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LONG-TERM COVERED INTEREST PARITY AND THE INTERNATIONAL SWAP MARKET

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This paper examines the pricing of long-term forward exchange contracts. It is established empirically that the traditional covered interest arbitrage pricing relationship is often violated, and that the behaviour of long- and short-term forward exchange rates is substantively different. It is argued that activity in the international currency and interest rate swap markets provides a potential explanation for the observed "mispricing". In particular, fixed-to-fixed currency swaps provide another form of arbitrage which can affect long-term forward exchange pricing.

1. INTRODUCTION

In recent years, a number of key innovations have emerged in the international capital markets. Of interest to this paper are the currency and interest rate swaps being used in the primary issue market for international bonds and the long-term forward contracts available in the foreign exchange market. The volume and amounts outstanding for these instruments, especially swaps, have experienced explosive growth since the early 1980s.[1] In addition to the major European and North American currencies, swaps are regularly done in Japanese yen as well as in Australian, New Zealand and Hong Kong dollars. In conjunction with the development of swaps, an active market in long-term forward currency contracts for the major currencies has also emerged.[2] The central objective of this paper is to explore the role that currency and interest rate swap trading plays in determining long-term forward exchange rates. Empirically, it is demonstrated that deviations from long-term covered interest parity differ substantively from short-term deviations. It is argued that the nature of swap dealing provides a potential explanation for the observed differences in the market behaviour of long- and short-term forward exchange rates.

In what follows, Section 2 provides institutional background on currency and interest rate swaps. The relevant instruments are described and rationales for usage discussed. The relationship between swaps and long-term forward contracts is also examined. Section 3 develops the requisite covered interest arbitrage conditions required to calculate the devia-

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1. The *International Financing Review* provides useful information on the details of specific offerings.
2. This paper follows the usual market convention and defines "long-term" to refer to maturities greater than one year.

tions of observed forward rates from arbitrage values. Possible explanations for deviations from theoretical arbitrage conditions are discussed. Section 4 presents a number of relevant empirical results, both on the distributional properties of the short- and long-term deviations and on certain regression specifications. Institutional factors are proposed to explain why the deviations from covered interest arbitrage for long-term forward contracts exhibit significantly different behaviour from deviations for short-term forwards. Finally, Section 5 summarises the important results contained in the paper.

2. INSTITUTIONAL BACKGROUND

Historically, swap financing evolved from the shortcomings associated with parallel and back-to-back loans.[3] While initially motivated by security and accounting difficulties arising from borrowing in different currencies, by the early 1980s it was widely recognised that swaps could be used for numerous purposes. With the growth of swap financing, intermediaries have been willing to take initially unmatched, *ie*, dealer, swap positions. The result has been a liquid market where various types of swap quotes are available on a regular basis. In turn, this has permitted increasingly sophisticated swap trades to be executed, while at the same time requiring techniques for hedging the temporary dealer swap risk to be "engineered". To facilitate the standardisation of swap terms, the International Swap Dealers Association (ISDA) has been formed by the major players.[4]

While a number of variations on swap financing are possible, the basic principle of a swap is an exchange of cash flows which are deemed to be equal in value at the time the swap is initiated. Given this prerequisite, two basic types of swap are available: the currency swap and the interest rate swap.[5] In an interest rate swap, the net cash flows being exchanged are based on fixed and floating interest rate borrowings. One borrower issues fixed rate debt and exchanges the resulting periodic net debt payments with another borrower issuing floating rate debt. A currency swap involves exchanging net cash flows arising from debt issues denominated in different currencies. Principal values are exchanged at initiation and maturity, typically at the same exchange rate. In practice these basic types of swaps are often combined, resulting in an exchange of borrowings in

3. Useful discussion of the early history can be found in Price and Henderson (1988) and Antl (1986). While a number of proprietary swap deals were done prior to 1981, the first widely publicised deal was a currency swap between IBM and the World Bank. Among other factors, swaps are an important legal advance over parallel and back-to-back loans which are governed by securities law, in which default provisions are unclear. Swaps fall within the realm of contract law in which default provisions are more straightforward.
4. To facilitate the increased liquidity in the swap market, the ISDA has provided a uniform set of definitions and contracts to standardise swap trading (ISDA, 1987, 1991). The growth of swap dealing has recently experienced a setback with a series of United Kingdom legal decisions voiding swap contracts entered into by local councils.
5. Various developments and combinations on these general types of swaps, not considered here, are possible, *eg*, cross-currency floating-to-floating interest rate. Antl (1986), Price and Henderson (1988), Miron and Swannell (1991) and IFR (1989) provide more indepth discussion of the various types. Swap trading techniques can be used in asset, as well as liability, management, *eg*, by combining a domestic fixed rate bond purchase with a swap. In addition, various combinations of swaps can be combined in "completing" a given, intermediated transaction.

different currencies which can involve either fixed or floating interest rates. To establish the connection between swaps and long-term forward exchange rates, it is useful to consider the relationship between a currency swap and a fully hedged foreign borrowing.

In a fixed-to-fixed currency swap, an agreed upon (usually spot) foreign exchange rate applicable to the closing date governs the exchange of principal at initiation and maturity, as well as the periodic net interest payments. In turn, the fixed periodic net payments are determined by negotiations, usually based on the interest differential in the different currencies prevailing at the time of closing, *ie*, the issuer subject to the highest interest rate will usually receive the net payment. On the other hand, in a fully hedged foreign borrowing, there is no counterparty. The borrowing is made directly in the target currency and the principal is exchanged into the desired currency at the current spot rate. The resulting (fixed) coupon payments and return of principal are then fully hedged using the forward market. In addition to generating a different sequence of cash flows from a currency swap, this type of borrowing also depends on the availability of the appropriate forward exchange quotes.

Ignoring the issue of long-term forward market liquidity, there are often practical benefits to doing currency swaps instead of fully hedged borrowings. For example, in many countries investor preferences favour domestic credits, *eg*, in Switzerland or Japan a well-known domestic corporation is likely to get a significantly lower borrowing rate than, say, a United States or Canadian corporation which does not have a substantial international reputation. A similar situation could prevail in reverse in the United States or Canada. In this case, borrowers requiring funding in foreign currency can exploit the borrowing advantage in their domestic market and swap into the desired currency, thereby significantly reducing foreign borrowing costs for both issuers.[6] In a fully hedged borrowing, which can be used either to acquire domestic or foreign funds, the "counterparty" is the forward foreign exchange market. Hence, the potential to exploit funding advantages arising from differential credit assessments is only indirectly available, *ie*, insofar as these benefits are reflected in long-term forward exchange rates. In the case of a fully hedged (foreign) borrowing to acquire domestic funds, credit assessment may have a negative effect.

In addition to funding advantages arising from differential credit assessments across countries, there are a number of other factors which could favour a currency swap over a fully hedged borrowing. For example, the ability to structure a currency swap as a series of foreign exchange transactions instead of as a foreign borrowing can lead to accounting and taxation advantages, both for the borrower and, particularly in the case of banks, for lenders (*eg*, Hull 1987, 1989). Other possible factors favouring a currency swap could include: the borrowing corporation wanting to conserve forward exchange lines of credit for other purposes; favourable pricing, *ie*, given the borrower's view of future exchange rates and interest rates (in the case of cross-currency interest rate swaps), the swap may be cheaper; and finally, regulatory restrictions imposed on overseas borrowings can be avoided.

6. A variation of differential credit assessment is differential credit spread compression. In this case, there are intercountry differences in the short- and long-term borrowing rate spread between strong and weak credits. Such differentials would generate cross-currency swap opportunities.

This latter case is becoming less important as many countries, *eg*, France and Japan, have significantly reduced both exchange controls and regulations governing capital flows.

3. PRICING OF LONG-TERM FORWARD EXCHANGE CONTRACTS

There is an intimate connection between the pricing of currency swaps and long-term forward exchange contracts. To see this, consider a currency swap of a Canadian for a United States dollar liability, both involving fixed interest rates. For one of the parties, this requires receiving Canadian and paying United States dollars, with all payments being predetermined when the swap is created. In turn, it is possible to sell an equivalent Canadian dollar payment stream forward for United States dollars. If the resulting present value of the *net* (currency swap minus forward sale) United States dollar cash flows is positive, an "arbitrage" opportunity has been created. In effect, fixed-to-fixed currency swaps can be regarded as a portfolio of forward exchange contracts. However, because the currency swap transaction is structured differently from a long-term forward exchange contract, the value of the "forward" contract embedded in the swap will typically differ from that observed in the forward exchange market. This creates the potential for arbitrage trading by intermediaries.

While it is possible to consider the pricing of long-term forward exchange contracts using the arbitrage relationship to currency swaps, there is another more traditional approach. Specifically, except for the maturity dating, long- and short-term forward exchange contracts are contractually identical. However, in practice there are important differences. While it has been possible to arrange long-term forward exchange transactions at least since the 1960s, until the 1980s the market was quite illiquid. Currently, even though there are active long-term forward markets in the major currencies out to ten years, the volumes traded are insignificant compared to those in short-term forwards. More importantly for present purposes, unlike short-term contracts where the "simple-interest-based" pricing formulae are well-known (*eg*, Stigum, 1981, Mahajan and Mehta, 1986), there is no universally accepted pricing mechanism for long-term forward contracts (*eg*, Antl (1986), chp III.3). Among other reasons, this is due to an inability to determine the interest rate at which the coupon payments and principal should be compounded.

To see this, consider extending the traditional short-term covered interest arbitrage pricing formula to an N year forward contract:

$$FF_N = \left\{ \frac{(1 + r_N)}{(1 + r_N^*)} \right\}^N S \qquad (1)$$

where FF_N is the N year (theoretical) *arbitrage consistent* forward exchange rate in domestic direct terms, S is the spot exchange rate in domestic direct terms, r_N is the N year domestic interest rate and r_N^* is the N year foreign interest rate.[7]

The arbitrage underlying equation (1) involves, say, a Eurobank accepting an N year interbank deposit in domestic (foreign) currency, converting at the spot exchange rate and making an N year interbank deposit in foreign (domestic) currency. This transaction is

7. "Domestic direct terms" is defined as units of domestic currency to units of foreign currency.

simultaneously covered by buying (selling) the domestic currency N periods forward using an N year forward exchange contract. This is a straightforward extension of covered interest arbitrage for money market securities. Insofar as N year deposit rates are available, this arbitrage should determine the long-term forward exchange rate. However, relative to the volume in the swap markets, the supply of long-term Eurodeposits is limited. Among other reasons, this is both because banks do not typically want to commit funds for such long periods and because investors have a wide range of competing zero coupon instruments.[8]

Given the pricing of long-term forward exchange contracts indicated by covered interest arbitrage, consider how activities in the swap market could impact forward exchange pricing. Assuming that market conditions dictate an imbalance between lenders' and borrowers' desire for debt offerings in a given currency, swap dealers will acquire residual, *ie*, unmatched and possibly variable, future foreign exchange positions. Because many swap dealers are banks, some of the risks associated with unmatched positions can be reduced by natural hedges which are available through regular banking activities. For example, this would be the case for a domestic bank providing a counterparty in a cross-currency interest rate swap involving a borrower issuing foreign currency floating rate debt and swapping into fixed rate domestic debt. This position could be matched with a floating-to-floating cross-currency swap and a fixed-to-floating domestic interest rate swap. The latter position could potentially be matched using the bank's domestic activities. However, the cross-currency (basis) swap position may present some difficulties.

While there are a number of potential methods for banks (and other swap market dealers) naturally to hedge a portion of the risk associated with unmatched swap positions, such opportunities are complicated when foreign exchange exposure, floating interest payments and the wide range of possible swap structures are considered (*eg*, Miron and Swannell, 1991). In this vein, long-term forward exchange contracts provide a direct hedging vehicle for intermediaries to handle residual foreign exchange risks. If it is not possible to offset the (undesired) risk using other means, it is always possible to offer forward exchange quotes which are sufficient to induce arbitrageurs or fully hedged borrowers to provide offsetting trades. Given that the intermediaries in the swap market are also the primary market makers in the long-term forward exchange market, there is considerable potential for swap market activity to affect long-term forward pricing.

4. EMPIRICAL RESULTS

Based on the discussion in Sections 2 and 3, there may be institutional reasons for long-term forward exchange rates to deviate from "arbitrage" values as calculated by equation (1). For example, this could arise due to the imbalances in dealer swap positions resulting from strong investor demand for bonds in a specific currency coupled with reluctance of borrowers to issue in that currency. In this case, dealers may seek to hedge

8. An additional complication in the analysis is that short-term covered interest arbitrage is typically executed using *short-term* currency swaps that combine the spot and forward exchange transactions (*eg*, Clinton 1988). However, as outlined in Section 2, long-term currency swaps are not structured in the same form as short-term swaps — which only involve an initial and a terminal cash flow.

out their residual positions using the long-term forward exchange market. In the absence of active covered interest arbitraging of forward rates in the deposit market, dealers may quote forward rates aimed at inducing hedging trades. However, whatever the dealer trading strategies may be, in the absence of a sufficiently liquid supply of long-term Eurodeposits in the currencies involved, covered interest arbitrage activity will not be capable of keeping long-term forward rates in line with values indicated by equation (1).

This raises an empirical question: do actual long-term forward rates differ from values consistent with covered interest arbitrage? To examine this issue, market closing data were taken from the *Globe and Mail* and the *Wall Street Journal* from 3 July 1990 to 28 December 1990. The spot rate and the long-term forward exchange rates selected are the United States/Canadian dollar with maturities of three, five, seven and ten years. While it is possible to get long-term Eurodeposit rates for United States dollars, due to a lack of liquidity this is not possible for Euro-Canadian deposits. As a result, in order to calculate deviations from arbitrage values as given by (1), appropriately dated United States Treasury notes and Government of Canada bonds were selected.[9] In order to minimise the impact of coupon size, the notes and bonds selected were those in the relevant maturity ranges which were trading closest to par.[10]

Taking r to be the Canadian rate and r* to be the United States rate and measuring the exchange rates in Canadian direct terms, then (1) can be manipulated to calculate the implied deviations of *observed* forward rates (defined as F_N) from covered interest arbitrage values, *ie*:

$$r_N - r_N^* - \left\{\left(\left[\frac{F_N}{S}\right]^{1/N} - 1\right)\left(1 + r_N^*\right)\right\} = \text{deviation}_N \qquad (2)$$

Measured in this fashion, deviations reflect the difference between Canadian interest rates and fully hedged United States interest rates. In this case, a negative deviation would reflect the Canadian rate being lower than the fully covered United States rate. For borrowers seeking Canadian funds, this would occur if it was cheaper to borrow in Canada than to borrow on a fully covered basis in the United States. Similarly, for borrowers seeking United States funds, negative deviations indicate that a United States borrower could issue fully hedged Canadian liabilities and reduce funding costs. A positive differential would indicate the reverse.

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9. The United States bonds selected were:
   3 year: 7 1/8, October 93 (Note)
   5 year: 8 7/8, July 95 (Note)
   7 year: 8 5/8, August 97 (Note)
   10 year: 8 7/8, May 00 (Note)
   The Canadian bonds selected were:
   3 year: 9.50 September 93
   5 year: 10.50 June 95
   7 year: 9.75 October 97
   10 year: 10.50 July 00
10. When available, use of bonds trading somewhat farther from par did not alter the results considerably.

Relevant statistical information on the size of the long-term deviations, expressed in annualised basis points, is given in Table 1. A number of observations are apparent. In particular, deviations for the three, five and seven year forwards were almost always negative, while the ten year case had no discernible tendency to be negative or positive. In addition, the absolute value of the deviations tended to decrease with term to maturity, with the largest average deviations occurring for the three year forward and the smallest average deviations for the ten year. In addition, all the deviations were insignificantly different from zero (at the 5% level). While the precise level of significance for the three and five year deviations must be qualified due to the decidedly non-normal skewness of the distributions, the observed skewness may also provide indirect evidence of a potential violation of arbitrage conditions in these cases (Poitras 1988).

TABLE 1
DISTRIBUTIONAL INFORMATION FOR DAILY DEVIATIONS BETWEEN CANADIAN AND FULLY COVERED UNITED STATES RATES, JULY–DECEMBER 1990, IN ANNUAL BASIS POINTS

Number of Observations: 113

Maturity	Mean	Std Dev	Min	Max	# Negative
Three Year	–53.4	22.1	–93.7	–0.01	113
Five Year	–36.2	17.9	–64.6	25.4	112
Seven Year	–16.2	13.3	–36.3	85.2	104
Ten Year	2.8	9.3	–21.5	28.8	40

Correlation Matrix

	Three	Five	Seven	Ten
Three	1.00			
Five	0.86	1.00		
Seven	0.29	0.33	1.00	
Ten	0.13	0.31	0.30	1.00

Distributional Tests*

	Skewness	Kurtosis	Chi^2	SR
Three Year	1.02	0.18	16.23	4.27
Five Year	0.71	0.07	9.04	4.92
Seven Year	0.35	0.27	2.98	4.90
Ten Year	0.06	0.004	0.11	5.44

* Skewness and kurtosis are the standardised third and fourth moments where the value for kurtosis has been centred about its value for the normal distribution. The chi-squared test (two degrees of freedom) is the omnibus test for normality recommended in D'Agostino and Stephens (1986, chap 7 and 9) as the preferred test for combining the information contained in skewness and kurtosis. SR is the studentised range.

As noted, these results indicate that borrowers desiring United States dollars, particularly for three to five years, could have achieved substantial funding advantages by issuing fully hedged Canadian dollar debt. Similarly, for borrowers seeking to acquire Canadian dollars, it would have been less expensive to issue Canadian dollar debt than to do fully hedged United States borrowing. While it is not possible to draw conclusive inferences as to the cause of the deviations, it does not appear that the observed results can be attributed to explanations such as transactions costs or liquidity risks. For example, if the deviations were due primarily to transactions costs, similar general behaviour would be expected for all the deviations. In addition, the size of the observed deviations is substantially larger than is indicated by the observed bid/offer spreads for either long-term forward contracts or currency swaps (*eg*, Miron and Swannell 1991). Finally, liquidity risks are not a likely explanation because the largest deviations are observed for the more liquid, shorter maturities.

One indirect method of assessing the nature of the long-term deviations is to examine comparable distributional results for money market securities which are known to be largely determined by covered interest arbitrage activity. For this purpose, (2) was again used to calculate short-term deviations using one and three month Bankers' Acceptances and three and six month federal government treasury bills.[11] This required adjusting the interest rates to account for the length of the trade, *eg*, multiplying by 91/365 for the three month rates (and setting N=1). The resulting basis point deviations were then grossed up so that all deviations were expressed on an annualised basis.[12] These results are given in Table 2. The contrast between the short-term and long-term results is immediate. While long-term deviations were predominately negative, short-term deviations tended to be positive, indicating that fully covered investments (not borrowings) in Canada were typically profitable. This is consistent with results from previous studies of short-term covered interest parity (*eg*, Poitras 1988).

Recognising that there are some limitations on using the short-term securities examined in Table 2 to precisely determine values consistent with covered interest arbitrage, it still appears as though there are substantive differences between the factors determining short- and long-term forward exchange rates. Similar conclusions can be drawn by examining the results of "hedge ratio" regressions, *ie*, a specification of the form:

$$\Delta r_t = b_0 + b_1 \Delta r_t^* + b_2 \Delta\{F_N - S\}_t + u_t \qquad (3)$$

where b_0, b_1, and b_2 are regression coefficients to be estimated and u_t is the regression residual which is assumed to have the usual properties (*eg*, Dhrymes 1978).

Selected regression estimates for equation (3) are provided in Table 3.[13] As with the distributional evidence, the regression results indicate significantly different behaviour for

11. These data were also taken from the *Globe and Mail* and *Wall Street Journal*. Eurodeposit rates were not used because the deviations for these rates are known to be near zero.
12. This procedure creates the somewhat misleading impression that the trades are more profitable than they actually were. For example, the actual average profit on the one month trade would only be one-twelfth of the amount stated.
13. Slight variations in specification did not alter the regression results substantively. In particular, raising the value of spread to the power N did not improve the significance of the relevant coefficient estimate, neither did expressing the equation in logs. Using the spread as the dependent variable also did not change the nature of the results.

TABLE 2
DISTRIBUTIONAL INFORMATION FOR DAILY DEVIATIONS BETWEEN CANADIAN AND FULLY COVERED UNITED STATES RATES, JULY–DECEMBER 1990, IN ANNUAL BASIS POINTS

Number of Observations: 113					
Interest Rate	Mean	Std Dev	Min	Max	# Negative
1 mo BA	–1.7	2.1	–45.9	96.6	57
3 mo BA	27.9	13.0	–11.6	71.4	3
3 mo Tbill	49.9	29.2	–6.6	111.9	3
6 mo Tbill	42.4	21.6	–7.8	84.7	1

Correlation Matrix				
	1 mo BA	3 mo BA	3 mo Tbill	6 mo Tbill
1 mo BA	1.00			
3 mo BA	0.37	1.00		
3 mo Tbill	0.17	0.50	1.00	
6 mo Tbill	0.25	0.33	0.88	1.00

Distributional Tests*				
	Skewness	Kurtosis	Chi^2	SR
1 mo BA	0.78	3.25	20.16	6.82
3 mo BA	0.51	1.79	6.38	6.39
3 mo Tbill	0.06	–0.64	0.83	4.33
6 mo Tbill	0.19	–0.62	0.96	4.08

* See Notes to TABLE 1

short- and long-term forward rates. Specifically, at the short end, changes in domestic interest rates tended to be contemporaneously related to changes in the forward exchange premium (and foreign interest rates). At the long end, no such effect was observed. The primary determinant of changes in long-term Canadian rates was changes in long-term United States rates.

The absence of a significant contemporaneous relationship between changes in both the long-term forward exchange premium and Canadian interest rates is further evidence consistent with the hypothesis that long- and short-term forward exchange rates are determined differently. In other words, long-term forward exchange rates are not determined by the covered interest arbitrage activity associated with short-term forward rates. Rather, pricing in the long-term forward exchange market is more likely to be affected by factors such as swap dealers seeking to hedge unbalanced swap positions arising from specific market conditions. In particular, the long-term forward premium will not *directly* impact swap transactions because, given the mechanics of cross-currency swap transactions, it is the spot exchange rate (and the interest rate differential) which primarily

TABLE 3
HEDGE RATIO REGRESSION RESULTS FOR SELECTED INTEREST RATES AND FORWARD EXCHANGE CONTRACTS, DAILY, JULY–DECEMBER 1990*

$$\Delta r_t = b_0 + b_1 \Delta r_t^* + b_2 \Delta\{F_N - S\}_t + u_t$$

Number of Observations: 113						
Dependent Variable	b_0	b_1	b_2	R^2	DW	SEE
Ten Year r	0.00 (0.20)	1.04 (13.3)	0.00 (0.00)	0.63	1.79	0.053
Three Year r	0.00 (0.21)	0.94 (8.61)	–0.33 (0.20)	0.41	1.51	0.065
1 mo BA r (not annualised)	–0.15 (2.46)	0.06 (2.41)	105.5 (5.79)	0.18	1.79	0.064
6 mo Tbill r (not annualised)	–0.01 (1.82)	0.21 (1.68)	34.5 (2.26)	0.07	2.13	0.07

* Values in brackets below coefficients are the absolute value of the t statistics for the null hypothesis that the coefficient value equals zero. DW is the value for the Durbin Watson test and SEE is the standard error of the regression. Standard errors and t statistics are calculated using White's (1980) heteroskedastic-consistent formula.

determine the swap rate. However, further empirical research is required to explore this hypothesis, *eg*, by directly examining the relationship between observed swap rates and the covered interest arbitrage deviations. It would also be useful to see if the behaviour of the United States/Canadian long-term forward market is replicated for other currencies.

5. SUMMARY

This paper examined the relationship between activities in the international swap market and the pricing of long-term foreign exchange contracts. Due to factors such as illiquidity in the supply of long-term Eurodeposits restricting arbitrage execution, long-term forward rates can deviate significantly from values consistent with the traditional covered interest arbitrage condition. Observing that a fixed-to-fixed currency swap can be regarded as a portfolio of "forward" contracts, it was argued that such deviations more likely arise from swap dealers using long-term forward contracts as instruments for hedging risk associated with unbalanced cross-currency swap positions. Empirical evidence was presented indicating that long-term forward rates, for the United States/Canadian dollar, deviated significantly from values consistent with long-term covered interest parity. In addition, a marked difference in the behaviour of the long- and short-term deviations was observed.

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