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Efficiency in the Forward Exchange Market: An Application of Co-Integration: Reply

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In this issue of the *Review*, Leddin comments on my recent (1988) paper which examined co-integration as a technique for analysing the efficiency of the forward exchange market. I wish to address a small number of the interesting points raised in this Comment.

Leddin states, when commenting on the apparent discrepancy between his results and mine, that care should be taken in view of the fact that his dataset contained only 39 observations and Engle and Granger (1987) provide critical values for 100 observations. He then states "Unfortunately, critical values for less than 100 observations are not as yet available". In Section 7 of Engle and Yoo (1987), critical values for varying orders of co-integrated systems are tabulated, for the three familiar test statistics. Included are values for n=50 as well as n=100.

There is no consensus, however, on the precise interpretation of the Engle and Yoo values. As presented, they do not make it unambiguously clear how to interpret their tables. I have proceeded therefore to interpret them with order = 2 as implying a co-integrating system with 2 variables. Using this interpretation and the values provided in Leddin's Comment, and employing the

*The views expressed in this reply are the author's own, and are not necessarily those of the Central Bank of Ireland.

critical values for n=100, I find that the two studies may not differ all that much. Leddin would find that the Dollar spot forward market is not efficient, while the Sterling market and the DM market (which I did not investigate) are apparently co-integrated and therefore would fulfil a necessary (but not sufficient) condition for efficiency. However, using critical values for n=50 with the above interpretation would give the result that we can accept the null of no co-integration, on the basis of the DF and ADF tests, for both the Dollar and the Sterling market. It would be accepted at 10 per cent in all cases and at 5 per cent except for the DF test in the Sterling market.

As far as equilibrium regressions are concerned, it may be recalled that the coefficient in the forward rates were in all cases very far from 1. I understand that Leddin, in contrast, has found values which are much closer to 1. It must be stated however that, in the context of a co-integrated system, no formal tests exist for this problem.

With regard to the matter of the potential problem of autocorrelation, while accepting the point that there may be a danger of introducing autocorrelation, it is not a necessary consequence that the OLS estimates of the co-integrating sector are in some ways less robust. Stock (1987) shows that the OLS estimates, in addition to being asymptotically the fastest to converge (asymptotically super consistent) is also the best estimator in small samples.

Perhaps I might finish with a pointer to future research. Recent work by Hylleberg *et al.* (1988) has formally investigated the existence of systems which exhibit co-integration at more than one spectral frequency. As there is a wide span of frequencies which could be fruitfully investigated in forward markets, it might be interesting to investigate at what frequencies markets are "more" or "less" efficient.

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