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In two recent articles in the Journal of Political Economy (April 1975 and Dec. 1977) Frenkel and Levich (henceforth F-L) undertook the very difficult task of trying to show that most discrepancies from covered-interest arbitrage parity can be explained by transaction costs in the securities and foreign exchange markets.

In this comment I will argue that F-L's data -- although perhaps the best published data available -- are subject to some limitations. I will adopt F-L's methodology (with reservations as noted) and will apply it to data of a higher quality. The resulting estimates of the transaction costs in the foreign exchange market are considerably lower than the estimates provided by F-L. These new estimates cast doubt on F-L's conclusion that most discrepancies from covered-interest arbitrage parity for U.S. and U.K. Treasury bills for the 1962-67 and 1973-75 periods can be explained by transaction costs.

1. F-L's Method of Estimating Transaction Costs in the Foreign Exchange Market.

F-L's method of estimating exchange market transaction costs is as follows:

A holder of dollars who desires to purchase pounds will purchase them indirectly (by first purchasing marks and then using the marks to buy pounds) rather than directly, if the total cost (including transaction costs) of buying them directly is greater than the total cost of buying them indirectly, i.e., if

$$(1) \quad (\$/£)(1+t_{\$/£}) > (\$/DM)(1+t_{\$/DM}) \cdot (DM/£)(1+t_{DM/£})$$

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where:

($/£) is the dollar price of the pound, etc.

$t_{\$/£}$ is the transaction cost (in per cent) involved in exchanging dollars for pounds, etc.

And if it is assumed that $t_{\$/£} = t_{\$/DM} = t_{DM/£,}$ then inequality (1) reduces to

$$(2)\left[\frac{(\$/£)}{(\$/DM)(DM/£)}\right] - 1 > t$$

Thus whenever inequality (2) obtains, holders of dollars will tend to go through marks to purchase pounds rather than simply purchasing them directly, and since this process tends to prevent the LHS of (2) from rising further, the upper limit of the LHS is a measure of t.

By similar reasoning, holders of pounds desiring to buy dollars will purchase them indirectly (by first buying marks and then using the marks to buy dollars) rather than directly, whenever

$$(3)\quad \left[\frac{(£/\$)}{(£/DM)(DM/\$)}\right] - 1 > t$$

Hence the upper limit of the LHS of inequality (3) is also a measure of t.

Or more simply, we can say that the upper limit of the absolute value of the discrepancy from triangular arbitrage parity is a measure of t.[1/]

2. F-L's Foreign Exchange Data.

To correctly measure the total transaction cost in the foreign exchange market (including one-half the bid-ask spread) by this method,

the exchange rates must:

1) be observed almost simultaneously.

2) be mid-points of the bid and ask quotations.

F-L's data, although perhaps the best published data available, do not meet precisely the above two criteria, especially the first.

Their spot and forward exchange rates involving the dollar for the 1962-69 period were taken from the International Monetary Fund's International Financial Statistics. According to the IMF (unofficially):[2/]

a) the $/C$ rates were the mid-points of the bid and ask quotations at noon New York time.

b) the $/£ rates were the mid- points of the bid and ask quotations at the closing of the London trading day (about noon New York time).

c) the $/DM rates were the official fixing prices about 1:00 p.m. Frankfurt time (about 7:00 a.m. New York time).

The spot and forward exchange rates involving the dollar for the 1973-75 period were taken from the International Monetary Market Year Book, and the Daily Information Bulletin published by the staff of the International Monetary Market (IMM) of the Chicago Mercantile Exchange. These were closing mid-point rates (about 4:00 p.m. New York time).

The spot and forward rates for the DM/£ and C$/£ in both periods were computed from data in the Montagu Monthly Review, Samuel Montagu and Co., Ltd. The spot rates were the mid-points of Montagu's extreme rates (lowest bid and highest ask) during the London trading day (about 3:00 a.m.

to noon New York time). The forward rates were computed by adding the mid-point of Montagu's closing forward bid and ask premiums to the mid-point of the daily range of spot rates.

Thus, while many of the exchange rates meet the mid-point criterion, they do not meet the simultaneity criterion. During the 1962-69 period the $/DM rates were always observed about 5 hours before the $/£ rates. More importantly, during the 1962-69 period the DM/£ and C$/£ rates were observed anywhere from zero to nine hours before the $/£ and $/C$ rates,[3] and during the 1973-75 period this gap widened to 4-13 hours.

Finally, by adding the mid-points of the London closing forward premiums to the mid-point of the daily range of spot rates, F-L may have introduced an additional source of bias into their estimates of transaction costs in the forward market -- the change in the forward premium between the time the spot rate was at the mid-point of its range and the time the London market closed.

3. Estimates Using Better Data.

In this section I apply F-L's methodology to data of a higher quality which was collected from the Reuters news service during a six-month period in 1976.[4] About 10:30 a.m. New York time each day, spot bid and ask quotations came across the Reuters wire from both the New York and London markets within one hour of each other.

Using the mid-points of the bid and ask quotations for the $/DM and $/C$ from the New York market and for the $/£, DM/£, and C$/£ from the London market, discrepancies from triangular arbitrage parity were

computed for triangular arbitrage between

a) $, £, and DM

b) $, £, and C$.

The values that bounded 95 per cent of these discrepancies (F-L's procedure for selecting the transaction cost) are shown in Table 1, row 2. In row 1 are the estimates made using daily Montagu-IFS data for the same six month period (about 124 daily sets of observations).

Note that the estimates made using the mid-points of the Reuters data (with less than an hour time difference between observations) are less than 1/3 of those made using the Montagu-IFS data.[5/]

Going one step further, it is possible to compute discrepancies from triangular arbitrage parity bettwen the $, £, and C$ using $/£, C$/£, and $/C$ exchange rates from the London market alone -- all of which were observed at the same time. The resulting transaction costs estimate (shown in row 3) is less than 1/5 of the corresponding estimate computed from the Montagu-IFS data.

Finally, to further illustrate the effect of the time difference on the estimates of the transaction costs, the previous calculation was repeated, but the $/C$ and $/£ rates were lagged exactly one day behind the C$/£ rate (weekends were excluded). The resulting transaction cost estimate (shown in row 4) is 3-1/2 times the estimate from Montagu-IFS data.

Clearly there is a strong positive relationship between the transaction cost estimates and the time difference between exchange rate

observations. And the use of high quality foreign exchange data -- mid-points of bid and ask quotations that were all observed at the same time -- yields estimates of foreign exchange market transaction costs that are less than 1/5 of those produced by Montagu-IFS data.

Table 1

Estimates of the percentage cost of transactions in the spot foreign exchange market for the period 4/26/76-10/22/76.

Data Sources	Triangular arbitrage between $, £, DM	$, £, C$
Montagu-IFS (up to 9 hours time difference)	0.664	0.505
Reuters (up to 1 hour time difference)	0.182	0.157
Reuters (no time difference)	--	0.090
Reuters (1 day time difference)	--	1.744

4. Effects on F-L's Conclusions

To illustrate how higher quality foreign exchange market data alone could affect F-L's conclusions (data closely comparable to F-L's will be used for the other variables) let us examine, for the same six month period in 1976, two of the cases that F-L looked at:

a) Covered-interest arbitrage between U.S. and U.K. Treasury bills,

b) Covered-interest arbitrage between Euro-dollars and Euro-sterling.[6/]

using:

1) Estimates of transaction costs in the spot exchange market based on both Reuters and Montagu-IFS data (for 1976).

2) F-L's estimates of transaction costs in the security markets (for the 1973-75 period).[7]

3) F-L's relationships between transaction costs in the spot and forward exchange markets (for the 1973-75 period).[8]

The percentage of discrepancies from covered-interest arbitrage parity that can be explained by different transaction costs are shown in Table 2. Note that for arbitrage between U.S. and U.K. Treasury bills (column 1), transaction costs computed using the Montagu-IFS foreign exchange data explain almost all of the discrepancies. In contrast the transaction costs computed using the Reuters foreign exchange data explain far fewer.

Clearly the use of the Montagu-IFS foreign exchange data would lead to the acceptance of the hypothesis that most discrepancies from covered-interest arbitrage can be explained by transaction costs, while use of the Reuters data would lead to its rejection.

Note, however, that for the case of arbitrage between Euro-dollars and Euro-sterling (column 2), the use of the higher quality Reuters exchange market data does not affect the results -- 100 per cent of the discrepancies are explained in all cases and hence the hypothesis would always be accepted.

These results do not seem unreasonable. The U.K. has long had very stringent capital controls. These controls have frequently caused

Table 2

Percentage of Discrepancies from Covered-Interest Arbitrage Parity that Are Explained by Various Transaction Costs.

Exchange Market Transaction Costs Calculated by Triangular Arbitrage Between		Covered Interest Arbitrage Between U.S.-U.K. Treasury Bills	Euro-dollar-Euro-sterling
£, $, and DM	Ω Montagu-IFS Data (up to 9 hours time difference)	96	100
	Ω' (same)	96	100
	Ω Reuters Data (up to 1 hour time difference)	58	100
	Ω' (same)	31	100
£, $, and C$	Ω Montagu-IFS Data (up to 9 hours time difference)	96	100
	Ω' (same)	96	100
	Ω Reuters Data (up to 1 hour time difference)	38	100
	Ω' (same)	31	100
	Ω Reuters Data (no time difference)	27	100
	Ω' (same)	23	100

Ω and Ω' are FL's measures of the difference between investing in covered-foreign and domestic securities when investors are initially in securities and cash respectively.

large discrepancies between domestic sterling and Euro-sterling interest rates, and one would expect them to also have caused large discrepancies from covered-interest arbitrage parity between U.S. and U.K. Treasury bills. On the other hand the absence of such controls in the Euro-currency markets makes it much more likely that discrepancies from covered-interest arbitrage parity between Euro-dollars and Euro-sterling are due only to transaction costs.[9/]

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FOOTNOTES

1/ To use this approach F-L assume that transaction costs in the foreign exchange market are relatively constant over time. However, Fieleke (1972 and 1975) has shown that the bid-ask spread -- a major component of transaction costs in the foreign exchange market -- varies widely over short periods of time. Fieleke's bid-ask spread computations for the pound and mark in 1970 (when both currencies were pegged) reveal variations in monthly averages (which are necessarily much smaller than variations in daily spreads) of 70% to 260%. By taking the upper limit of discrepancies from triangular arbitrage parity as their measure of transaction costs, F-L tend to measure the highest transaction cost that occurred during the period under consideration. This necessarily biases their estimates of t upward.

2/ The official notes published in IFS usually do not include the time at which the rates were recorded.

3/ A small sample of the data published by Montagu for the period 1962-67 indicates that the daily range of movement for the spot DM/£ and C$/£ rates during the London trading day was on average about 1/10 of a per cent. Consequently, it seems quite likely that the upper limit of the

discrepancy from triangular arbitrage parity of approximately 1/20 of a per cent that F-L found for the spot market during this period was due to the movement of exchange rates during the lag of up to 9 hours between the times that the different rates existed, rather than to transaction costs.

4/ The beginning and ending dates (April 26 and October 22) were determined by different dates of adoption and ending of daylight saving time in the U.S. and the U.K., which would have introduced another hour time difference between the exchange rate observations.

5/ The estimates of transaction costs based on F-L's data sources shown in row 1 are roughly comparable to the estimates F-L (1977) made for the 1973-75 period (0.523 and 0.438 respectively).

6/ Ideally all of the data used to compute discrepancies from covered-interest arbitrage parity (the two interest rates and the forward premium) also should be observed at the same time and should be mid-points of the bid and ask quotations.

The data for covered-interest arbitrage between Euro-dollars and Euro-sterling was taken from the Bank of England's Quarterly Bulletin (the same source F-L used for the 1962-69 period). The rates are all "middle market rates as recorded by the Bank of England during the late afternoon" on Fridays.

The data for arbitrage between U.S. and U.K. Treasury bills was also taken from the Bank of England Quarterly Bulletin. The forward premiums are Friday late London afternoon mid-rates (which would probably be about

11:00 a.m. New York time); the U.K. Treasury bill rates are ask prices after the weekly tender (about 9:00 a.m. New York time) on Friday; and the U.S. Treasury bill rates are ask prices at an unspecified time on Friday. Thus two of the prices are not mid-rates and there is a difference of at least two hours between the times that they were observed.

For the 1962-69 period F-L used data from the Federal Reserve Bulletin for arbitrage between U.S. and U.K. (and between U.S. and Canadian) Treasury bills. The U.S. Treasury bill rates were 11:00 a.m. ask rates in N.Y.; the premiums were 11:00 a.m. mid-rates in New York; the U.K. Treasury bills were London opening (about 4:00 a.m. New York time) ask rates. Unfortunately this data is no longer published.

7/ F-L (1977) found that transaction costs in the securities markets were much higher in the 1973-75 period than in the 1962-69 period. I assumed that they were approximately the same in 1976 as in 1973-75.

It should be noted that to obtain their estimates of transaction costs in the securities market, F-L multiply the bid-ask spread in that market by 2.5 -- citing Demsetz's conclusion (1968) that the bid-ask spread comprises about 40 per cent, and the commission brokerage about 60 per cent, of the total transaction cost.

However, Demsetz's relationship between the bid-ask spread and the total transaction cost applies only to individual stocks on the New York Stock Exchange, where the volume of transactions per stock is much lower than for the securities normally involved in covered-interest arbitrage, and where an S.E.C. enforced cartel maintained brokerage fees at a high level.

Consequently there is every reason to expect that in the markets for securities normally involved in covered-interest arbitrage, the brokerage fee, or analogous components of the transaction cost, are a much smaller percentage of the total than for individual stocks on the N.Y.S.E. Hence one half the bid-ask spread should be multiplied by a much smaller factor than 2.5 to obtain the total transaction cost.

8/ Since the Reuters data on the forward exchange market was not of high quality, and since the IFS forward market data that F-L used is no longer published, it was not possible to compare estimates of transaction costs computed from the two sources. Consequently, to determine how smaller estimates of transaction costs in the foreign exchange market might have affected F-L's results, I assumed that transaction costs in the forward market bore the same relationship to transaction costs in the spot market as F-L (1977) found for the 1973-75 period. That is, for transaction costs computed by triangular arbitrage between \$, £, and DM, $t_f = (0.96941) \text{ X } (t_s)$; and for triangular arbitrage between \$, £, and C\$, $t_f = (1.00913) \text{ X } (t_s)$.

9/ However, it should be stressed that these results are only meant to illustrate the point that the use of higher quality data for one of the variables can change F-L's conclusion. These results should not be regarded as hard evidence either for or against the hypothesis that most discrepancies from covered-interest arbitrage parity can be explained by transaction costs, because of:

a) the theoretical problems with F-L's method of measuring transaction costs in the foreign exchange and securities markets (mentioned in footnotes 1 and 7).

b) the inadequate quality of the data used to compute discrepancies from covered-interest arbitrage parity between U.S. and U.K. Treasury bills (as discussed in footnote 6).

c) the shortness of the period considered.

In my judgement, given the very small size of the variables involved, to accurately determine whether transaction costs explain discrepancies from covered-interest arbitrage parity it is necessary to:

a) observe all of the data -- exchange rates, interest rates, forward premiums -- at the same time.

b) use all bid and ask (or mid-point) quotations.

Such data is very costly to gather, but without it the value of this kind of empirical analysis is questionable. It is also necessary, in my judgement, to compute transaction costs in the securities and foreign exchange markets <u>for each day separately</u> by multiplying 1/2 the bid-ask spread by a factor considerably smaller than 2.5 (say 1.5).