Appendix A: Specification and Diagnostic Tests Used (in order applied)

Augmented Dickey-Fuller (ADF) Test (Dickey and Fuller, 1979)

A time series is stationary if the mean and autocovariances do not depend on time. A series that achieves stationarity after first-differencing is said to have a unit root, and to be integrated of order one. (EViews User's Guide, p 297) Since standard statistical inference procedures do not apply to regressions that contain a nonstationary variable, unit root testing on all series is recommended before using them for regression estimation. (EViews User's Guide, p 298)

The ADF Test tests for a unit root, and controls for higher-order serial correlation in a series. For all series in this paper, twelve lagged first-difference terms, a constant, and a linear time trend were included in the ADF Test specification. This was done on the presumption that all series contained an underlying trend. (EViews User's Guide, pp 299-300)

Correlogram

A correlogram (example at Table 1) displays the autocorrelation and partial autocorrelation functions up to a specified order of 36 lags. Autocorrelation functions show the pattern of temporal dependence in the EPRR series, or fitted equation, and generally only make sense for time series data. (EViews User's Guide, p 156)

Q-Statistic (Ljung and Box, 1979)

The Ljung-Box Q-Statistic, with its corresponding probability value, is a test statistic for the null hypothesis of no autocorrelation for a specified order of autocorrelation lags. (EViews User's Guide, p 159) If there is no serial correlation, the autocorrelations and partial autocorrelations at all lags should be nearly zero, and all Q-Statistics should be insignificant with large probability-values. (EViews User's Guide, p 275)

Breusch-Godfrey Serial Correlation (Lagrangian Multiplier (LM)) Test (Godfrey, 1988)

In Ordinary Least Squares (OLS) regression, time series residuals are often found to be serially correlated with their own lagged values. Serial correlation means (a) OLS is no longer an efficient linear estimator, (b) standard errors are incorrect and generally overstated, and (c) OLS estimates are biased and inconsistent if, as in this paper, a lagged dependent variable is used as a regressor. (EViews User's Guide, p 273)

This test is an alternative to the Q-Statistic for testing for serial correlation. It is available for residuals from OLS, and the original regression may include autoregressive (AR) terms. Unlike the Durbin-Watson Test, the Breusch-Godfrey Test may be used to test for serial correlation beyond the first order, and is valid in the presence of lagged dependent variables. (EViews User's Guide, p 338)

Equations 2.1, 2.3, and all even-numbered equations from Equations 3.1 through 3.20 contain INFLATION as a regressor. Since INFLATION is used to form EPRR, the dependent variable for all equations in this paper, this latter property is a necessary one when testing for serial correlation.

The null hypothesis of the Breusch-Godfrey Test is that there is no serial correlation up to the specified number of lags. The Breusch-Godfrey Test regresses the residuals on the original regressors and lagged residuals up to the specified lag order. The number of observations multiplied by R^2 is the Breusch-Godfrey Test statistic. (EViews User's Guide, p 338)

White Heteroskedasticity Test (White, 1980)

OLS estimates are consistent in the presence of heteroskedasticity, but the standard errors are no longer valid. The White Test is a test for heteroskedasticity in OLS residuals. (Eviews User's Guide, p 340)

The null hypothesis of the White Test is that there is no heteroskedasticity. The test statistic is computed by an auxiliary regression of the squared residuals on all possible cross-products of the regressors. The number of observations times the R^2 from the test regression is used to compute the White Test statistic. (EViews User's Guide, p 340)

Newey-West Heteroskedasticity and Autocorrelation (HAC) Consistent Covariance Estimator (Newey and West, 1987)

The Newey-West HAC Estimator is a general covariance matrix estimator used to treat heteroskedasticity. It is consistent in the presence of both heteroskedasticity and autocorrelation of unknown form. (EViews User's Guide, p 252)

Wald Test (Wald, 1943)

The Wald Test is a coefficient restrictions test that asks whether the regression estimation coefficients jointly explain any of the variation in the dependent variable. It tests the central question of this paper, the constancy of the EPRR in Germany over the period 1970-2000.

The null hypothesis is that all coefficients for explanatory variables are equal to zero. (EViews User's Guide, p 329) The Wald Test reports two test statistics, the F-Statistic and the Chi^2 Statistic, both based on an estimation of the unrestricted regression (i.e., without imposing the coefficient restrictions in the null hypothesis) and measuring how close the unrestricted estimation results are to the restricted estimation results. If the restrictions are true (i.e., all coefficients are equal to zero), unrestricted estimations should be close to restricted estimations. (EViews User's Guide, pp 330-332) If the probability is less than the significance level being tested (e.g., 5%), the null hypothesis that all independent variable coefficients are jointly equal to zero is rejected. (EViews User's Guide, p 329)

When equations are nonlinear, care should be exercised in F-Statistic interpretation. (EViews User Guide, Student Version 2.0, p 216) The Chi^2 Statistic may be a better guide for nonlinear equations such as Equations 2.1 and 2.3, and is reported for this reason in Tables 2 and 4. (EViews User's Guide, p 333) Also, lagged dependent variables among the regressors, such as are used throughout this paper, mean regressors are not independent of the disturbances, and F-Statistic probabilities should be used as an approximation. (EViews User Guide, Student Version 2.0, p 217)

Chow Breakpoint Test (Chow, 1960)

The Chow Breakpoint Test is a data stability test that estimates separate regressions for subsamples of the data. Significant differences in the results indicate a structural change in the relationship. Data is frequently partitioned based on historical events suspected of altering the regression relationship. (EViews User's Guide, p 341) In this paper, breakpoint tests were conducted for Equations 2.1 and 2.3. Breakpoints were selected to correspond to the breakdown of the Bretton Woods gold/fixed exchange rate regime (1973:03), German monetary union (1990:07), and European monetary union (1999:01).

The null hypothesis is that there is no structural change in the constancy of the EPRR before or after the breakpoint date. (EViews User's Guide, p 343) The Chow Breakpoint Test reports two test statistics, the F-Statistic based on a comparison of the restricted and unrestricted sum of squared residuals, and the log-likelihood ratio (LR) Statistic based on a comparison of the restricted and unrestricted maximum of the log-likelihood function. (EViews User's Guide, p 342) If the probability is less than the significance level being tested (e.g., 5%), the null hypothesis that there is no structural change in the equation is rejected. (EViews User's Guide, pp 251 and 396)

Appendix B: Modifications to Original Equations and Results of Final Equations

Dependent variable for all equations is the ex post real rate of interest (EPRR). INFLATION has a lag of 1 in all equations where it appears as an independent variable. All other explanatory variables have a lag structure (or power structure, in the case of Equations 2.2 and 2.3) of 1, 2, 3, 6, 9, and 12.

Equation 2.1: Inflation

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing autocorrelation (AC) greater than two standard errors (SE) at all autocorrelations through 27, and Ljung-Box Q-Statistic showing zero probability of rejecting the null hypothesis of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing 46.3% probability of rejecting the null hypothesis of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows no AC exceeding two SE for all but lags 12, 24, and 36, and the Ljung-Box Q-Statistic remains at zero probability.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of rejecting the null hypothesis of no serial correlation.

(3) White Test shows probability of rejecting the null hypothesis fell to 36.5%.

Equation 2.2: Time

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE at all autocorrelations through seventeen, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows no AC greater than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of

no serial correlation.

(3) White Test remains at zero probability.

Equation 2.3: Inflation + Time

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE at all autocorrelations through seventeen, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlation shows autocorrelation less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test remains at zero probability.

Equation 3.1: M3

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE at all autocorrelations through 23, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Newey-West HAC Estimator not applied, since White Test shows 94.4% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 1.4% probability of no heteroskedasticity.

Equation 3.2: Inflation + M3

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE

at all autocorrelations through 22, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Newey-West HAC Estimator not applied, since White Test shows 92.8% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 1.1% probability of no heteroskedasticity.

Equation 3.3: Industrial Production

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE at all autocorrelations through 27, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing 19% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 31.9% probability of no heteroskedasticity.

Equation 3.4: Inflation + Industrial Production

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE at all lags through 27, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing 20.7% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlation shows AC less than two SE for all but lags 12, 15, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 31.5% probability of no heteroskedasticity.

Equations 3.5: Government Revenues

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE at all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Newey-West HAC Estimator not applied, since White Test shows 100.% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlation shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no serial correlation.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 72.9% probability of no heteroskedasticity.

Equation 3.6: Inflation + Government Revenues

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Newey-West HAC Estimator not applied, since White Test shows 99.3% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 56.4% probability of no heteroskedasticity.

Equation 3.7: Government Expenditures

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE

for all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing 8.3% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 16.7% probability of no heteroskedasticity.

Equation 3.8: Inflation + Government Expenditures

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator, based on White Test showing 14.6% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 18.0% probability of no heteroskedasticity.

Equation 3.9: Surplus/Deficit

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 23, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Newey-West HAC Estimator not applied, since White Test shows 75.5% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 5.1% probability of no heteroskedasticity.

Equation 3.10: Inflation + (Surplus/Deficit)

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 23, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing 44.5% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 6.8% probability of no heteroskedasticity.

Equation 3.11: Unemployment

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 24, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows zero probability of no heteroskedasticity.

Equation 3.12: Inflation + Unemployment

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE

for all lags through 24, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows zero probability of no heteroskedasticity.

Equation 3.13: Stock Market

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 22, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 90.7% probability of no heteroskedasticity.

Equation 3.14: Inflation + Stock Market

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 23, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic remains at zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 89.4% probability of no heteroskedasticity.

Equation 3.15: Leading Indicators

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic shows zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 51.9% probability of no heteroskedasticity.

Equation 3.16: Inflation + Leading Indicators

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic shows zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 47.6% probability of no heteroskedasticity.

Equations 3.17: Exchange Rate

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE

for all lags through 27, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 0.5% probability of no heteroskedasticity.

Equation 3.18: Inflation + Exchange Rate

(a) Modifications to original equation:

(1) Added AR(1) through AR(22) based on correlogram showing AC greater than two SE for all lags through 27, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing zero probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 0.3% probability of no heteroskedasticity.

Equations 3.19: Trade Balance

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing 49.8% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic shows zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 24.9% probability of no heteroskedasticity.

Equation 3.20: Inflation + Trade Balance

(a) Modifications to original equation:

(1) Added AR(1) through AR(12) based on correlogram showing AC greater than two SE for all lags through 26, and Ljung-Box Q-Statistic showing zero probability of no AC.

(2) Applied Newey-West HAC Estimator based on White Test showing 49.7% probability of no heteroskedasticity.

(b) Results of final equation:

(1) Correlogram shows AC less than two SE for all but lags 12, 24, and 36, and Ljung-Box Q-Statistic shows zero probability of no AC.

(2) Breusch-Godfrey Test shows no improvement in AC, remaining at zero probability of no serial correlation.

(3) White Test shows 13.1% probability of no heteroskedasticity.

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