency of the Market for Foreign Exchange Under Floating Exchange Rates." *Review of Economics and Statistics* (February 1978), pp. 111–20.
5. Harry C. Eastman. "The Hedging of Commercial Transactions Between U.S. and Canadian Residents: A Canadian View." In *Canadian-United States Financial Relationships*, Federal Reserve Bank of Boston Conference Series No. 6, 1971.
6. Eugene F. Fama. "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance* (May 1970), pp. 383–417.
7. Eugene F. Fama and Merton H. Miller. *The Theory of Finance*. Holt, Rinehart and Winston, 1972.
8. Charles Freedman. "Long-Term Bond Rates, Martingales and Efficient Markets." Mimeo: Bank of Canada, 1979.
9. Michael J. Hamburger and Elliott N. Platt. "The Expectations Hypothesis and the Efficiency of the Treasury Bill Market." *Review of Economics and Statistics* (May 1975), pp. 190–99.
10. D. L. Kaserman. "The Forward Exchange Rate: Its Determination and Behavior as a Predictor of the Future Spot Rate." *Proceedings of the American Statistical Association,* 1973, pp. 417–22.
11. Steven W. Kohlhagen. "The Forward Rate as an Unbiased Predictor of the Future Spot Rate." Mimeo: University of California (Berkeley), 1974.
12. Steven W. Kohlhagen. *The Behavior of Foreign Exchange Markets—A Critical Survey of the Empirical Literature*. Monograph: Solomon Brothers Center for the Study of Financial Institutions, New York University, 1978-3.
13. Richard M. Levich. "Further Results on the Efficiency of Markets for Foreign Exchange." In *Managed Exchange Rate Flexibility: The Recent Experience*. FRB Boston Conference Series No. 20, October 1978.
14. Richard M. Levich. "Tests of Forecasting Models and Market Efficiency in the International Money Market." In *The Economics of Exchange Rates*, eds. J. A. Frenkel, H. G. Johnson. Addison-Wesley, 1978.
15. Richard M. Levich. "Analyzing the Accuracy of Foreign Exchange Advisory Services: Theory and Evidence." Mimeo: New York University, prepared for the Conference on Exchange Risk and Exposure at N.Y.U., February 1979.
16. Richard M. Levich. "On the Efficiency of Markets for Foreign Exchange." In *International Economic Policy, Theory and Evidence*, eds. R. Dornbusch, J. A. Frenkel. Johns Hopkins University Press, 1979.
17. Anselm London. "The Efficiency of the Canada-U.S. Foreign Exchange Market." Mimeo: Bank of Canada, 1978.
18. Ronald I. McKinnon. "Floating Foreign Exchange Rates 1973–74: The Emperor's New Clothes." In *Institutional Arrangements and the Inflation Problem*, eds. K. Brunner, A. H. Meltzer. Carnegie-Rochester Conference Series, Vol. 3. Amsterdam: North-Holland, 1976.

[5] McKinnon [18] has hypothesized that the reason for the large variance in exchange rates has been the absence of large amounts of capital available for speculation over time horizons longer than a day or two. Two reasons for this may be that banks themselves rarely take speculative positions over long time periods and banks often choose not to write forward contacts for those they believe to be speculators.

19. Michael Mussa. "Our Recent Experience with Fixed and Flexible Exchange Rates: A Comment." In *Institutional Arrangements and the Inflation Problem.* See fn. 18.
20. Michael G. Porter. "A Theoretical and Empirical Framework for Analyzing the Term Structure of Exchange Rate Expectations." *IMF Staff Papers* (November 1971), pp. 613–45.
21. Robert J. Shiller. "The Volatility of Long-Term Interest Rates and Expectations Models of the Term Structure." *Journal of Political Economy* (December 1979), pp. 1190–1219.
22. Jeremy J. Siegel. "Risk, Interest Rates, and the Forward Exchange." *Quarterly Journal of Economics* (May 1972), pp. 303–309.
23. Ralph Tryon. "Testing for Rational Expectations in Foreign Exchange Markets." International Finance Discussion Papers No. 139: Board of Governors of the Federal Reserve System, 1979.