THE SPOT-FORWARD EXCHANGE RATE RELATION AND INTERNATIONAL MARKET CONDITIONS

Matt McPherson, Gonzaga University
John Vilasuso, West Virginia University

ABSTRACT
This paper examines whether the relation between spot and forward exchange rates is stable, and if not, the implications for international market conditions. We document structural breaks for the U.S. and U.K. currencies vis-a-vis the Canadian dollar. We consider two applications in an effort to determine the consequences of this structural change in international asset and goods markets. First, we find that the dynamic structure linking stock return volatility across countries is affected by change in the spot-forward relation, and second the elasticity of Canadian import demand with respect to spot exchange rates has also been affected by this change.

INTRODUCTION

Since the collapse of the Bretton Woods system of fixed parities in the early 1970s, the forward exchange rate has assumed a primary role in hedging against fluctuations in future spot exchange rates. The effectiveness of hedging currency risk, however, depends in part on the relation between spot and forward exchange rates. If, for example, the forward rate is used to predict future spot exchange rates, then instability in the spot-forward exchange rate relation produces larger forecast errors. Tong (1996) and Briys and Solnick (1992) show that in the context of a dynamic hedging model, larger forecast errors reduce the benefits of hedging currency risk. [1] Consequently, structural change in the spot-forward exchange rate relation may affect trade in international asset and goods markets. The objectives of this paper are thus twofold. First, we empirically examine whether the long-run relation between spot and forward exchange rates is stable over the post-Bretton Woods era,[2] and second we explore the implications for international market conditions should the spot-forward relation exhibit structural change.

Stability of the spot-forward exchange rate relation is examined using the test developed by Hansen (1992) based on the fully modified estimator of Phillips and Hansen (1990). This methodology is particularly appealing in exchange rate studies for a number of reasons. First, we focus on the long-run or cointegrating relation between spot and forward exchange rates. Because numerous studies support the claim that these series are cointegrated, the regressor is necessarily endogenous.[3] The fully modified estimator - in contrast to ordinary least squares - corrects for endogeneity bias.[4] Second, there is no need to specify a priori the timing of structural change. Instead, the testing methodology evaluates the (alternative) hypothesis of a break of unknown timing.

[1] The effects of instability in the spot-forward exchange rate relation can also be interpreted in terms of a risk premium. In the absence of news, for example, larger forecast errors are associated with a higher risk premium (see, e.g. Fama 1984). This is confirmed in empirical studies by Wolff (1987) and Nijman, Palm, and Wolff (1993) who report that approximately half of the forecast error is due to variation in the risk premium.

[2] Surprisingly little work has examined whether the spot-forward exchange rate relation is stable. One exception is a recent paper by Sakoulis and Zivot (1999). Sakoulis and Zivot focus on the forward premium and document multiple structural breaks. A key difference between this work and our paper is that we empirically estimate the long-run relation between spot and forward exchange rates, rather than restricting it to be a $(1-1)'$ cointegrating vector.

[3] See, for example, Hakkio and Rush (1989), Liu and Maddala (1992), Naka and Whitney (1995), and Norrbin and Reffett (1996).

[4] Norrbin and Reffett (1996) also recognize the effects of invalid exogeneity assumptions on cointegration analysis.

This is a more reasonable description of post-Bretton Woods exchange rate data as it would be difficult to justify a particular break date a priori. And third, because we focus on the cointegrating relation between the spot and forward rate, inference may be complicated due to serial correlation or heteroskedasticity which is commonly detected in exchange rate data (see, e.g. Bollerslev 1990; Fong and Ouliaris 1995). The fully modified testing methodology eliminates concern as it includes a robust estimator of the covariance matrix.

We document a structural break in the long-run relation between spot and forward exchange rates for both the U.S. and U.K. currencies vis-a-vis the Canadian dollar. And perhaps more important, we find that these structural breaks have important implications for international asset and goods market conditions. The first application we explore concerns the correlation between international stock market volatility. Bodart and Reding (1999) study the impact of the exchange rate regime - and the accompanying degree of exchange rate volatility - on the correlation between time-varying stock market volatilities. Here, we adopt their methodology and ask whether return volatility is also effected by the nature of the spot-forward exchange rate relation. Empirical results find that this is indeed the case, suggesting that volatility linkages between international stock markets depend in part on the spot-forward exchange rate relation.

The second application we consider is bilateral trade flows. Because the effectiveness of hedging currency risk depends in part on the relation between spot and forward exchange rates, a structural break is expected to affect the sensitivity of imports to currency values. We follow the empirical specification presented by Deyak, Sawyer, and Sprinkle (1993), but augment the import demand model to allow for the influence of a structural break in the spot-forward exchange rate relation. Empirical results show that a structural break does affect the elasticity of Canadian import demand with respect to exchange rates.

The remainder of the paper is organized as follows. In the next section we present a brief outline of Hansen's (1992) structural break test and report results for the country pairs Canada-U.S. and Canada-U.K. In Section 3, we explore two applications in an effort to determine whether a break in the spot-forward exchange rate relation affects international return volatility correlations and import demand. The final section concludes and discusses possible avenues for future research.

THE SPOT-FORWARD EXCHANGE RATE RELATION

This section is divided into two parts. In the first part, we present a brief description of the structural break test developed by Hansen (1992), and in the second part, we apply this technique to Canadian exchange rate data for the post-Bretton Woods period.

A. Structural Stability Test

Hansen's (1992) structural stability test is based on the fully modified (FM) estimator developed by Phillips and Hansen (1990). The FM parameter estimates are obtained in two steps. In the first step, ordinary least squares (OLS) is used to obtain an initial estimate of the parameter vector, and in the second step, a semiparametric adjustment is made to correct for parameter bias induced by endogeneity of the regressors. The importance of the semiparametric adjustment is alluded to by Banerjee et. al. (1986) who present Monte Carlo evidence that OLS parameter bias can be large in finite samples.

Let s_t and f_t be the spot and forward exchange rate, respectively. Also, suppose that each series is I(1) which is almost unanimously reported in recent exchange rate studies. A cointegrating relation is captured by $s_t = A x_t + u_t$ (1)

where $x_{t'} = (1 \; f_t)$ for $t = 1,...,T$ and $A = [a_0 \; a_1]$. Let $\Delta f_t = v_t$ such that v_t is a mean-zero covariance stationary series. Following the notation presented by Hansen (1992), define $z_{t'} = (u_t \; v_t)$ and the matrices

$$\Omega = \lim_{T \to \infty} \frac{1}{T} \sum_{t=1}^{T} \sum_{j=1}^{T} E(z_j z_{t'}) \quad \text{and} \quad \Lambda = \lim_{T \to \infty} \frac{1}{T} \sum_{t=1}^{T} \sum_{j=1}^{t} E(z_j z_{t'}). \tag{2}$$

Partitioned with conformity with z_t, let

$$\Omega = \begin{bmatrix} \Omega_{uu} & \Omega_{uv} \\ \Omega_{vu} & \Omega_{vv} \end{bmatrix} \quad \text{and} \quad \Lambda = \begin{bmatrix} \Lambda_{uu} & \Lambda_{uv} \\ \Lambda_{vu} & \Lambda_{vv} \end{bmatrix}. \tag{3}$$

Finally, define

$$\Omega_{u.v} = \Omega_{uu} - \Omega_{uv} \Omega_{vv}^{-1} \Omega_{vu} \quad \text{and} \quad \Lambda_{vu}^{+} = \Lambda_{vu} - \Lambda_{vv} \Omega_{vv}^{-1} \Omega_{vu}. \tag{4}$$

The term $\Omega_{u.v}$ is the long-run variance of u_t conditional on v_t, and Λ_{vu}^{+} measures the extent of parameter bias due to endogeneity of f_t.

In the first step, we use OLS to obtain parameter estimates of the cointegrating vector $\hat{A}$ and the residuals $\hat{z}_{t'} = (\hat{u}_t \;\; \Delta f_t)$. In the second step, estimates of the matrices shown in (3) are obtained. This is accomplished by estimating a VAR for pre-whitened values of $\hat{z}_{t'}$, and estimates of $\hat{\Omega}$ and $\hat{\Lambda}$ are obtained by recoloring. The FM estimator of the cointegrating vector is

$$\hat{A}^{t} = \left[\sum_{t=1}^{T} s_t^{+} x_t^{'} - \left(0 \hat{\Lambda}_{vu}^{+'}\right) \right] \left[\sum_{t=1}^{T} x_t x_t^{'} \right]^{-1} \tag{5}$$

where $s_t^{+} = s_t - \hat{\Omega}_{uv} \Omega_{vv}^{-1} v_t$. The FM residuals are then $u_t^{+} = s_t^{+} - \hat{A}^{+} x_t$.

The possibility of a structural change in the cointegrating relation is evaluated using a Wald-type test. For example, suppose a change occurs at time τ such that $A_t = A_1$ for $t \leq \tau$, and $A_t = A_2$ for $t > \tau$. If the timing of the break is known, then the null hypothesis $A_1 = A_2$ is evaluated using

$$F_{nt} = tr\{ S_{n't} V_{nt}^{-1} S_{nt} \hat{\Omega}_{u.v}^{-1} \} \tag{6}$$

where

$$S_{nt} = \sum_{m=1}^{t} (x_m \hat{u}_m^{+'} - (0 \;\; \hat{\Lambda}_{vu}^{+})'), \quad V_{nt} = M_{nt} - M_{nt} M_{nn}^{-1} M_{nt}, \quad \text{and} \quad M_{nt} = \sum_{m=1}^{t} x_m x_{m'}.$$

Essentially, F_{nt} is a Wald test where A_1 and A_2 correspond to subsample parameter estimates and the full sample variance is used to construct the test statistic. If the timing of the break is unknown - as is usually the case in practice - then the null hypothesis is evaluated using $SupF = sup_{(t/T) \in \Theta} F_{nt}$

(7)

where Θ is a compact set of (0,1). In the empirical work to follow, we follow the suggestion of Andrews (1991) and set $\Theta = [0.10, 0.90]$. Critical values for $SupF$ are tabulated by Hansen (1992). As noted by Hansen, the $SupF$ test is appropriate for examining the existence of an abrupt change in the long-run relation between spot and forward exchange rates.

B. Empirical Results
Data were obtained from Statistics Canada and consist of monthly spot and 90-day forward exchange rates for the U.S. and the U.K. currencies vis-a-vis the Canadian dollar. The sample begins on June 1970 which corresponds to the official date beginning the floating period. The data end in December 1999.

Unit root tests (not shown) find that spot and forward exchange rates are I(1), which is consistent with previous studies. Plots of F_{nt} are shown in Figures 1 and 2. Estimates are based on prewhitening $\hat{z}_t$ using a VAR(1). Heteroskedastic and autocorrelation consistent estimates of $\hat{\Omega}$ and $\hat{\Lambda}$ use a Barlett kernel where the bandwidth parameter is set according to the guidelines presented by Andrews (1991). The 5-percent critical value for $SupF$ is also shown. Beginning with results for the U.S. dollar shown in Figure 1, the $SupF$ test points to the existence of a statistically significant structural break in the spot-forward exchange rate relation at the 5-percent level. A break is also evident for the U.K. currency as Figure 2 illustrates that the $SupF$ statistic exceeds its 5-percent critical value.

The magnitude of the $SupF$ statistics along with p-values are collected in Table 1. P-values are computed using the polynomial approximation provided by Hansen (1992). The timing of the break is also reported which corresponds to the date at which F_{nt} achieves its maximum value. In the case of the U.S. currency, the break in the spot-forward exchange rate relation occurs in March 1975, while the break date for the U.K. currency occurs almost two years later: February 1977.

FM parameter estimates of the intercept (a_0) and the slope (a_1) terms included in the vector A are collected in Table 2. For comparison, OLS estimates are also shown. Differences between the estimated parameters is due to endogeneity bias associated with OLS estimation. That is, parameter differences can be attributed to the semiparametric adjustment shown in expression (5) for the FM estimator that corrects for endogeneity bias. For the full sample shown in panel A, the effects of regressor endogeneity are more apparent for the U.K. currency. For example, the intercept term is almost five times larger when FM estimation is used. In contrast, endogeneity bias is negligible for the slope parameter as the FM and OLS estimates are almost identical.

To examine the influence of the structural breaks, we re-estimate the spot-forward exchange rate relation for the subperiods defined by the break dates shown in Table 1. Parameter estimates are shown in panels B and C of Table 2. For both FM and OLS estimation, there are notable differences in the parameter estimates. Results for the U.K. currency for the two subperiods are consistent with the work of Sakoulis and Zivot (1999) on the forward premium.[5] For instance, the restriction that spot and forward exchange rates are linked by a $(1\text{-}1)'$ cointegrating vector is not rejected for each subperiod. In this case, observed differences in the estimated values of the intercept term can be interpreted as structural change in the forward premium. Parameter estimates for the subperiods are also very different for the U.S. dollar. But in the case of the U.S. dollar, both the slope and intercept change. For example, the null hypothesis that U.S. spot and forward exchange rates are linked by a $(1\text{-}1)'$ cointegrating vector is rejected, and the restriction that slope estimates are the same across subperiods is also rejected for both estimation methods. In addition, the estimated value of the intercept term is also statistically different across subperiods.

APPLICATIONS

Our objective in this section is to determine whether the detected breaks in the spot-forward exchange rate relation have affected conditions in international asset and goods markets. Two applications are considered in turn.

A. *International Stock Market Correlations*
In a recent paper, Bodart and Reding (1999)

[5] A key result presented by Sakoulis and Zivot (1999) is that structural change in the forward premium may explain the forward premium puzzle. This anomaly refers to the common finding that the forward exchange rate is not an unbiased predictor of future spot exchange rates (see Engel 1996 for a review of this literature). Sakoulis and Zivot show via Monte Carlo simulations that if a true structural change is ignored, then a rejection of the forward rate unbiasedness hypothesis may be traced to parameter bias.

show that for a sample of European countries, the exchange rate regime influences the correlation between asset return volatilities. In this part, we adopt their methodology and ask whether a structural break in the spot-forward relation has affected cross country stock market volatility correlations. A bivariate GARCH(1,1) model is specified:

$$r_t = \mu + \rho r_{t-1} + e_t \tag{8}$$

$$r_t^* = \mu^* + \rho^* r_{t-1}^* + e_t^* \tag{9}$$

$$h_t = k + \gamma e_{t-1}^2 + \eta h_{t-1} \tag{10}$$

$$h_t^* = k^* + \gamma^* (e_{t-1}^*)^2 + \eta^* h_{t-1}^* \tag{11}$$

$$h_t^{ij} = [r + \xi B_t]\,[h_t h_t^*]^{1/2} \tag{12}$$

where r_t are Canadian returns, r_t^* are foreign returns (either U.S. or U.K.), and $\varphi_t \_ N(0, H_t)$ where $\varphi_{t'} = (e_t \;\; e_t^*)$ and $vech(H_t) = (h_t \;\; h_t^{ij} \;\; h_t^*)'$. We adopt the constant correlation specification of Bollerslev (1990) as shown in (12), but also include the influence of structural change in the spot-forward relation which is captured by the parameter ξ. An indicator variable B_t is used such that we set $B_t = 1$ before the break dates shown in Table 1, and $B_t = 0$ otherwise. Note that if $\xi = 0$, the model reduces to the constant correlation, r, specification.

The model is estimated using quasi-maximum likelihood. Stock return data consist of monthly index returns including dividends, and were obtained from the Morgan Stanley database. Parameter estimates are shown in Table 3. Focusing on ξ, empirical results support the claim that cross-country return volatility correlations are affected by structural change in the spot-forward exchange rate relation at the 5-percent significance level for the U.K., and at the 10-percent level for the U.S.[6]

This influence, however, is very different for the country pairs. Bodart and Reding (1999) suggest that theory can explain both a positive and a negative estimate of ξ. During periods of high exchange rate volatility, contagion effects are more likely due to noise trading or herd behavior. Therefore, investors are more apt to use international markets to discern domestic market conditions, and a positive relation between asset market volatility correlation and exchange rate volatility is anticipated. On the other hand, consider a situation where exchange rate volatility is lower, possibly due to credible interventionist policies. In this situation, fundamentals are more important which ultimately leads to greater volatility correlation, thereby supporting an inverse relation. For the exchange rates examined here, we find statistically significant higher exchange rate volatility after the break dates. Specifically, squared (log differences) spot exchange rates are higher following the break in the spot-forward exchange rate relation (not shown). Results then summarized in Table 3 are consistent with the 'fundamentals' explanation for the U.S. market, but results for the U.K. are supportive of the 'contagion' explanation. In any event, empirical evidence summarized in Table 3 illustrates that the relation between spot and forward exchange rates in part shapes volatility patterns observed in international stock markets.[7]

B. Import Demand

In this part we estimate Canadian import demand both before and after the break date in the spot-forward exchange rate relation. Because the change in the spot-forward exchange rate relation influences the effectiveness of hedging, we focus on whether the sensitivity of import demand to spot exchange rates has changed. The empirical model is due to Deyak, Sawyer, and Sprinkle (1993)

---

[6] The bivariate GARCH(1,1) model appears to adequately fit the data. Ljung-Box tests applied to the squared standardized residuals do not indicate the presence of statistically significant serial correlation.

[7] As noted by Bodart and Reding (1999), it is possible that a volatility effect - correlations between markets is higher due to higher stock market volatility - is driving the main results reported in Table 3. To check this, we estimated univariate GARCH(1,1) models for each index return series both before and after the break dates reported in Table 1. We find no evidence that return volatility is higher since the break date at conventional significance levels.

$$\ln m_t = b_0 + b_1 \ln y_t + b_2 \ln p_t + b_3 \ln p_t^* + b_4 \ln s_t + \sum_{2}^{12} \delta_i D_i + v_t \qquad (13)$$

where m_t is real Canadian imports, y_t is real domestic income measured by the Canadian industrial production index, p_t is the domestic price measured by the Canadian wholesale price index, p_t^* is the foreign price measured by the foreign wholesale price index, s_t is the spot exchange rate (measured as units of foreign currency per Canadian dollar), D_i is a set of monthly seasonal dummies, and v_t is a mean-zero disturbance term.[8] Import and exchange rate data was obtained from Statistics Canada. Remaining data was obtained from the IFS database.

The Canadian import demand equation for the U.S. is augmented to include the influence of trade agreements and major changes in tax policy. We include the indicator variable NAFTA to capture the effects of the North Amercan Free Trade Agreement in 1996. The trade agreement variable takes on a value of one after the agreement is in place and zero before. We also include the variable GST to pick up the influence of the Goods and Service Tax (GST). The GST variable is equal to one after the GST was put in place, and zero before. Our reasoning for including this variable is that Canadian imports include travel spending which has been shown to be influenced by the introduction of the GST, and in the case of the U.S., Canadian travel spending has at times accounted for almost 10 percent of Canadian merchandise imports (Vilasuso and Menz 1998). In contrast, Canadian travel spending in the U.K. is negligible, and as a result, the GST indicator variable is not included in the estimated import demand equation.

Parameter estimates are collected in Table 4.[9]

The import elasticity with respect to spot exchange rates is very different across subperiods. For each estimated import demand equation, the volume of Canadian imports appears largely unaffected by spot exchange rates before the break in the spot-forward exchange rate relation, as parameter estimates are not significantly different from zero. But following the break dates, import demand is significantly related to spot exchange rates. These finding are consistent with the notion that the effectiveness of hedging currency risk in the forward market is reduced, making import demand more sensitive to spot exchange rates.[10]

CONCLUSION

Using the structural break test developed by Hansen (1992), we document a statistically significant change in the spot-forward exchange rate relation for the U.S. and U.K. currencies vis-a-vis the Canadian dollar. One implication of the structural break is that the effectiveness of hedging currency risk is affected, which has important implications for conditions in international asset and goods markets.

In this paper we explore two applications to illustrate this point. The first application concerns the correlation between return volatility across international stock markets. We find that the dynamic structure linking international stock market volatility is affected by change in the spot-forward exchange rate relation. The second application investigates Canadian import demand. Because the effectiveness of hedging is affected by structural change in the spot-forward exchange rate relation, it is reasonable to conjecture that the import elasticity with respect to spot exchange rates has also changed. Empirical evidence does indeed support this claim.

The results of this paper can be extended in a number of ways. For example, recent studies suggest that working with disaggregated trade data may yield important insights. McKenzie (1999), in a survey of the literature, reports that restricting import demand elasticities across commodities is often rejected. At

[8] Consistent with the work of Deyak, Sawyer, and Sprinkle (1993), we find that the variables included in (13) are I(1) and evidence of a cointegrating relation (not shown). Thus, we also estimate the model in level form.

[9] Consistent with the work of Senhadji and Montenegro (1999) on trade flows, there is little difference between OLS and FM parameter estimates for the import demand model. As a result, we report OLS estimates so as to facilitate comparison with existing studies. See Deyak, Sawyer, and Sprinkle (1993) for a review of this empirical literature.

[10] Parameter estimates for the remaining determinants are in line with those reported by Deyak, Sawyer, and Sprinkle (1993). Also consistent with their work, we find that consumers respond differently to changes in domestic prices and foreign prices, therefore rejecting homogeneity in prices.

the very least, the sensitivity of import demand to exchange rates is likely to differ between durable and nondurable goods (see, e.g. Lee 1999). Another extension involves delving more deeply into asset market conditions to determine how 'fundamentals' and 'contagion' effects are translated across international stock markets. We leave these topics for future work.

REFERENCES

Andrews, D.W.K., 1991. Heteroskedasticity and autocorrelation consistent covariance matrix estimation. Econometrica 59, 817-858.

Banerjee, A., Dolado, J. J., Hendry, D. F., Smith, G. W., 1986. Exploring equilibrium relationships in econometrics through static models: Some Monte Carlo evidence. Oxford Bulletin of Economics and Statistics 48, 253-277.

Bodart, V., Reding, P., 1999. Exchange rate regime, volatility and international correlations on bond and stock markets. Journal of International Money and Finance 18, 133-151.

Hakkio, C.S., Rush, M., 1989. Market efficiency and cointegration: An application to the Sterling and Deutschemark exchange markets. Journal of International Money and Finance 8, 75-88.

Hansen, B.E., 1992. Tests for parameter instability in regressions with I(1) processes. Journal of Business & Economic Statistics 10, 321-335.

Lee, J., 1999. The effect of exchange rate volatility on trade in durables. Review of International Economics 7, 189-201.

Liu, P.C., Maddala, G.S., 1992. Rationality of survey data and tests for market efficiency in the foreign exchange markets. Journal of International Money and Finance 11, 366-381.

McKenzie, M.D., 1999. The impact of exchange rate volatility on international trade flows. Journal of Economic Surveys 13, 71-106.

Naka, A., Whitney, G., 1995. The unbiased forward rate hypothesis re-examined. Journal of International Money and Finance 14, 857-867.

Nijman, T.E., Palm, F.C., Wolff, C.C.P., 1993. Premia in forward foreign exchange as unobserved components: A note. Journal of Business & Economic Statistics 11, 361-365.

Norrbin, S.C., Reffett, K.L., 1996. Exogeneity and forward rate unbiasedness. Journal of International Money and Finance 15, 267-274.

Bollerslev, T., 1990. Modeling the coherence in short-run nominal exchange rates: A multivariate generalized ARCH model. Review of Economics and Statistics 72, 498-505.

Bollerslev, T., Wooldridge, J. M., 1992. Quasi-maximum likelihood estimation and inference in dynamic models with time varying covariances. Econometric Reviews 11, 143-172

Briys, E., Solnick, B., 1992. Optimal currency hedge ratios and interest rate risk. Journal of International Money and Finance 11, 431-445.

Deyak, T.A., Sawyer, W.C., Sprinkle, R.L., 1993. The adjustment of Canadian import demand to changes in income, prices, and exchange rates. Canadian Journal of Economics 26, 890-900.

Engel, C., 1996. The forward discount anomaly and the risk premium: A survey of recent evidence. Journal of Empirical Finance 3, 123-191.

Fama, E.F., 1984. Forward and spot exchange rates. Journal of Monetary Economics 14, 319-338.

Fong, W.M., Ouliaris, S., 1995. Spectral tests of the martingale hypothesis for exchange rates. Journal of Applied Econometrics 10, 255-271.

Phillips, P.C.B., Hansen, B.E., 1990. Statistical inference in instrumental variables regression with I(1) processes. Review of Economic Studies 57, 99-125.

Sakoulis, G., Zivot, E., 1999. Time-variation and structural change in the forward discount: Implications for the forward rate unbiasedness hypothesis. University of Washington Working Paper.

Senhadji, A.S., Montenegro, C.E., 1999. Time series analysis of export demand equations: A cross-country analysis. IMF Staff Papers 46, 259-273.

Tong, W.H.S., 1996. An examination of dynamic hedging. Journal of International Money and Finance 15, 19-35.

Vilasuso, J., Menz, F., 1998. Domestic price, (expected) foreign price, and travel spending by Canadians in the United States. Canadian Journal of Economics 31, 1139-1153.

Wolff, C.C.P., 1987. Forward foreign exchange rates, expected spot rates, and premia: A signal-extraction approach. Journal of Finance 42, 395-406.

Table 1. Structural break test results

Currency vis-a-vis the Canadian Dollar	*SupF*	Break Date
U.S. Dollar	14.46 (0.02)	March 1975
British Pound	12.61 (0.05)	February 1977

Notes: P-values of the *SupF* test are shown in parentheses. The break date coincides with the timing of *SupF*.

Table 2. Parameter estimates

	Intercept		Slope	
Sample Period	FM	OLS	FM	OLS
A. June 1970 - Dec. 1999				
U.S. Dollar	0.020	0.017	0.996	0.997
	(0.02)	(0.01)	(0.01)	(0.01)
British Pound	0.023	0.005	0.995	0.998
	(0.02)	(0.02)	(0.02)	(0.01)
B. June 1970 - Break Date				
U.S. Dollar	0.297	0.305	0.935	0.934
	(0.15)	(0.15)	(0.03)	(0.03)
British Pound	-0.055	-0.089	1.008	1.015
	(0.03)	(0.03)	(0.01)	(0.01)
C. Break Date - Dec. 1999				
U.S. Dollar	0.115	0.089	0.977	0.982
	(0.01)	(0.01)	(0.01)	(0.01)
British Pound	0.013	0.007	0.997	0.998
	(0.02)	(0.02)	(0.01)	(0.01)

Notes: Estimation methods are fully modified (FM) and ordinary least squares (OLS) estimation. The subsamples are defined by the break dates shown in Table 1. Robust standard errors are shown in parentheses.

Table 3. Bivariate GARCH(1,1) parameter estimates

Parameter	U.S. Dollar	British Pound
μ	0.014* (0.00)	0.011* (0.00)
ρ	-0.117* (0.05)	-0.004 (0.06)
μ^*	0.011* (0.00)	0.014* (0.00)
ρ^*	-0.019 (0.05)	-0.055 (0.05)
k	0.001* (0.00)	0.001* (0.00)
γ	0.103* (0.04)	0.159* (0.04)
η	0.593* (0.18)	0.580* (0.12)
k^*	0.001* (0.00)	0.001* (0.00)
γ^*	0.154* (0.05)	0.118* (0.03)
η^*	0.577* (0.11)	0.841* (0.03)
r	0.730* (0.02)	0.603* (0.03)
ξ	0.064 (0.04)	-0.222* (0.09)

Notes: GARCH(1,1) parameter estimates are based on (quasi) maximum likelihood estimation. Bollerslev and Wooldridge (1992) standard errors are shown in parentheses. A '*' indicates statistical significance at the 5-percent level.

Table 4. Import demand parameter estimates

	Imports from U.S.		Imports from U.K.	
Variable	1970-1975	1975-1999	1970-1977	1977-1999
Constant	-0.281 (0.54)	-0.490 (0.31)	0.307 (0.82)	-3.422* (0.57)
$\ln y_t$	1.290* (0.19)	1.713* (0.06)	0.519* (0.22)	1.883* (0.16)
$\ln p_t$	1.898 (1.00)	0.266 (0.19)	0.574 (0.31)	0.775* (0.30)
$\ln p_t^*$	-1.600 (0.98)	-0.439* (0.20)	-0.498 (0.39)	-1.121* (0.26)
$\ln s_t$	0.847 (0.75)	0.223* (0.07)	0.020 (0.20)	0.759* (0.10)
GST		0.153* (0.01)		
NAFTA		0.078* (0.01)		

Notes: Parameter estimates are obtained from OLS estimation. Standard errors are shown in parentheses. A '*' indicates significance at the 5-percent level.

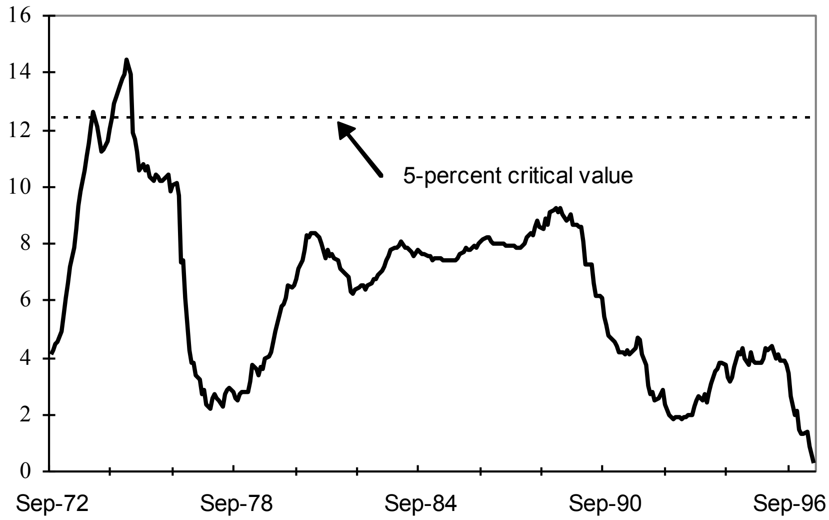

FIGURE 1. F_{nt} statistics for Canada/U.S. exchange rates.

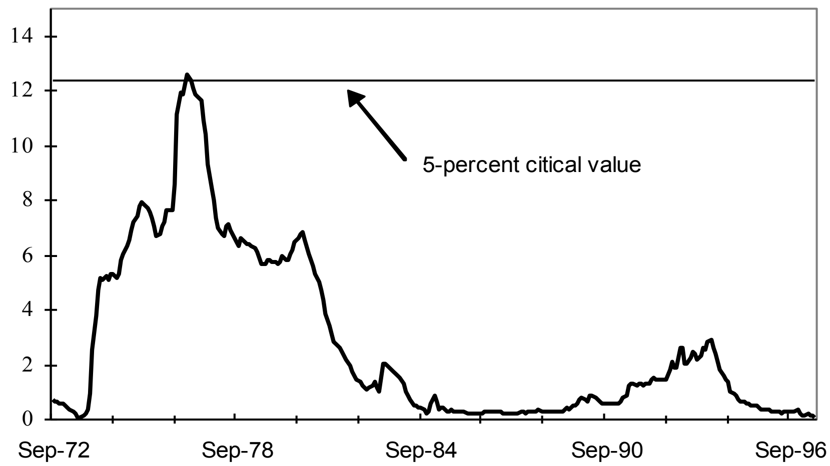

FIGURE 2. F_{nt} statistics for Canada/U.K. exchange rates.