PDF RENDERIZATION OF examples.R

```
################################################
# Define dataset of usage (data.table required) and selected variables for coint. analysis. The dependa

library(data.table) # for simple and performant data manipulation
library(plm) # needed for systemfit to handle panel structure
```

```
##
## Attaching package: 'plm'
```

```
## The following object is masked from 'package:data.table':
##
##     between
```

```
library(systemfit) # for FGLS system linear models
```

```
## Loading required package: Matrix
```

```
## Loading required package: car
```

```
## Loading required package: carData
```

```
## Loading required package: lmtest
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
##
## Please cite the 'systemfit' package as:
## Arne Henningsen and Jeff D. Hamann (2007). systemfit: A Package for Estimating Systems of Simultaneou
##
## If you have questions, suggestions, or comments regarding the 'systemfit' package, please use a forum
## https://r-forge.r-project.org/projects/systemfit/
```

```
library(magrittr) # For piping with %>% without dplyr dependencies
library(aod) # for performing F Bounds test

# install and import this library
library(systemfitECM)

# Create the sample dataset
set.seed(1234) # For reproducibility
countries <- c("Austria", "Germany", "Italy")
period <- 1992:2019
table_dt <- data.table(
    reporter = rep(countries, each = length(period)),
    year = rep(period, length(countries)),
    tech_exports = rnorm(length(countries) * length(period), 5000, 1000), # Sample tech_exports data
    rprices = rnorm(length(countries) * length(period), 100, 20), # Sample rprices data
    fincome = rnorm(length(countries) * length(period), 40000, 5000), # Sample fincome data
    investment = rnorm(length(countries) * length(period), 40000, 5000), # Sample rprices data
    consumption = rnorm(length(countries) * length(period), 40000, 5000) # Sample fincome data
```

```
)

# Set remaining control parameters
sel_variables <- c("tech_exports", "rprices", "fincome") # first is dependant variable in systemfit
instruments <- c("fincome", "investment", "consumption") # first is endogenous regressor and remaining
method <- "SUR"
estimation3SLS <- "EViews"
lags <- 2
iterations <- 1


# Get an Unrestricted ECM using systemfit methods
pre_exp <- uecm_systemfit(
    dt = table_dt,
    col_names = sel_variables,
    nlags = lags,
    grouping = "reporter",
    method = method,
    iterations = iterations,
    method_solv = estimation3SLS, # only 3sls,
    inst_list = instruments # endo first, then remaining
)
pre_exp %>%
    summary() %>%
    print()
```

```
##
## systemfit results
## method: SUR
##
##         N DF      SSR     detRCov   OLS-R2 McElroy-R2
## system 78 54 54654981 1.99784e+17 0.605906   0.689013
##
##          N DF      SSR     MSE     RMSE       R2   Adj R2
## Austria 26 18 20244973 1124721 1060.529 0.597843 0.441448
## Germany 26 18 14060731  781152  883.828 0.483310 0.282375
## Italy   26 18 20349277 1130515 1063.257 0.667121 0.537668
##
## The covariance matrix of the residuals used for estimation
##          Austria Germany    Italy
## Austria 760982.3  167603 -77634.2
## Germany 167603.4  515581 160551.5
## Italy   -77634.2  160552 762267.1
##
## The covariance matrix of the residuals
##         Austria Germany   Italy
## Austria  778653  304595 -106477
## Germany  304595  540797  217755
## Italy   -106477  217755  782665
##
## The correlations of the residuals
##           Austria  Germany     Italy
## Austria  1.000000 0.469389 -0.136394
## Germany  0.469389 1.000000  0.334706
```

```
## Italy   -0.136394 0.334706  1.000000
##
##
## SUR estimates for 'Austria' (equation 1)
## Model Formula: Austria_tech_exports_diff ~ Austria_rprices_diff + Austria_fincome_diff +
##     Austria_tech_exports_lag1 + Austria_rprices_lag1 + Austria_rprices_lag2 +
##     Austria_fincome_lag1 + Austria_fincome_lag2
## <environment: 0x559f25db5120>
##
##                       Estimate   Std. Error  t value  Pr(>|t|)
## (Intercept)       6037.8083306 2272.9879481  2.65633  0.016072 *
## rprices_diff         7.1391458   11.3708283  0.62785  0.537989
## fincome_diff         0.0177894    0.0286941  0.61997  0.543048
## tech_exports_lag1   -1.2319512    0.1855446 -6.63965 3.124e-06 ***
## rprices_lag1         3.2241948   14.4189596  0.22361  0.825581
## rprices_lag2       -20.2585350   13.1331131 -1.54255  0.140337
## fincome_lag1         0.0157863    0.0396285  0.39836  0.695052
## fincome_lag2         0.0229561    0.0279645  0.82090  0.422442
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1060.528508 on 18 degrees of freedom
## Number of observations: 26 Degrees of Freedom: 18
## SSR: 20244972.909698 MSE: 1124720.717205 Root MSE: 1060.528508
## Multiple R-Squared: 0.597843 Adjusted R-Squared: 0.441448
##
##
## SUR estimates for 'Germany' (equation 2)
## Model Formula: Germany_tech_exports_diff ~ Germany_rprices_diff + Germany_fincome_diff +
##     Germany_tech_exports_lag1 + Germany_rprices_lag1 + Germany_rprices_lag2 +
##     Germany_fincome_lag1 + Germany_fincome_lag2
## <environment: 0x559f25db5120>
##
##                       Estimate   Std. Error  t value Pr(>|t|)
## (Intercept)       -2.15899e+03  2.51532e+03 -0.85834 0.401991
## rprices_diff       5.31883e+00  7.49499e+00  0.70965 0.487013
## fincome_diff       1.24792e-02  3.27609e-02  0.38092 0.707724
## tech_exports_lag1 -7.73714e-01  2.09777e-01 -3.68827 0.001682 **
## rprices_lag1       2.32199e+00  1.15637e+01  0.20080 0.843106
## rprices_lag2       7.63021e+00  7.15314e+00  1.06669 0.300209
## fincome_lag1       5.84161e-02  4.05650e-02  1.44006 0.167017
## fincome_lag2       5.22909e-02  3.42182e-02  1.52816 0.143855
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 883.827889 on 18 degrees of freedom
## Number of observations: 26 Degrees of Freedom: 18
## SSR: 14060731.261804 MSE: 781151.736767 Root MSE: 883.827889
## Multiple R-Squared: 0.48331 Adjusted R-Squared: 0.282375
##
##
## SUR estimates for 'Italy' (equation 3)
## Model Formula: Italy_tech_exports_diff ~ Italy_rprices_diff + Italy_fincome_diff +
##     Italy_tech_exports_lag1 + Italy_rprices_lag1 + Italy_rprices_lag2 +
```

```
##     Italy_fincome_lag1 + Italy_fincome_lag2
## <environment: 0x559f25db5120>
##
##                       Estimate   Std. Error  t value   Pr(>|t|)
## (Intercept)       8796.0837142 3696.3609208  2.37966  0.0285945 *
## rprices_diff        -3.1626627   11.6225478 -0.27211  0.7886308
## fincome_diff        -0.0133641    0.0385372 -0.34678  0.7327748
## tech_exports_lag1   -0.9978453    0.1822593 -5.47487 3.3615e-05 ***
## rprices_lag1       -20.5271170   14.5076880 -1.41491  0.1741613
## rprices_lag2        14.6201925   13.2525644  1.10320  0.2844728
## fincome_lag1        -0.1373035    0.0441797 -3.10784  0.0060742 **
## fincome_lag2         0.0627692    0.0394548  1.59091  0.1290384
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1063.25698 on 18 degrees of freedom
## Number of observations: 26 Degrees of Freedom: 18
## SSR: 20349277.297539 MSE: 1130515.405419 Root MSE: 1063.25698
## Multiple R-Squared: 0.667121 Adjusted R-Squared: 0.537668
```

```r
# Apply and F Bound-Test for equations in systems following Pesaran (2001)
bounds_F_results <- systemfit_boundsF_test(
    system_ecm = pre_exp,
    units = countries,
    sel_variables = sel_variables
)
bounds_F_results %>%
    print()
```

```
## [1] 14.85674  5.95483 10.79634
```

```r
# get an example panel series ECT
ect_test <- get_ect_systemfit(
    systemfit_uecm_coefs = pre_exp,
    nperiods = length(period),
    nunits = length(countries),
    sel_variables = sel_variables,
    table_dt = table_dt
)
ect_test %>%
    print()
```

```
##     key time       ect_x
##  1:   1    1          NA
##  2:   1    2  2994.70896
##  3:   1    3  6856.07233
##  4:   1    4  2985.57547
##  5:   1    5   377.82822
##  6:   1    6 14783.76374
##  7:   1    7  2447.86498
##  8:   1    8  3563.34431
##  9:   1    9  6142.81153
## 10:   1   10  2110.69837
## 11:   1   11  1022.74676
## 12:   1   12 14219.84751
```

```
## 13:   1   13   -73.48052
## 14:   1   14  3683.91127
## 15:   1   15  6970.70110
## 16:   1   16  3054.12668
## 17:   1   17  2221.94947
## 18:   1   18 15269.91420
## 19:   1   19  -377.38292
## 20:   1   20  3310.19071
## 21:   1   21  8659.72380
## 22:   1   22  2392.01664
## 23:   1   23  2213.55467
## 24:   1   24 13357.92070
## 25:   1   25  2327.14308
## 26:   1   26  3564.01469
## 27:   1   27  4883.69201
## 28:   1   28  2374.87457
## 29:   2    1          NA
## 30:   2    2 14697.78699
## 31:   2    3   137.61765
## 32:   2    4  5316.42765
## 33:   2    5  6699.50573
## 34:   2    6  1632.04577
## 35:   2    7  2012.74681
## 36:   2    8 13644.17161
## 37:   2    9  -361.68260
## 38:   2   10  2035.73081
## 39:   2   11  4568.28172
## 40:   2   12  1496.21679
## 41:   2   13  1887.87821
## 42:   2   14 17197.89431
## 43:   2   15   277.05167
## 44:   2   16  3376.62199
## 45:   2   17  5417.83888
## 46:   2   18  1023.70952
## 47:   2   19  2027.33724
## 48:   2   20 13813.12947
## 49:   2   21  -440.14816
## 50:   2   22  3772.95886
## 51:   2   23  6374.80760
## 52:   2   24   785.56792
## 53:   2   25  2012.45404
## 54:   2   26 14269.12926
## 55:   2   27   366.92429
## 56:   2   28  3869.59089
## 57:   3    1          NA
## 58:   3    2  4004.75558
## 59:   3    3  1876.66501
## 60:   3    4 19285.36074
## 61:   3    5  -320.46341
## 62:   3    6  4899.26332
## 63:   3    7  9161.96142
## 64:   3    8  2408.41163
## 65:   3    9  2037.30726
## 66:   3   10 14184.19946
```

```
## 67:   3   11  2657.12291
## 68:   3   12  3086.41122
## 69:   3   13  8010.35048
## 70:   3   14  4625.28593
## 71:   3   15  3181.84199
## 72:   3   16 14849.15956
## 73:   3   17   -22.90016
## 74:   3   18  3867.68998
## 75:   3   19  6466.88446
## 76:   3   20  4857.68909
## 77:   3   21  2426.81239
## 78:   3   22 13549.02362
## 79:   3   23   292.27859
## 80:   3   24  4418.71450
## 81:   3   25  5958.62992
## 82:   3   26  2151.49109
## 83:   3   27  2378.56135
## 84:   3   28 14657.33157
##     key time       ect_x
```

```r
# Finally, get a Restricted ECM using systemfit methods
pos_exp <- recm_systemfit(
    uecm_model = pre_exp,
    dt = table_dt,
    col_names = sel_variables,
    nlags = lags,
    grouping = "reporter",
    method = method,
    iterations = iterations,
    nunits = length(countries),
    nperiods = length(period),
    method_solv = estimation3SLS, # only 3sls,
    inst_list = instruments # endo first, then remaining
)
pos_exp %>%
    summary() %>%
    print()
```

```
##
## systemfit results
## method: SUR
##
##         N DF      SSR     detRCov   OLS-R2 McElroy-R2
## system 78 57 29318615 3.48132e+16 0.788596   0.812207
##
##          N DF      SSR    MSE    RMSE       R2   Adj R2
## Austria 26 19 11915327 627122 791.911 0.763307 0.688562
## Germany 26 19  4498980 236788 486.609 0.834676 0.782468
## Italy   26 19 12904308 679174 824.120 0.788908 0.722247
##
## The covariance matrix of the residuals used for estimation
##          Austria  Germany    Italy
## Austria 451736.9  60096.8   8409.8
## Germany  60096.8 171523.1 -18271.3
## Italy     8409.8 -18271.3 495023.2
```

```
##
## The covariance matrix of the residuals
##          Austria  Germany    Italy
## Austria 458281.8  89551.6  15387.7
## Germany  89551.6 173037.7 -30932.0
## Italy    15387.7 -30932.0 496319.5
##
## The correlations of the residuals
##           Austria   Germany      Italy
## Austria 1.0000000  0.318007  0.0322646
## Germany 0.3180071  1.000000 -0.1055496
## Italy   0.0322646 -0.105550  1.0000000
##
##
## SUR estimates for 'Austria' (equation 1)
## Model Formula: Austria_tech_exports_diff ~ Austria_rprices_diff + Austria_fincome_diff +
##     Austria_tech_exports_diff2 + Austria_rprices_diff2 + Austria_fincome_diff2 +
##     Austria_ect
## <environment: 0x559f2a587db8>
##
##                         Estimate   Std. Error  t value   Pr(>|t|)
## (Intercept)        -4.03604e+02  2.03395e+02 -1.98433   0.061853 .
## rprices_diff        1.12793e+01  1.25762e+01  0.89688   0.381008
## fincome_diff       -1.96131e-03  2.57621e-02 -0.07613   0.940110
## tech_exports_diff2  5.63734e-01  5.83772e-02  9.65675 9.2105e-09 ***
## rprices_diff2      -9.31231e+00  7.76668e+00 -1.19901   0.245265
## fincome_diff2       2.89546e-03  1.61378e-02  0.17942   0.859506
## ect                 8.74136e-02  3.19230e-02  2.73826   0.013063 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 791.91066 on 19 degrees of freedom
## Number of observations: 26 Degrees of Freedom: 19
## SSR: 11915327.37602 MSE: 627122.493475 Root MSE: 791.91066
## Multiple R-Squared: 0.763307 Adjusted R-Squared: 0.688562
##
##
## SUR estimates for 'Germany' (equation 2)
## Model Formula: Germany_tech_exports_diff ~ Germany_rprices_diff + Germany_fincome_diff +
##     Germany_tech_exports_diff2 + Germany_rprices_diff2 + Germany_fincome_diff2 +
##     Germany_ect
## <environment: 0x559f2a587db8>
##
##                         Estimate   Std. Error  t value   Pr(>|t|)
## (Intercept)         57.60248709 117.23907401  0.49132    0.62882
## rprices_diff        17.01856387   6.51001541  2.61421    0.01706 *
## fincome_diff        -0.00778215   0.02814897 -0.27646    0.78518
## tech_exports_diff2   0.53324520   0.05451505  9.78161 7.5022e-09 ***
## rprices_diff2       -6.19108485   3.58666030 -1.72614    0.10055
## fincome_diff2       -0.01062862   0.01535461 -0.69221    0.49718
## ect                 -0.00618245   0.01923229 -0.32146    0.75137
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 486.609119 on 19 degrees of freedom
## Number of observations: 26 Degrees of Freedom: 19
## SSR: 4498980.252348 MSE: 236788.434334 Root MSE: 486.609119
## Multiple R-Squared: 0.834676 Adjusted R-Squared: 0.782468
##
##
## SUR estimates for 'Italy' (equation 3)
## Model Formula: Italy_tech_exports_diff ~ Italy_rprices_diff + Italy_fincome_diff +
##     Italy_tech_exports_diff2 + Italy_rprices_diff2 + Italy_fincome_diff2 +
##     Italy_ect
## <environment: 0x559f2a587db8>
##
##                         Estimate   Std. Error  t value   Pr(>|t|)
## (Intercept)        -288.1468010  217.9266723 -1.32222   0.201793
## rprices_diff         -6.3570450   14.1880263 -0.44806   0.659179
## fincome_diff         -0.0763235    0.0400151 -1.90737   0.071706 .
## tech_exports_diff2    0.4754335    0.0565842  8.40223 8.0268e-08 ***
## rprices_diff2         7.5212556    9.0844796  0.82792   0.417992
## fincome_diff2         0.0625594    0.0258035  2.42446   0.025473 *
## ect                   0.0455283    0.0288816  1.57638   0.131443
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 824.12019 on 19 degrees of freedom
## Number of observations: 26 Degrees of Freedom: 19
## SSR: 12904307.673067 MSE: 679174.088056 Root MSE: 824.12019
## Multiple R-Squared: 0.788908 Adjusted R-Squared: 0.722247
```