Appendix 2. Unit Root Tests

Unit root tests are performed on the levels of each of the original data series and also on first differences of the logarithms of the variables. These tests involve Models 1, 2, and 3 defined as follows:

Model 1 $$\Delta Y_t = d_0 + d_1 Y_{t-1} + d_2 t + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t$$

Model 2 $$\Delta Y_t = d_0 + d_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j Y_{t-j} + \varepsilon_t$$

Model 3 $$\Delta Y_t = d_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t$$

Except for the British Pound and Italian Lira, each of the original data series contains a trend. Thus, Model 1 will be used to construct unit root tests for the German Mark, Japanese Yen, French Franc, and Belgium Franch, while Model 2 is used for the British Pound and Italian Lira. Since the first differences of logarithms for each of the six series fluctuate around zero and do not include a trend, Model 3 is used to investigate stationarity for the transformed data. In each case, the null hypothesis is that of stationarity ($d_1 = 0$). The following table summarizes the results of these tests.

Results of Unit Root Tests (ADF-test)

	Original Data	First Difference of log variables
DM	-3.33(1)	-52.20(0)*
£	-1.38(1)	-50.95(0)*
¥	-1.42(3)	-15.95(9)*
FF	-3.24(1)	-22.31(5)*
BF	-2.63(1)	-22.44(5)*
IL	-2.69(6)	-30.56(2)*

DM: German deutsche mark, British pound; ¥: Japanese yen, FF: French franc; BF: Belgian franc; IL: Italian lira.
The number of lags used to remove serial correlation in the residuals is reported in parentheses.
* Indicates the statistics are significant at the 5% level based on the MacKinnon[1] critical values.

Based on these test results, the null hypothesis of a unit root in each of the original data series can not be be rejected using an ADF[2] test at the 5% level. Furthermore, the stationarity hypothesis of the first differences of logarithms of the data is consistent with the test results.

---

[1]MacKinnon, J.G. 1991. Critical Values for Cointegration Tests, Chapter 13 in Long-run Economic Relationships: Readings in Cointegration, edited by R.F. Engle and C.W.J. Granger, Oxford University Press.

[2]Dickey, D.A. and W.A. Fuller. 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statisitcal Association 74:427-31.