Applied Time Series Analysis

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Contents

1 Course Information

Course presenter: Prof. J. Fedderke
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2 Lectures

The course is offered in the second semester and consists of 2 double periods per week.

3 Assessment

The course will be assessed on the basis of:

- A 24 hour examination covering both theory and applied topics.
- Problem sets and projects to be completed during the course.

Weighting is 60% on the examination, and 40% on coursework (problem sets and projects).

4 Course texts

Enders. W., 2004, *Applied Econometric Time Series Analysis*, 2'nd Edition, John Wiley.

Fedderke, J.W., 2004, Applied Time Series Analysis,
Notes at: http://www.commerce.uct.ac.za/Economics/staff/jfedderke/PHD_Papers.asp

Useful background references:

Hamilton, J.D., 1994, *Time Series Analysis*, Princeton: University Press.

Hendry, D.F., 1995, *Dynamic Econometrics*, Oxford: University Press.

5 Course Objectives

- Demonstration of the limitations of OLS techniques in time series contexts.
- Developing an ability to identify the time series characteristics of the data.
- Dealing with nonstationarity in estimation

ABOVE ALL:

1. Developing an appreciation of the unique difficulties imposed by time series contexts
2. Being able to apply those techniques we cover in practical application

6 Course Content

1. A Brief Reminder of OLS Analysis
    - Principles
    - Diagnostics
    - Applications
2. Why OLS is misleading for Time Series Analysis
3. Estimation of Stationary Time Series Models
    - The meaning and importance of stationarity
    - The autocorrelation function and its interpretation
    - ARMA models
    - Box-Jenkins model-selection
    - ARCH and GARCH processes
    - ML estimation of ARCH-M and GARCH models
4. Estimation of Nonstationary Time Series Models
    (a) Univariate Characteristics of the Data
        i. The role of trends
        ii. Meaning and significance of Unit Roots
        iii. Testing for trends and Unit Roots:
            A. Dickey-Fuller and Augmented Dickey-Fuller Tests
            B. Phillips-Perron Tests
            C. Structural changes and Perron Tests
    (b) Vector Autoregressive Models (VAR's)
        i. Stability and stationarity
        ii. Identification
        iii. Estimation
        iv. Hypothesis testing and diagnostics
    (c) Cointegration Analysis
        i. The meaning and importance of cointegration
        ii. The Granger Representation Theorem: meaning and significance
        iii. Estimating the cointegrating vectors:
            A. Unique cointegrating vectors:
                - Engle&Granger Two Step Procedure
                - Engle&Yoo Three Step Procedure
                - Exogeneity and Cointegration
                - Testing for Cointegration
                - Pesaran ARDL Cointegration technique
                - Problems

B. Multivariate cointegration: the Johansen ML methodology
- Testing for the number of cointegrating vectors
- Estimating the cointegrating vectors
- Interpretation of the loading matrix
- Causality in integrated systems
- Identification & testing restrictions

5. ARCH and GARCH Estimation

    (a) ARCH processes and their estimation.
    (b) GARCH processes and their estimation.
    (c) ARCH-M and GARCH-M models.

6. Dynamic Panel Estimation

    (a) Pooled OLS, GLS, Fixed and Random Effects and their limitations.
    (b) GMM.
    (c) Dynamic Fixed Effects.
    (d) Mean Group Estimator.
    (e) Pooled Mean Group Estimator.

7 Readings

1. Session: Methodology.

   Banerjee, A., Dolado, J., Galbraith, J.W., and Hendry, D.F., 1993, *Cointegration, Error-Correction, and the Econometric Analysis of Non-stationary Data*, Oxford: University Press, ch1.

   Fedderke, Notes, ch1.

   Mizon, G.E., 1995, Progressive Modeling of Macroeconomic Time Series: The LSE Methodology, in K.D.Hoover (ed.), *Macroeconometrics: Developments, Tensions and Prospects*, Dordrecht: Kluwer Academic Publishers, 1995.

   Tinbergen, J., 1951, *Econometrics*, J. Wiley & Sons, Inc., New York.

2. Session: Time Series Properties and Concepts I

   Banerjee, A., Dolado, J., Galbraith, J.W., and Hendry, D.F., 1993, *Cointegration, Error-Correction, and the Econometric Analysis of Non-stationary Data*, Oxford: University Press, ch1.

   Cuthbertson, K., Hall, S.G. and Taylor, M.P., 1992, *Applied Econometric Techniques*, Harvester Wheatsheaf, ch4.

   Fedderke, Notes, ch2.

3. Session: Time Series Properties and Concepts II

   Banerjee, A., Dolado, J., Galbraith, J.W., and Hendry, D.F., 1993, *Cointegration, Error-Correction, and the Econometric Analysis of Non-stationary Data*, Oxford: University Press, ch3.

   Chatfield, C., 1996, *The Analysis of Time Series: An Introduction*, Chapman & Hall, ch's3&4.

   Cuthbertson, K., Hall, S.G. and Taylor, M.P., 1992, *Applied Econometric Techniques*, Harvester Wheatsheaf, ch3.

   Enders, W., 1995, *Applied Econometric Time Series*, John Wiley, ch2.

   Mills, T.C., 1993, *The Econometric Modelling of Financial Time Series*, Cambridge; University Press, ch2.

   Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch9.

   Fedderke, Notes, ch4.

4. Session: ARCH and GARCH

   Bollerslev, T., 1986, Generalized Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics*, 31, 307-27.

   Enders, W., 1995, *Applied Econometric Time Series*, John Wiley, ch3.

Engle, R.F., 1982, Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation, *Econometrica*, 50, 987-1006.

Engle, R.F., Lilien, D.M., and Robins, R.P., 1987, Estimating Time-Varying Risk Premia in the Term Structure: The ARCH-M Model, *Econometrica*, 55, 391-407.

Engle, R.F., and Ng, V.K., 1993, Measuring and Testing the Impact of News on Volatility, *Journal of Finance*, 48, 1749-78.

Mills, T.C., 1993, *The Econometric Modelling of Financial Time Series*, Cambridge; University Press, ch4&7.

Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, palgrave, ch16.

Fedderke, Notes, ch3.

5. Session: Integration and Cointegration I

   Banerjee, A., Dolado, J., Galbraith, J.W., and Hendry, D.F., 1993, *Cointegration, Error-Correction, and the Econometric Analysis of Non-stationary Data*, Oxford: University Press, ch 5,6.

   Engle, R.F., and Granger, C.W.J., 1987, Co-integration and Error Correction: Reepresentation, Estimation and Testing, *Econometrica*, 55, 251-76.

   Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 6.

   Fedderke, Notes, ch4,5.

6. Session: Univariate Time Series Properties of Data

   Banerjee, A., Dolado, J., Galbraith, J.W., and Hendry, D.F., 1993, *Cointegration, Error-Correction, and the Econometric Analysis of Non-stationary Data*, Oxford: University Press, ch 4.

   Banerjee, A., 1995, Dynamic Specification and Testing for Unit Roots and Cointegration, in K.D.Hoover (ed.), *Macroeconometrics: Developments, Tensions and Prospects*, Dordrecht: Kluwer Academic Publishers, 1995.

   Dickey, D.A., and Fuller, W.A., 1979, Distribution of the estimators for autoregressive time series with a unit root, *Journal of the American Statistical Association*, 74, 427-31.

   Dickey, D.A., and Fuller, W.A., 1981, Likelihood ratio test statistics for autoregressive time series with a unit root, *Econometrica*, 49, 1057-72.

   Holden, D., and Perman, R., 1994, Unit Roots and Cointegration for the Economist, in B.B. Rao, (ed.), *Cointegration for the Applied Economist*, London: Macmillan.

   Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 6,7.

Perron, P., 1994, Trend, Unit Root and Structural Change in Macroeconomic Time Series, in B.B. Rao, (ed.), *Cointegration for the Applied Economist*, London: Macmillan.

Maddala, G.S., and Kim, I-M., *Unit Roots, Cointegration and Structural Change*, Cambridge: University Press, ch 4.

Agiakoglu, C., and Newbold, P., 1992, Empirical Evidence on Dickey-Fuller Type Tests, *Journal of Time Series Aanalysis*, 13, 471-83.

De Jong, D.N., Nankervis, J.C., Savin, N.E., and Whiteman, 1992, The Power Problems of Unit Root Tests in Time Series with Autoregressive Errors, *Journal of Econometrics*, 53, 323-43.

Schwert, G.W., 1989, Tests for Unit Roots: A Monte Carlo Investigation, *Journal of Business and Economic Statistics*, 7, 147-59.

Anderson, T.W., 1971, *The Statistical Analysis of Time Series*, New York: John Wiley & Sons, ch's 6-9.

Chatfield, C., *The Analysis of Time Series*, 5'th ed., Chapman & Hall, ch 7.

7. Session: Single Equation Approaches to Estimation under Nonstationary Data: Integration and Cointegration II

Banerjee, A., Dolado, J., Galbraith, J.W., and Hendry, D.F., 1993, *Cointegration, Error-Correction, and the Econometric Analysis of Non-stationary Data*, Oxford: University Press, ch 5,6,7.

Engle, R.F., and Granger, C.W.J., 1987, Co-integration and Error Correction: Representation, Estimation and Testing, *Econometrica*, 55, 251-76.

Engle, R.F., and Yoo, B.S., 1991, Cointegrated econoic time series: An overview with new results, in R.F.Engle and C.W.J.Granger (eds.), *Long-Run Economic Relationships*, Oxford: University Press, 237-66.

Mankiw, N.G., and Shapiro, M.D., 1986, Do We Rejct Too Often? *Economics Letters*, 20, 139-45.

Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 8.

Phillips, P.C.B., 1986, Understanding Spurious Regressions in Econometrics, *Journal of Econometrics*, 33, 311-40.

Phillips, P.C.B., 1987, Time Series Regression with a Unit Root, *Econometrica*, 55, 277-301.

Stock, J.H., 1987, Asymptotic Properties of Least-Squares Estimators of Co-integrating Vectors, *Econometrica*, 55, 1035-56.

Also:

Granger, C.W.J., and Newbold, P., 1974, Spurious Regressions in Econometrics, Journal of Econometrics, 2, 111-20.

Hansen, B.E., 1992, Testing for Parameter Instability in Linear Models, *Journal of Policy Modeling*, 14, 517-33.

MacKinnon, J.G., 1991, Critical Values for Cointegration Tests, in R.F.Engle and C.W.J.Granger (eds.), *Long-Run Economic Relationships*, Oxford: University Press, 267-76.

Yule, G.U., 1926, Why Do We Sometimes Get Nonsense Correlations Between Time Series? A Study in Sampling and the Nature of Time Series, *Journal of the Royal Statistical Society*, 89, 1-64.

8. Session 8:

Banerjee, A., Dolado, J., Galbraith, J.W., and Hendry, D.F., 1993, *Cointegration, Error-Correction, and the Econometric Analysis of Non-stationary Data*, Oxford: University Press, ch 8.

Johansen, S., 1991, Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, *Econometrica*, 59(6), 1551-80.

Johansen, S., and Juselius, K., 1990, Maximum Likelyhood Estimation and Inference on Cointegration - with applications to the demand for money, *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.

Johansen, S., and Juselius, K., 1992, Testing structural hypotheses in a multivariate cointegrating analysis of the PPP and the UIP for UK, *Journal of Econometrics*, 53, 211-44.

Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 14.

Wickens, M.R., 1996, Interpreting cointegrating vectors and common stochastic trends, *Journal of Econometrics*, 74, 255-71.

9. Session 9: The demand for money

Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 10, 15.

10. Session 10: The term structure of interest rates

Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 11.

11. Session 11: The Phillips curve

Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 12.

12. Session 12: The exchange rate and purchasing power parity

Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 13, 15.

13. Session 13: Wage differentials in the US

    Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 15.

14. Session 14: The IS/LM model

    Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 15.

15. Session 15: The Demand for Imports

    Patterson, K., 2000, *An Introduction to Applied Econometrics: a time series approach*, Palgrave, ch 15.

8 Problem Sets

8.1 Stationarity

1. Suppose that you are told that the data generating process of a time series is given by:
$$\left(1-\rho_1 L-\rho_2 L^2\right) y_t=u_t$$
where L denotes the lag operator. Now discuss the stationarity properties of y_t under the following conditions, explaining your answer in each instance:

   (a) Given $\rho_2 = 0$, consider:
      i. $\rho_1 < 1$
      ii. $\rho_1 > 1$
      iii. $\rho_1 = 1$

   (b) Given $\rho_2 = 0.2$, consider:
      i. $\rho_1 < 1$
      ii. $\rho_1 > 1$
      iii. $\rho_1 = 1$

   (c) Given $\rho_1 = 0$, consider:
      i. $\rho_2 < 1$
      ii. $\rho_2 > 1$
      iii. $\rho_2 = 1$

   (d) Given $\rho_1 < 1$, consider:
      i. $\rho_2 < 1$
      ii. $\rho_2 > 1$
      iii. $\rho_2 = 1$

   (e) Given $\rho_1 = 1$, consider:
      i. $\rho_2 < 1$
      ii. $\rho_2 > 1$
      iii. $\rho_2 = 1$

   (f) Demonstrate that your analytical fidnigns hold under numerical suimulation.

2. Suppose that you are told that the data generating process of a time series is given by:
$$\left(1-\rho_1 L-\rho_2 L^2\right) y_t=\delta+u_t$$
where L denotes the lag operator. Now discuss the stationarity properties of y_t under the following conditions, explaining your answer in each instance:

(a) Given $\rho_2 = 0$, consider:

   i. $\rho_1 < 1$
   ii. $\rho_1 > 1$
   iii. $\rho_1 = 1$

(b) Given $\rho_2 = 0.2$, consider:

   i. $\rho_1 < 1$
   ii. $\rho_1 > 1$
   iii. $\rho_1 = 1$

(c) Given $\rho_1 = 0$, consider:

   i. $\rho_2 < 1$
   ii. $\rho_2 > 1$
   iii. $\rho_2 = 1$

(d) Given $\rho_1 < 1$, consider:

   i. $\rho_2 < 1$
   ii. $\rho_2 > 1$
   iii. $\rho_2 = 1$

(e) Given $\rho_1 = 1$, consider:

   i. $\rho_2 < 1$
   ii. $\rho_2 > 1$
   iii. $\rho_2 = 1$

(f) Demonstrate that your analytical fidnigns hold under numerical suimulation.

3. Let us begin by creating a random variable, and examining its characteristics, as a base-point for comparison.

   (a) Load the METHODTIME1000 file into a time series statistics package (such as PCGIVE, MICROFIT, EVIEWS).
   (b) Generate a random variable, labelled ut, that is normally distributed.
   (c) Plot ut, and characterise the first and second moments of its distribution (its mean and standard deviation/variance).
   (d) Calculate $\sum ut$.
   (e) Investigate the autocorrelation function of ut. Of what significance is the information you obtain?
   (f) Investigate the histogram of ut. Of what significance is the information you obtain?

4. Now generate the following time series with the ut random variable:

$$\begin{aligned}
y_t &= 0.5 + y_{t-1} + ut \\
y_t &= 1 + y_{t-1} + ut \\
y_t &= y_{t-1} + ut \\
y_t &= 0.5 + 0.5 \cdot y_{t-1} + ut \\
y_t &= 1 + 0.5 \cdot y_{t-1} + ut \\
y_t &= 0.5 \cdot y_{t-1} + ut \\
y_t &= 0.1 \cdot y_{t-1} + ut \\
y_t &= 0.95 \cdot y_{t-1} + ut \\
y_t &= 0.999 \cdot y_{t-1} + ut \\
y_t &= 0.5 + 0.5 \cdot t + ut
\end{aligned}$$

where ut is the random variable from Exercise 1, and in each case $y_0 = 1$. Now:

   (a) Given the information listed above concerning the various data generating processes, what is your prior expectation of the last value of each of the variables, and why?
   (b) Recall your evaluation of $\sum ut$. Can you make your answer to the preceding question more precise?
   (c) Observe the last value of each y_t series that you have constructed. Where your expectations fulfilled? Can you explain?
   (d) Plot the various y_t series that you have constructed, and characterise their means and variances. Explain the significance of your findings.

5. Repeat Exercise 2, but with each of the y_t series expressed in first differences.

8.2 ARCH and GARCH Problems

1. The file USWPI.XLS contains data on the US Wholesale Producer Index (henceforth the USWPI) over the 1960Q1 1992Q4 period. Load the data into MICROFIT. Derive the WPI-based inflation rate for the US (henceforth termed π). Now:

   (a) On the basis of visual inspection of the data, assess the likelihood of the presence of ARCH effects in π.
   (b) Formally demonstrate whether in:

$$\pi_t = c + \sum_{i=1}^{k} \beta_i \pi_{t-i} + \varepsilon_t \qquad (1)$$

   $ARCH(p)$ effects are present in the data.

i. Is this result sensitive to the specification of k?
ii. Is the result sensitive to the specification of p?

(c) In the light of the result you have obtained under question (1b), proceed under $ARCH(p)$ estimation of equation (1):

i. Report and assess the $ARCH(p)$ results.
ii. Report and assess the $GARCH(k, q)$ results. Is it feasible to allow $k < p, q < p$?
iii. Given the results obtained under question (1(c)ii), test for the presence of asymmetry in the impact of innovations on volatility by means of the distribution of the conditional variance and the news curve.

2. The file WHEAT.XLS contains the Beveridge (1921) annual index of European Wheat Prices, over the 1500-1869 period, as well as a detrended price index over the same period. Load the data into MICROFIT. Derive the inflation rate in European wheat prices (henceforth termed π). Now:

(a) On the basis of visual inspection of the data, assess the likelihood of the presence of ARCH effects in π.
(b) Formally demonstrate whether in:

$$\pi_t = c + \sum_{i=1}^{k} \beta_i \pi_{t-i} + \varepsilon_t \tag{2}$$

$ARCH(p)$ effects are present in the data.

i. Is this result sensitive to the specification of k?
ii. Is the result sensitive to the specification of p?

(c) In the light of the result you have obtained under question (2b), proceed under $ARCH(p)$ estimation of equation (2):

i. Report and assess the $ARCH(p)$ results.
ii. Report and assess the $GARCH(k, q)$ results. Is it feasible to allow $k < p, q < p$?
iii. Given the results obtained under question (2(c)ii), test for the presence of asymmetry in the impact of innovations on volatility by means of the distribution of the conditional variance and the news curve.

Beveridge, W.H., 1921, Weather and harvest cycles, *Economic Journal*, 31, 429-52.

3. The file WOLFER.XLS contains Waldmeier (1961) data on sunspot activity over the 1749-1924 period, computed as Wolfer's number, henceforth denoted $\mathfrak{W}$. Load the data into MICROFIT. Now:

Country Code	Country	Country Code	Country
BA	Brazil	RU	Russia
HK	Hong Kong	KO	Korea (South)
IN	Indonesia	SA	South Africa
JA	Japan	SI	Singapore
MA	Malaysia	TA	Taiwan
PH	Philippines	TH	Thailand

Table 1: Country Codes

(a) On the basis of visual inspection of the data, assess the likelihood of the presence of ARCH effects in $\mathfrak{W}$.

(b) Formally demonstrate whether in:

$$\mathfrak{W}_t = c + \sum_{i=1}^{k} \beta_i \mathfrak{W}_{t-i} + \varepsilon_t \tag{3}$$

$ARCH(p)$ effects are present in the data.

i. Is this result sensitive to the specification of k?

ii. Is the result sensitive to the specification of p?

(c) In the light of the result you have obtained under question (3b), proceed under $ARCH(p)$ estimation of equation (3):

i. Report and assess the $ARCH(p)$ results.

ii. Report and assess the $GARCH(k, q)$ results. Is it feasible to allow $k < p, q < p$?

iii. Given the results obtained under question (3(c)ii), test for the presence of asymmetry in the impact of innovations on volatility by means of the distribution of the conditional variance and the news curve.

Waldmeier, M., 1961, *Sunspot Activity in the Years 1610-1960*, Zürich: Schulthess & Co.

4. The file EXCHANGE.XLS contains exchange rate data with respect to the US-Dollar, for a number of countries. Denote the exchange rate by e_t. Data is daily, and covers the 1/1/1990 to 1/7/1997 period. Load the data into MICROFIT. Countries covered are:

Now:

(a) On the basis of visual inspection of the data, assess the likelihood of the presence of ARCH effects in e_t.

(b) Formally demonstrate whether in:

$$e_t = c + \sum_{i=1}^{k} \beta_i e_{t-i} + \varepsilon_t \tag{4}$$

Country Code	Country	Country Code	Country
BA	Brazil	RU	Russia
HK	Hong Kong	KO	Korea (South)
IN	Indonesia	SA	South Africa
JA	Japan	SI	Singapore
MA	Malaysia	TA	Taiwan
PH	Philippines	TH	Thailand

Table 2: Country Codes

$ARCH(p)$ effects are present in the data.

(c) In the light of the result you have obtained under question (4b), proceed under $GARCH(p)$ estimation of equation (4). Report and assess your results.

(d) In the light of the result you have obtained under question (4b), proceed under $AGARCH(p)$ estimation of equation (4). Report and assess your results.

(e) In the light of the result you have obtained under question (4b), proceed under $EGARCH(p)$ estimation of equation (4). Report and assess your results.

(f) Given the results obtained under questions (4c - 4e), test for the presence of asymmetry in the impact of innovations on volatility by means of the distribution of the conditional variance and the news curve.

5. The file STOCK.XLS contains stock market index data for a number of countries. Denote the rate of return on the index by R_t. Data is daily, and covers the 1/1/1990 to 30/12/1998 period. Load the data into MICROFIT. Countries covered are:

Now:

(a) On the basis of visual inspection of the data, assess the likelihood of the presence of ARCH effects in e_t.

(b) Formally demonstrate whether in:

$$R_t = c + \sum_{i=1}^{k} \beta_i R_{t-i} + \varepsilon_t \qquad (5)$$

$ARCH(p)$ effects are present in the data.

(c) In the light of the result you have obtained under question (5b), proceed under $GARCH(p)$ estimation of equation (5). Report and assess your results.

(d) In the light of the result you have obtained under question (5b), proceed under $AGARCH(p)$ estimation of equation (5). Report and assess your results.

(e) In the light of the result you have obtained under question (5b), proceed under $EGARCH(p)$ estimation of equation (5). Report and assess your results.

(f) Given the results obtained under questions (5c - 5e), test for the presence of asymmetry in the impact of innovations on volatility by means of the distribution of the conditional variance and the news curve.

8.3 Spurious Regression Problems

1. Load the data file labelled METHOD1000 into a time series statistical analysis package. Now:

   (a) Construct two distinct random variables, $ut, vt \sim N$.

   (b) Construct:

      i. $y_t = 1 + y_{t-1} + ut$
         $x_t = -1 + x_{t-1} + vt$

      ii. $a_t = a_{t-1} + ut$
          $b_t = b_{t-1} + vt$

      iii. $m_t = 1 + 0.5 \cdot m_{t-1} + ut$
           $n_t = -1 + 0.5 \cdot n_{t-1} + vt$

   (c) Suppose that the following regressions are proposed:

      i. $y_t = \alpha_0 + \alpha_1 \cdot x_t + \varepsilon_t$

      ii. $a_t = \beta_0 + \beta_1 \cdot b_t + \varepsilon_t$

      iii. $m_t = \gamma_0 + \gamma_1 \cdot n_t + \varepsilon_t$

   (d) What would your prior expectation be concerning $\alpha_1, \beta_1, \gamma_1$?

   (e) What would be your prior expectation concerning the $R^{2\prime}s$ of each of the regression equations?

   (f) Carry out the regressions. Do your results conform to your expectations? Can you explain your findings?

   (g) Plot the residuals of each of your regression equations. What do they imply?

2. Load the data file labelled JSE into a time series statistical analysis package. Consider the JSE variable contained in the data file. It represents the South African stock market index, in monthly frequency.

   (a) Plot the JSE index, and outline the implications of the plot.

   (b) Construct two distinct random variables, $ut, vt \sim N$.

Country Code	Country	Country Code	Country
BA	Brazil	RU	Russia
HK	Hong Kong	KO	Korea (South)
IN	Indonesia	SA	South Africa
JA	Japan	SI	Singapore
MA	Malaysia	TA	Taiwan
PH	Philippines	TH	Thailand

Table 3: Country Codes

(c) Construct:

i. $y_t = 1 + y_{t-1} + ut$
$x_t = -1 + x_{t-1} + vt$

ii. $a_t = a_{t-1} + ut$
$b_t = b_{t-1} + vt$

iii. $m_t = 1 + 0.5 \cdot m_{t-1} + ut$
$n_t = -1 + 0.5 \cdot n_{t-1} + vt$

(d) Consider the following relationships:

$$\begin{aligned} JSE &= \alpha_0 + \alpha_1 \cdot y_t + \alpha_2 \cdot x_t + \varepsilon_t \\ JSE &= \beta_0 + \beta_1 \cdot a_t + \beta_2 \cdot b_t + \varepsilon_t \\ JSE &= \gamma_0 + \gamma_1 \cdot m_t + \gamma_2 \cdot n_t + \varepsilon_t \end{aligned}$$

(e) What would your prior expectation be of the α_1, α_2; β_1, β_2; and γ_1, γ_2 coefficients, and why?

(f) What would be your expectation of the $R^{2\prime}s$ for each of your regressions, and why?

(g) Run the regressions, and report your results. Do they conform to you prior expectations? Can you explain your findings?

(h) Investigate the residual plots of each of the repressions. What do you infer from the plots?

3. The file EXCHANGE.XLS contains exchange rate data with respect to the US-Dollar, for a number of countries. Denote the exchange rate by e_t. Data is daily, and covers the 1/1/1990 to 1/7/1997 period. Load the data into MICROFIT. Countries covered are:

Now construct:

(a) i. $y_t = 1 + y_{t-1} + ut$
$x_t = -1 + x_{t-1} + vt$

ii. $a_t = a_{t-1} + ut$
$b_t = b_{t-1} + vt$

Country Code	Country	Country Code	Country
BA	Brazil	RU	Russia
HK	Hong Kong	KO	Korea (South)
IN	Indonesia	SA	South Africa
JA	Japan	SI	Singapore
MA	Malaysia	TA	Taiwan
PH	Philippines	TH	Thailand

Table 4: Country Codes

iii. $m_t = 1 + 0.5 \cdot m_{t-1} + ut$
$n_t = -1 + 0.5 \cdot n_{t-1} + vt$

(b) Suppose that the following regressions are proposed:

i. $e_{i,t} = \alpha_0 + \alpha_1 \cdot y_t + \alpha_2 \cdot x_t + \varepsilon_t$

ii. $e_{i,t} = \beta_0 + \beta_1 \cdot a_t + \beta_2 \cdot b_t + \varepsilon_t$

iii. $e_{i,t} = \gamma_0 + \gamma_1 \cdot m_t + \gamma_2 \cdot n_t + \varepsilon_t$
where $e_{i,t}$ denotes the exchange rates of the countries i, in the data set.

(c) What would your prior expectation be concerning $\alpha_1, \alpha_2, \beta_1, \beta_2, \gamma_1, \gamma_2$?

(d) What would be your prior expectation concerning the $R^{2\prime}s$ of each of the regression equations?

(e) Carry out the regressions. Do your results conform to your expectations? Can you explain your findings?

(f) Plot the residuals of each of your regression equations. What do they imply?

4. The file STOCK.XLS contains stock market index data for a number of countries. Denote the rate of return on the index by R_t. Data is daily, and covers the 1/1/1990 to 30/12/1998 period. Load the data into MICROFIT. Countries covered are:

Now construct:

(a) i. $y_t = 1 + y_{t-1} + ut$
$x_t = -1 + x_{t-1} + vt$

ii. $a_t = a_{t-1} + ut$
$b_t = b_{t-1} + vt$

iii. $m_t = 1 + 0.5 \cdot m_{t-1} + ut$
$n_t = -1 + 0.5 \cdot n_{t-1} + vt$

(b) Suppose that the following regressions are proposed:

i. $R_{i,t} = \alpha_0 + \alpha_1 \cdot y_t + \alpha_2 \cdot x_t + \varepsilon_t$

ii. $R_{i,t} = \beta_0 + \beta_1 \cdot a_t + \beta_2 \cdot b_t + \varepsilon_t$

Country Code	Country	Country Code	Country
BA	Brazil	RU	Russia
HK	Hong Kong	KO	Korea (South)
IN	Indonesia	SA	South Africa
JA	Japan	SI	Singapore
MA	Malaysia	TA	Taiwan
PH	Philippines	TH	Thailand

Table 5: Country Codes

iii. $R_{i,t} = \gamma_0 + \gamma_1 \cdot m_t + \gamma_2 \cdot n_t + \varepsilon_t$
where $R_{i,t}$ denotes the stock market rates of return of the countries i, in the data set.

(c) What would your prior expectation be concerning $\alpha_1, \alpha_2, \beta_1, \beta_2, \gamma_1, \gamma_2$?

(d) What would be your prior expectation concerning the $R^{2\prime}s$ of each of the regression equations?

(e) Carry out the regressions. Do your results conform to your expectations? Can you explain your findings?

(f) Plot the residuals of each of your regression equations. What do they imply?

8.4 Univariate Time Series Characteristics Problems

1. Load the data file EXCHANGE.XLS contains exchange rate data with respect to the US-Dollar, for a number of countries. Denote the exchange rate by e_t. Data is daily, and covers the 1/1/1990 to 1/7/1997 period. Load the data into MICROFIT. Countries covered are:

   Now:

   (a) Plot the exchange rate variables, and assess whether the variables are likely to be more useful in levels or in log transform. Hint: it will be useful to plot the variable both in levels and in log transform.

   (b) Conduct an Ermini-Hendry test on the exchange rate variables, in order to assess whether the variables are more appropriately used in log or levels form.

   (c) Use the SC criterion to assess the appropriate scale transformation of the data.

2. Load the data file STOCK.XLS contains stock market index data for a number of countries. Denote the rate of return on the index by R_t. Data is daily, and covers the 1/1/1990 to 30/12/1998 period. Load the data into MICROFIT. Countries covered are:

   Now:

Country Code	Country	Country Code	Country
BA	Brazil	RU	Russia
HK	Hong Kong	KO	Korea (South)
IN	Indonesia	SA	South Africa
JA	Japan	SI	Singapore
MA	Malaysia	TA	Taiwan
PH	Philippines	TH	Thailand

Table 6: Country Codes

(a) Plot the rate of return variables, and assess whether the variables are likely to be more useful in levels or in log transform. Hint: it will be useful to plot the variable both in levels and in log transform.

(b) Conduct an Ermini-Hendry test on the exchange rate variables, in order to assess whether the variables are more appropriately used in log or levels form.

(c) Use the SC criterion to assess the appropriate scale transformation of the data.

3. Load the data file ZAMB, providing data on monetary aggregates for Zambia. Now:

(a) Plot the M3 variable for Zambia, and assess whether the variable is likely to be more useful in levels or in log transform. Hint: it will be useful to plot the variable both in levels and in log transform.

(b) Conduct an Ermini-Hendry test on the Zambian M3 variable, in order to assess whether the variable is more appropriately used in log or levels form.

(c) Repeat the above for Zambian short-term interest rates, real GDP, and inflation rates.

(d) Use the SC criterion to assess the appropriate scale transformation of the data.

4. Create the random variables specified in Exercise 4 of Section 8.1. Now:

(a) Generate the autocorrelation function for each random variable, and interpret its meaning.

(b) Generate the spectral density function for each random variable, and interpret its meaning.

(c) Contrast the autocorrelation and spectral density functions of ut.

(d) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.

(e) Repeat with the Phillips Perron test.

(f) Repeat the above exercises on the data in first difference format.

5. Load the JSE data set once more. Now:

   (a) Generate the autocorrelation functions for JSE and INTEREST, and interpret their meaning.
   (b) Generate the spectral density functions for JSE and INTEREST, and interpret their meaning.
   (c) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.
   (d) Repeat with the Phillips Perron test.
   (e) Assess the relevance of utilizing unit roots allowing for the presence of structural breaks.
   (f) Test for the presence of seasonal unit roots.
   (g) Repeat the above exercises on the data in first difference format.

3 Load the ZAMB data set once more. Now:

   (a) Generate the autocorrelation functions for M3, TBR, INFLAT and RGDPFC, and interpret their meaning.
   (b) Generate the spectral density functions for M3, TBR, INFLAT and RGDPFC, and interpret their meaning.
   (c) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.
   (d) Repeat with the Phillips Perron test.
   (e) Assess the relevance of utilizing unit roots allowing for the presence of structural breaks.
   (f) Test for the presence of seasonal unit roots.
   (g) Repeat the above exercises on the data in first difference format.

6. Load the STOCK data set once more. Now:

   (a) Generate the autocorrelation functions for the data, and interpret their meaning.
   (b) Generate the spectral density functions for the data, and interpret their meaning.
   (c) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.
   (d) Repeat with the Phillips Perron test.
   (e) Assess the relevance of utilizing unit roots allowing for the presence of structural breaks.
   (f) Test for the presence of seasonal unit roots.

(g) Repeat the above exercises on the data in first difference format.

7. Load the EXCHANGE data set once more. Now:

   (a) Generate the autocorrelation functions for the data, and interpret their meaning.
   (b) Generate the spectral density functions for the data, and interpret their meaning.
   (c) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.
   (d) Repeat with the Phillips Perron test.
   (e) Assess the relevance of utilizing unit roots allowing for the presence of structural breaks.
   (f) Test for the presence of seasonal unit roots.
   (g) Repeat the above exercises on the data in first difference format.

8. Load the WHEAT data set once more. Now:

   (a) Generate the autocorrelation functions for the data, and interpret their meaning.
   (b) Generate the spectral density functions for the data, and interpret their meaning.
   (c) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.
   (d) Repeat with the Phillips Perron test.
   (e) Assess the relevance of utilizing unit roots allowing for the presence of structural breaks.
   (f) Test for the presence of seasonal unit roots.
   (g) Repeat the above exercises on the data in first difference format.

9. Load the WOLFER data set once more. Now:

   (a) Generate the autocorrelation functions for the data, and interpret their meaning.
   (b) Generate the spectral density functions for the data, and interpret their meaning.
   (c) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.
   (d) Repeat with the Phillips Perron test.
   (e) Assess the relevance of utilizing unit roots allowing for the presence of structural breaks.
   (f) Test for the presence of seasonal unit roots.

(g) Repeat the above exercises on the data in first difference format.

10. Load the USWPI data set once more. Now:

    (a) Generate the autocorrelation functions for the data, and interpret their meaning.
    (b) Generate the spectral density functions for the data, and interpret their meaning.
    (c) Use the Perron ADF test-sequence in order to assess the stationarity properties of the data.
    (d) Repeat with the Phillips Perron test.
    (e) Assess the relevance of utilizing unit roots allowing for the presence of structural breaks.
    (f) Test for the presence of seasonal unit roots.
    (g) Repeat the above exercises on the data in first difference format.

8.5 EG Problems

1. Load the data file labelled JSE into a time series statistical package. Create the following random variable pairs:

    (a) $y_t = 1 + y_{t-1} + ut$
    $x_t = -1 + x_{t-1} + vt$
    (b) $a_t = a_{t-1} + ut$
    $b_t = b_{t-1} + vt$
    (c) $m_t = 1 + 0.5 \cdot m_{t-1} + ut$
    $n_t = -1 + 0.5 \cdot n_{t-1} + vt$
    Now:
    (d) Given your previous results concerning the univaraite time series characteristics of the data, would it be legitimate to estimate the relationship:
    $$h_t = \alpha + \beta j_t + \varepsilon_t$$
    where h_t and j_t each represent one of the random variables in the variable pairs defined above?
    (e) What would be your theoretical prior regarding the relationship between the random variable pairs?
    (f) Is it legitimate to proceed with EG cointegration estimation?
    (g) Proceed in all instances, and discuss the quality of your results.

2. Now consider the JSE variable contained in the data file, representing the South African stock market index in monthly frequency.

(a) Consider the following relationships:

$$\begin{aligned} JSE_t &= \alpha_0 + \alpha_1 \cdot y_t + \alpha_2 \cdot x_t + \varepsilon_t \\ JSE_t &= \beta_0 + \beta_1 \cdot a_t + \beta_2 \cdot b_t + \varepsilon_t \\ JSE_t &= \gamma_0 + \gamma_1 \cdot m_t + \gamma_2 \cdot n_t + \varepsilon_t \end{aligned}$$

(b) What would be your theoretical prior regarding the relationship between the variables?

(c) Is it legitimate to proceed with EG cointegration estimation?

(d) If so, proceed, and discuss the quality of your results.

(e) Now consider the following relationship:

$$JSE_t = \theta_0 + \theta_1 YIELDS_t + \varepsilon_t$$

where YIELDS represents the JSE stock market dividend yield, provided in the JSE data file. Ensure that the univariate time series characteristics of the data are such that the proposed relationship is legitimate.

(f) What might our theoretical prior be for this relationship?

(g) Are satisfied that the univariate time series characteristics of the data is such as to allow you to proceed? Define what you mean by an appropriate relationship.

(h) Do the results confirm your theoretical priors? Explain your answer.

(i) Is it legitimate to proceed with EG cointegration estimation?

(j) If so, proceed, and discuss the quality of your results.

(k) Formulate the ECM.

(l) Discuss the quality of your results.

3. Load the ZAMB data set once more. Now:

(a) Ensure that the univariate time series characteristics of the data allow you to proceed with the estimation of a money demand function for Zambia.

(b) Are satisfied that the univariate time series characteristics of the data is such as to allow you to proceed? Define what you mean by an appropriate relationship.

(c) Do the results confirm your theoretical priors? Explain your answer.

(d) Is it legitimate to proceed with EG cointegration estimation?

(e) If so, proceed, and discuss the quality of your results.

(f) Formulate the ECM.

(g) Discuss the quality of your results.

4. In the attached data file PPPSA you will find the following variables:

- - $PPISA$ which denotes the PPI for South Africa.
  - E which denotes the exchange rate between the South African Rand and the US \$, specified as the Rand : \$ rate.
  - $PPIUSA$ which denotes the PPI for the United States of America.
  - RSA which denotes the South African short term interest rate.
  - $RUSA$ which denotes the US short term interest rate.
  - $GOLD$ which denotes the \$ price of gold.

  We know from economic theory that we can formulate the following theory concerning the determination of exchange rates:

$$eP^* = P \tag{6}$$

  where e denotes the domestic currency price per unit of foreign currency, P^* denotes foreign prices, and P domestic prices.

  We also know that uncovered interest parity suggests that:

$$i = i^* + \frac{e^e_{+1} - e}{e} \tag{7}$$

  where e^e_{+1} denotes the expected exchange rate in the next period, i the domestic interest rate, and i^* the foreign interest rate.

  Now, bearing in mind that $GOLD$ may not be entirely extraneous here:

1. (a) What would be your theoretical prior regarding the relationship between the variables?
   (b) Is it legitimate to proceed with EG cointegration estimation?
   (c) If so, proceed, and discuss the quality of your results.
   (d) Formulate the ECM.
   (e) Discuss the quality of your results.
   (f) Consider an alternative specification, which suggests that $e = F(P, P^*, i, i^*)$. Proceed by:
      i. What would be your theoretical prior regarding the relationship between the variables?
      ii. Is it legitimate to proceed with EG cointegration estimation?
      iii. If so, proceed, and discuss the quality of your results.
      iv. Formulate the ECM.
      v. Discuss the quality of your results.

8.6 EY Problems

1. Load the data file labelled JSE into a time series statistical package. Create the following random variable pairs:

   (a) $y_t = 1 + y_{t-1} + ut$
   $x_t = -1 + x_{t-1} + vt$

   (b) $a_t = a_{t-1} + ut$
   $b_t = b_{t-1} + vt$

   (c) $m_t = 1 + 0.5 \cdot m_{t-1} + ut$
   $n_t = -1 + 0.5 \cdot n_{t-1} + vt$
   Now:

   (d) Given your previous results concerning the univaraite time series characteristics of the data, would it be legitimate to estimate the relationship:
   $$h_t = \alpha + \beta j_t + \varepsilon_t$$
   where h_t and j_t each represent one of the random variables in the variable pairs defined above?

   (e) What would be your theoretical prior regarding the relationship between the random variable pairs?

   (f) Is it legitimate to proceed with EY cointegration estimation?

   (g) Proceed in all instances, and discuss the quality of your results.

2. Now consider the JSE variable contained in the data file, representing the South African stock market index in monthly frequency.

   (a) Consider the following relationships:
   $$\begin{aligned} JSE_t &= \alpha_0 + \alpha_1 \cdot y_t + \alpha_2 \cdot x_t + \varepsilon_t \\ JSE_t &= \beta_0 + \beta_1 \cdot a_t + \beta_2 \cdot b_t + \varepsilon_t \\ JSE_t &= \gamma_0 + \gamma_1 \cdot m_t + \gamma_2 \cdot n_t + \varepsilon_t \end{aligned}$$

   (b) What would be your theoretical prior regarding the relationship between the variables?

   (c) Is it legitimate to proceed with EY cointegration estimation?

   (d) Proceed in all instances, and discuss the quality of your results.

   (e) Now consider the following relationship:
   $$JSE_t = \theta_0 + \theta_1 YIELDS_t + \varepsilon_t$$
   where YIELDS represents the JSE stock market dividend yield, provided in the JSE data file. Ensure that the univariate time series characteristics of the data are such that the proposed relationship is legitimate.

(f) What might our theoretical prior be for this relationship?

(g) Is it legitimate to proceed with EY cointegration estimation?

(h) If so, proceed, and discuss the quality of your results.

3. Load the ZAMB data set once more. Now:

   (a) Ensure that the univariate time series characteristics of the data allow you to proceed with the estimation of a money demand function for Zambia.

   (b) If you are satisfied that the univariate time series characteristics of the data is such as to allow you to proceed, test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.

   (c) Do the results confirm your theoretical priors? Explain your answer.

   (d) Is it legitimate to proceed with EY cointegration estimation?

   (e) If so, proceed, and discuss the quality of your results..

4. In the attached data file PPPSA you will find the following variables:

- – $PPISA$ which denotes the PPI for South Africa.
  – E which denotes the exchange rate between the South African Rand and the US \$, specified as the Rand : \$ rate.
  – $PPIUSA$ which denotes the PPI for the United States of America.
  – RSA which denotes the South African short term interest rate.
  – $RUSA$ which denotes the US short term interest rate.
  – $GOLD$ which denotes the \$ price of gold.

  We know from economic theory that we can formulate the following theory concerning the determination of exchange rates:

$$eP^* = P \tag{8}$$

  where e denotes the domestic currency price per unit of foreign currency, P^* denotes foreign prices, and P domestic prices.

  We also know that uncovered interest parity suggests that:

$$i = i^* + \frac{e^e_{+1} - e}{e} \tag{9}$$

  where e^e_{+1} denotes the expected exchange rate in the next period, i the domestic interest rate, and i^* the foreign interest rate.

  Now, bearing in mind that $GOLD$ may not be entirely extraneous here:

1. (a) What would be your theoretical prior regarding the relationship between the variables?

(b) Now consider the PPP exchange rate relation for South Africa. Ensure that the univariate time series characteristics of the data are such that the proposed relationship is legitimate.

(c) What might our theoretical prior be for this relationship?

(d) Is it legitimate to proceed with EY cointegration estimation?

(e) If so, proceed, and discuss the quality of your results.

(f) Consider an alternative specification, which suggests that $e = F(P, P^*, i, i^*)$. Proceed by:

  i. What would be your theoretical prior regarding the relationship between the variables.

  ii. Is it legitimate to proceed with EY cointegration estimation?

  iii. If so, proceed, and discuss the quality of your results.

8.7 ARDL Problems

1. Load the data file labelled JSE into a time series statistical package. Create the following random variable pairs:

   (a) $y_t = 1 + y_{t-1} + ut$
   $x_t = -1 + x_{t-1} + vt$

   (b) $a_t = a_{t-1} + ut$
   $b_t = b_{t-1} + vt$

   (c) $m_t = 1 + 0.5 \cdot m_{t-1} + ut$
   $n_t = -1 + 0.5 \cdot n_{t-1} + vt$
   Now:

   (d) Given your previous results concerning the univaraite time series characteristics of the data, would it be legitimate to estimate the relationship:
   $$h_t = \alpha + \beta j_t + \varepsilon_t$$
   where h_t and j_t each represent one of the random variables in the variable pairs defined above?

   (e) What would be your theoretical prior regarding the relationship between the random variable pairs?

   (f) Test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.

   (g) Do the results confirm your theoretical priors? Explain your answer.

   (h) Is it legitimate to proceed with ARDL cointegration estimation?

   (i) Proceed in all instances, and discuss the quality of your results.

2. Now consider the JSE variable contained in the data file, representing the South African stock market index in monthly frequency.

   (a) Consider the following relationships:

$$\begin{aligned} JSE_t &= \alpha_0 + \alpha_1 \cdot y_t + \alpha_2 \cdot x_t + \varepsilon_t \\ JSE_t &= \beta_0 + \beta_1 \cdot a_t + \beta_2 \cdot b_t + \varepsilon_t \\ JSE_t &= \gamma_0 + \gamma_1 \cdot m_t + \gamma_2 \cdot n_t + \varepsilon_t \end{aligned}$$

   (b) What would be your theoretical prior regarding the relationship between the variables?

   (c) Test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.

   (d) Do the results confirm your theoretical priors? Explain your answer.

   (e) Is it legitimate to proceed with ARDL cointegration estimation?

   (f) Proceed in all instances, and discuss the quality of your results.

   (g) Now consider the following relationship:

$$JSE_t = \theta_0 + \theta_1 YIELDS_t + \varepsilon_t$$

   where YIELDS represents the JSE stock market dividend yield, provided in the JSE data file. Ensure that the univariate time series characteristics of the data are such that the proposed relationship is legitimate.

   (h) What might our theoretical prior be for this relationship?

   (i) If you are satisfied that the univariate time series characteristics of the data is such as to allow you to proceed, test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.

   (j) Do the results confirm your theoretical priors? Explain your answer.

   (k) Is it legitimate to proceed with ARDL cointegration estimation?

   (l) If so, proceed, and discuss the quality of your results.

3. Load the ZAMB data set once more. Now:

   (a) Ensure that the univariate time series characteristics of the data allow you to proceed with the estimation of a money demand function for Zambia.

   (b) If you are satisfied that the univariate time series characteristics of the data is such as to allow you to proceed, test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.

(c) Do the results confirm your theoretical priors? Explain your answer.

(d) Is it legitimate to proceed with ARDL cointegration estimation?

(e) If so, proceed, and discuss the quality of your results.

4. In the attached data file PPPSA you will find the following variables:

- – $PPISA$ which denotes the PPI for South Africa.
  – E which denotes the exchange rate between the South African Rand and the US \$, specified as the Rand : \$ rate.
  – $PPIUSA$ which denotes the PPI for the United States of America.
  – RSA which denotes the South African short term interest rate.
  – $RUSA$ which denotes the US short term interest rate.
  – $GOLD$ which denotes the \$ price of gold.

  We know from economic theory that we can formulate the following theory concerning the determination of exchange rates:

$$eP^* = P \tag{10}$$

  where e denotes the domestic currency price per unit of foreign currency, P^* denotes foreign prices, and P domestic prices.

  We also know that uncovered interest parity suggests that:

$$i = i^* + \frac{e^e_{+1} - e}{e} \tag{11}$$

  where e^e_{+1} denotes the expected exchange rate in the next period, i the domestic interest rate, and i^* the foreign interest rate.

  Now, bearing in mind that $GOLD$ may not be entirely extraneous here:

1. (a) What would be your theoretical prior regarding the relationship between the variables?

   (b) Test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.

   (c) Do the results confirm your theoretical priors? Explain your answer.

   (d) Is it legitimate to proceed with ARDL cointegration estimation?

   (e) If so, proceed, and discuss the quality of your results.

   (f) Now consider the PPP exchange rate relation for South Africa. Ensure that the univariate time series characteristics of the data are such that the proposed relationship is legitimate.

   (g) What might our theoretical prior be for this relationship?

(h) If you are satisfied that the univariate time series characteristics of the data is such as to allow you to proceed, test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.

(i) Do the results confirm your theoretical priors? Explain your answer.

(j) Is it legitimate to proceed with ARDL cointegration estimation?

(k) If so, proceed, and discuss the quality of your results.

(l) Consider an alternative specification, which suggests that $e = F(P, P^*, i, i^*)$. Proceed by:

   i. What would be your theoretical prior regarding the relationship between the variables?
   ii. Test for the presence of an appropriate relationship between the variables, using the ARDL PSS F-tests. Define what you mean by an appropriate relationship.
   iii. Do the results confirm your theoretical priors? Explain your answer.
   iv. Is it legitimate to proceed with ARDL cointegration estimation?
   v. If so, proceed, and discuss the quality of your results.

8.8 VECM Problems

1. In the attached data file PPPSA you will find the following variables:

- $PPISA$ which denotes the PPI for South Africa.
- E which denotes the exchange rate between the South African Rand and the US \$, specified as the Rand : \$ rate.
- $PPIUSA$ which denotes the PPI for the United States of America.
- RSA which denotes the South African short term interest rate.
- $RUSA$ which denotes the US short term interest rate.
- $GOLD$ which denotes the \$ price of gold.

We know from economic theory that we can formulate the following theory concerning the determination of exchange rates:

$$eP^* = P \tag{12}$$

where e denotes the domestic currency price per unit of foreign currency, P^* denotes foreign prices, and P domestic prices.

We also know that uncovered interest parity suggests that:

$$i = i^* + \frac{e^e_{+1} - e}{e} \tag{13}$$

where e^e_{+1} denotes the expected exchange rate in the next period, i the domestic interest rate, and i^* the foreign interest rate.

Now, bearing in mind that $GOLD$ may not be entirely extraneous here:

1. (a) Establish whether the univariate time series properties of the data is such as to make estimation of either equation 12 and/or 13 feasible by means of the Johansen approach.

   (b) Establish the number of cointegrating vectors that are present in the specifications given by equations 12 and 13, and if appropriate proceed by estimating the relationship under appropriate just-identifying restrictions. Discuss the results you obtain, paying particular attention to weak exogeneity where appropriate, to the error correction mechanism present in your data, and to the impluse response functions that you obtain from the cointegrating vectors.

   (c) Consider an alternative specification, which suggests that $e = F(P, P^*, i, i^*)$. Proceed by:

      i. Discussing the a priori appropriate restrictions that you might wish to impose on the cointegrating space. You may need to consider the possibility of both multiple cointegrating vectors, as well as the possibility of using conditioning assumptions in the process of identification.

      ii. Proceed to estimation, first establishing the number of cointegrating vectors present in the data.

      iii. Discuss the results you obtain, with particular reference to whether or not they confirm or falsify the theoretical propositions from which you began. Further analyse the results you obtain in the light of the weak exogeneity properties where appropriate, to the error correction mechanism present in your data, and to the impluse response functions that you obtain from the cointegrating vectors.

2.

9 Possible Term Project Topics

Term projects should take the form of a tightly structured exposition of relevant theory, data structure, and relevant estimation results together with an evaluation of the results.

9.1 ARCH & GARCH Projects

Possible topics include, but are not restricted to:

1. Modelling inflation. Preference will be given to South African or developing country applications. The requirement is that any project contrast two different countries' inflation rate processes.

2. Savings rates. Preference will be given to South African or developing country applications. The requirement is that any project contrast two different countries' savings rate processes.

3. Excess returns in yields. Preference will be given to South African or developing country applications. The requirement is that any project contrast two different countries' savings rate processes.

4. Asymmetry in returns on stock market indexes. Preference will be given to South African or developing country applications. The requirement is that any project contrast two different countries' savings rate processes.

Alternative and motivated modelling exercises will be considered on application. Crucial to the evaluation of any proposal will be the feasibility of the underlying modelling exercise.

9.2 Structural Modelling Projects

Possible topics include, but are not restricted to:

1. The demand for money. Preference will be given to South African or developing country applications.

2. The term structure of interest rates. Preference will be given to South African or developing country applications.

3. The Phillips curve. Preference will be given to South African or developing country applications.

4. The exchange rate and purchasing power parity. Preference will be given to South African or developing country applications.

5. The IS/LM model. Preference will be given to South African or developing country applications.

6. Import demand functions. Preference will be given to South African or developing country applications.