A MATLAB LIBRARY OF TEMPORAL DISAGGREGATION METHODS: SUMMARY

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1. INTRODUCTION

This release of the Matlab temporal disaggregation library includes some new features:

- stock first as a temporal disaggregation case (interpolation)
- new graphs for univariate Denton
- univariate Denton, proportional variant
- univariate temporal disaggregation by means of an ARIMA model-based procedure due to Guerrero (1990)
- multivariate temporal disaggregation by means of an two-step method due to Rossi (1982). The first step requires a preliminary univariate disaggregation that may be perfomed by Fernández, Chow-Lin or Litterman.

The library includes a set of function to perform temporal disaggregation (distribution, averaging and interpolation), according to the following structure:

Adjustment or quadratic programming methods:

- bfl (Boot-Feibes-Lisman)
- denton_uni, denton_uni_prop
- sw (Stram-Wei method)

served by: tduni_print (ASCII output), tduni_plot (graphic output)

Model-based (or BLUE) methods:

- chowlin
- fernandez
- litterman
- ssc (Santos Silva-Cardoso method: a dynamic version of Chow-Lin)

served by: td_print (ASCII output), td_plot (graphic output)

- guerrero

served by: td_print_G (ASCII output), td_plot (graphic output)

Multivariate methods that include a transversal restriction:

- rossi
- denton
- difonzo

served by: mtd_print (ASCII output), mtd_plot (graphic output)

Extrapolation is feasible using chowlin, fernandez, litterman, ssc and difonzo. Constrained extrapolation can be performed also by means of difonzo.

The presentation of the functions is self-contained: help text, script to run the function and output (ASCII file and plots).

This library is rather specific. Combining it with the *Econometrics Toolbox* of Professor James LeSage is a sensible decision. In fact, some procedures require to have access to it, although this dependence may be circumvented by appropriate code modification. For more information, consult his Internet site:

http://jpl.econ.utoledo.edu/faculty/lesage

2. BOOT-FEIBES-LISMAN

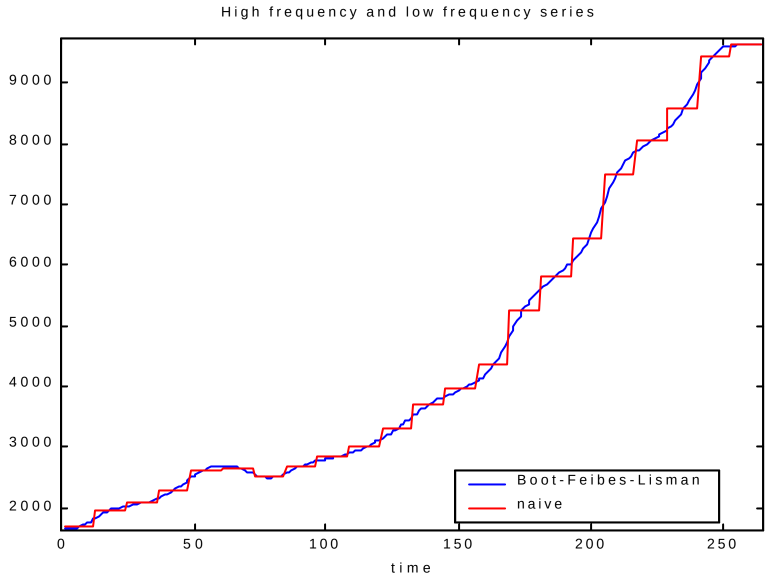
```
PURPOSE: Temporal disaggregation using the Boot-Feibes-Lisman method
---------------------------------------------------------------------
SYNTAX: res=bfl(Y,ta,d,s);
---------------------------------------------------------------------
OUTPUT: res: a structure
        res.meth  = 'Boot-Feibes-Lisman';
        res.N     = Number of low frequency data
        res.ta    = Type of disaggregation
        res.s     = Frequency conversion
        res.d     = Degree of differencing
        res.y     = High frequency estimate
        res.et    = Elapsed time
---------------------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
        ta: type of disaggregation
            ta=1 ---> sum (flow)
            ta=2 ---> average (index)
            ta=3 ---> last element (stock) ---> interpolation
            ta=4 ---> first element (stock) ---> interpolation
        d: objective function to be minimized: volatility of ...
            d=0 ---> levels
            d=1 ---> first differences
            d=2 ---> second differences
        s: number of high frequency data points for each low frequency data point
            s= 4 ---> annual to quarterly
            s=12 ---> annual to monthly
            s= 3 ---> quarterly to monthly
---------------------------------------------------------------------
LIBRARY: sw
---------------------------------------------------------------------
SEE ALSO: tduni_print, tduni_plot
---------------------------------------------------------------------
REFERENCE: Boot, J.C.G., Feibes, W. y Lisman, J.H.C. (1967)
"Further methods of derivation of quarterly figures from annual data",
Applied Statistics, vol. 16, n. 1, p. 65-75.
```

Application:

```
Y=load('c:\x\td\data\Y.anu');
res=bfl(Y,1,1,12);
tduni_print(res,'td.sal');
tduni_plot(res);
edit td.sal
```

ASCII file containing detailed output:

```
 ****************************************************
 TEMPORAL DISAGGREGATION METHOD: Boot-Feibes-Lisman
 ****************************************************
----------------------------------------------------
 Number of low-frequency observations  :   22
 Frequency conversion                  :   12
 Number of high-frequency observations :  264
 ----------------------------------------------------
 Degree of differencing                :    1
 Type of disaggregation: sum (flow).
 ----------------------------------------------------
 High frequency series (columnwise):
 ----------------------------------------------------
 4972.2800
 4971.1389
 .........
 .........
 .........
 7898.7692
 7899.3631
 7899.6600
 ----------------------------------------------------
 Elapsed time:   0.3200
```



3. STRAM-WEI

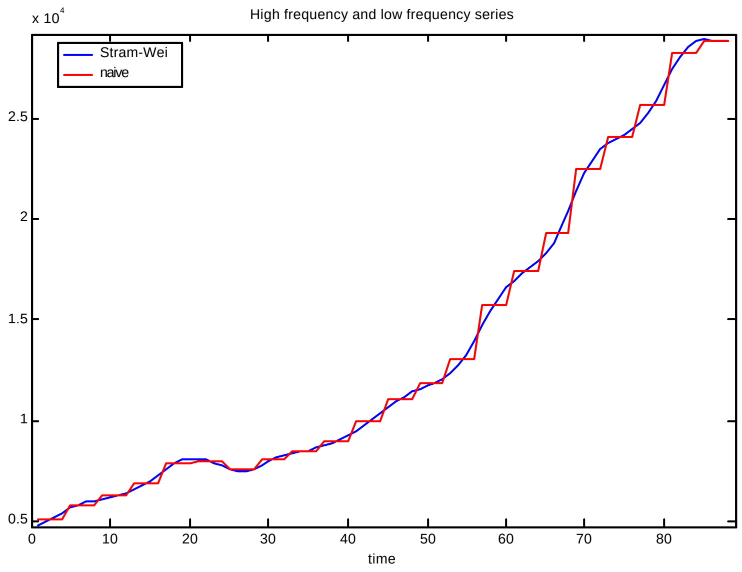
```
PURPOSE: Temporal disaggregation using the Stram-Wei method.
---------------------------------------------------------------------
SYNTAX: res = sw(Y,ta,d,s,v);
---------------------------------------------------------------------
OUTPUT: res: a structure
       res.meth  = 'Stram-Wei';
       res.N     = Number of low frequency data
       res.ta    = Type of disaggregation
       res.d     = Degree of differencing
       res.s     = Frequency conversion
       res.H     = nxN temporal disaggregation matrix
       res.y     = High frequency estimate
       res.et    = Elapsed time
---------------------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
      ta: type of disaggregation
           ta=1 ---> sum (flow)
           ta=2 ---> average (index)
           ta=3 ---> last element (stock) ---> interpolation
           ta=4 ---> first element (stock) ---> interpolation
      d: number of unit roots
      s: number of high frequency data points for each low frequency data point
         s= 4 ---> annual to quarterly
         s=12 ---> annual to monthly
         s= 3 ---> quarterly to monthly
      v: (n-d)x(n-d) VCV matrix of high frequency stationary series
---------------------------------------------------------------------
LIBRARY: aggreg, aggreg_v, dif, movingsum
---------------------------------------------------------------------
SEE ALSO: bfl, tduni_print, tduni_plot
---------------------------------------------------------------------
REFERENCE: Stram, D.O. & Wei, W.W.S. (1986) "A methodological note on the
disaggregation of time series totals", Journal of Time Series Analysis,
vol. 7, n. 4, p. 293-302.
```

Application:

```
Y=load('c:\x\td\data\Y.anu');
N = length(Y);  n = s*N;
% Defining the VCV matrix of stationary high-frequency time series
% Assumption of the example: IMA(d,2)
th1 =  0.9552; th2 = -0.0015; va = 0.87242 * ((223.5965)^2);
acf0 = va * (1+th1^2+th2^2); acf1 = -va * th1 * (1-th2); acf2 = -va * th2;
a0(1:n-d)=acf0; a1(1:n-d-1)=acf1; a2(1:n-d-2)=acf2;
v=diag(a0)+diag(a1,-1)+diag(a2,-2); v=v+tril(v)';
res = sw(Y,1,1,4,v);
tduni_print(res,'sw.sal');
tduni_plot(res);
edit sw.sal
```

ASCII file containing detailed output:

```
****************************************************
TEMPORAL DISAGGREGATION METHOD: Stram-Wei
****************************************************
----------------------------------------------------
Number of low-frequency observations  :   22
Frequency conversion                  :    4
Number of high-frequency observations :   88
----------------------------------------------------
Degree of differencing                :    1
Type of disaggregation: sum (flow).
----------------------------------------------------
High frequency series (columnwise):
----------------------------------------------------
4792.4658
5015.8665
 ........
 ........
 ........
28880.7153
28822.8148
----------------------------------------------------
Elapsed time:   0.1100
```



4. DENTON

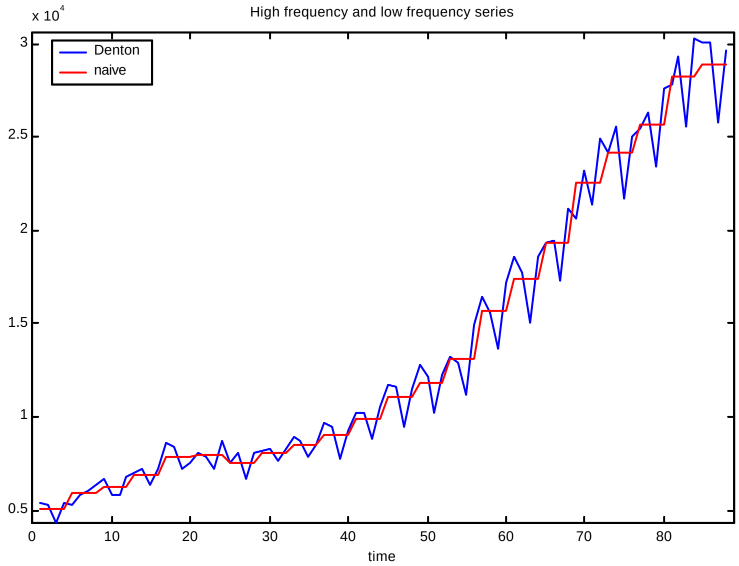
```
PURPOSE: Temporal disaggregation using the Denton method
--------------------------------------------------------------------
SYNTAX: res=denton_uni(Y,x,ta,d,s);
--------------------------------------------------------------------
OUTPUT: res: a structure
        res.meth  = 'Denton';
        res.N     = Number of low frequency data
        res.ta    = Type of disaggregation
        res.s     = Frequency conversion
        res.d     = Degree of differencing
        res.y     = High frequency estimate
        res.x     = High frequency indicator
        res.U     = Low frequency residuals
        res.u     = High frequency residuals
        res.et    = Elapsed time
--------------------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
       x: nx1 ---> vector of low frequency data
       ta: type of disaggregation
           ta=1 ---> sum (flow)
           ta=2 ---> average (index)
           ta=3 ---> last element (stock) ---> interpolation
           ta=4 ---> first element (stock) ---> interpolation
       d: objective function to be minimized: volatility of ...
           d=0 ---> levels
           d=1 ---> first differences
           d=2 ---> second differences
       s: number of high frequency data points for each low frequency data point
           s= 4 ---> annual to quarterly
           s=12 ---> annual to monthly
           s= 3 ---> quarterly to monthly
--------------------------------------------------------------------
LIBRARY: aggreg, bfl
--------------------------------------------------------------------
SEE ALSO: tduni_plot, tduni_print
--------------------------------------------------------------------
REFERENCE: Denton, F.T. (1971) "Adjustment of monthly or quarterly
series to annual totals: an approach based on quadratic minimization",
Journal of the American Statistical Society, vol. 66, n. 333, p. 99-102.
```

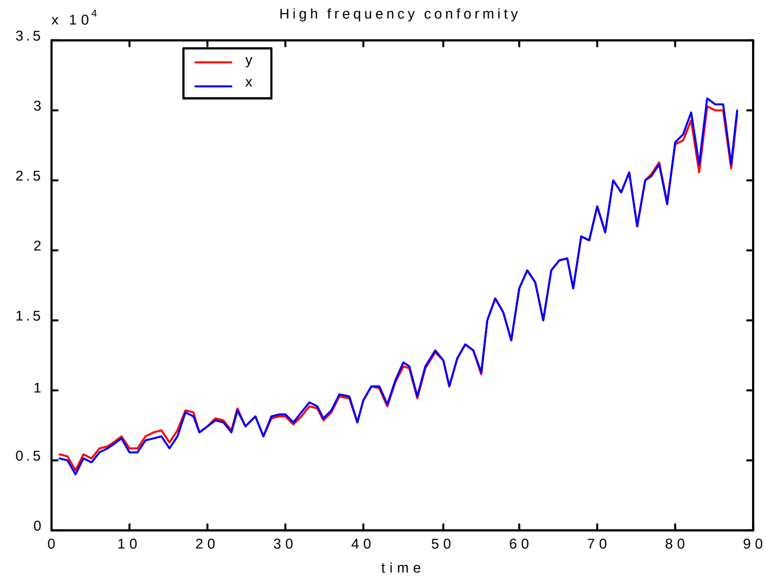
Application:

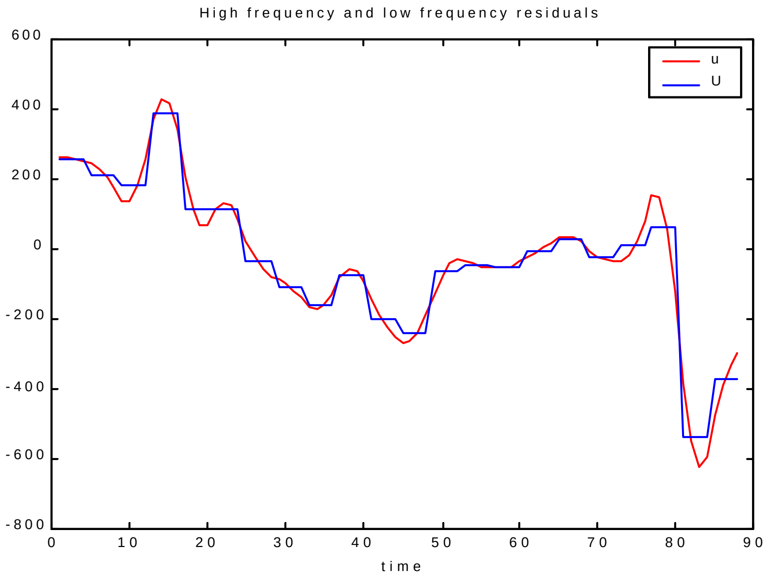
```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.ind');
res=denton_uni(Y,x,1,1,4);
tduni_print(res,'td.sal');
tduni_plot(res);
edit td.sal
```

ASCII file containing detailed output:

```
 ***************************************************
 TEMPORAL DISAGGREGATION METHOD: Denton
 ***************************************************
---------------------------------------------------
 Number of low-frequency observations  :   22
 Frequency conversion                  :    4
 Number of high-frequency observations :   88
 ---------------------------------------------------
 Degree of differencing                :    1
 Type of disaggregation: sum (flow).
 ---------------------------------------------------
 High frequency series (columnwise):
 ---------------------------------------------------
 15374.9285
 15169.7571
 ..........
 ..........
 ..........
 24883.3098
 20609.0705
 24415.4509
 ---------------------------------------------------
 Elapsed time:   0.0500
```




High frequency conformity
x 10^4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
90
time
y
x


High frequency and low frequency residuals
600
400
200
0
-200
-400
-600
-800
0
10
20
30
40
50
60
70
80
90
time
u
U

5. CHOW-LIN

```
PURPOSE: Temporal disaggregation using the Chow-Lin method
------------------------------------------------------------
SYNTAX: res=chowlin(Y,x,ta,s,type);
------------------------------------------------------------
OUTPUT: res: a structure
         res.meth    ='Chow-Lin';
         res.ta      = type of disaggregation
         res.type    = method of estimation
         res.N       = nobs. of low frequency data
         res.n       = nobs. of high-frequency data
         res.pred    = number of extrapolations
         res.s       = frequency conversion between low and high freq.
         res.p       = number of regressors (including intercept)
         res.Y       = low frequency data
         res.x       = high frequency indicators
         res.y       = high frequency estimate
         res.y_dt    = high frequency estimate: standard deviation
         res.y_lo    = high frequency estimate: sd - sigma
         res.y_up    = high frequency estimate: sd + sigma
         res.u       = high frequency residuals
         res.U       = low frequency residuals
         res.beta    = estimated model parameters
         res.beta_sd = estimated model parameters: standard deviation
         res.beta_t  = estimated model parameters: t ratios
         res.rho     = innovational parameter
         res.aic     = Information criterion: AIC
         res.bic     = Information criterion: BIC
         res.val     = Objective function used by the estimation method
         res.r       = grid of innovational parameters used by the estimation method
------------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
       x: nxp ---> matrix of high frequency indicators (without intercept)
       ta: type of disaggregation
          ta=1 ---> sum (flow)
          ta=2 ---> average (index)
          ta=3 ---> last element (stock) ---> interpolation
          ta=4 ---> first element (stock) ---> interpolation
       s: number of high frequency data points for each low frequency data points
          s= 4 ---> annual to quarterly
          s=12 ---> annual to monthly
          s= 3 ---> quarterly to monthly
       type: estimation method:
          type=0 ---> weighted least squares
          type=1 ---> maximum likelihood
------------------------------------------------------------
LIBRARY: aggreg
------------------------------------------------------------
SEE ALSO: litterman, fernandez, td_plot, td_print
------------------------------------------------------------
REFERENCE: Chow, G. y Lin, A.L. (1971) "Best linear unbiased
distribution and extrapolation of economic time series by related
series", Review of Economic and Statistics, vol. 53, n. 4, p. 372-375.
```

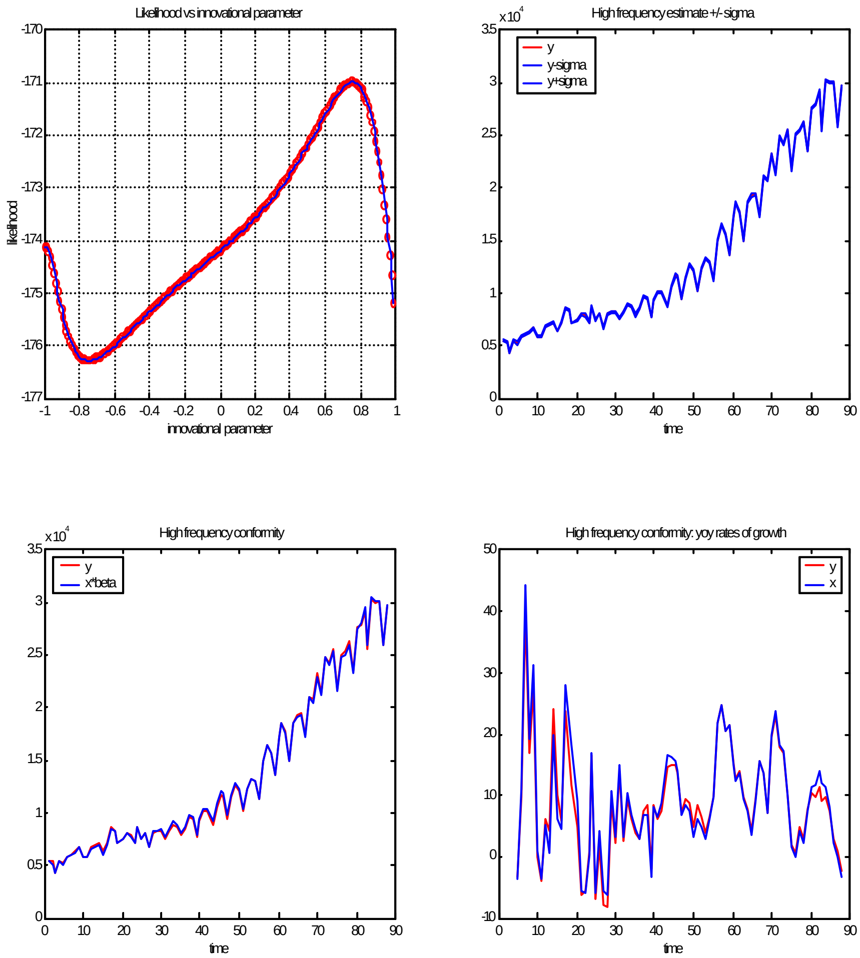
Application:

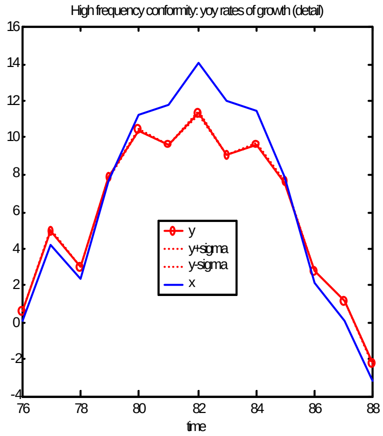
```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.ind');
res=chowlin(Y,x,1,4,1);
td_print(res,'td.sal',1);      % op1=1: series are printed in ASCII file
td_plot(res);
edit td.sal
```

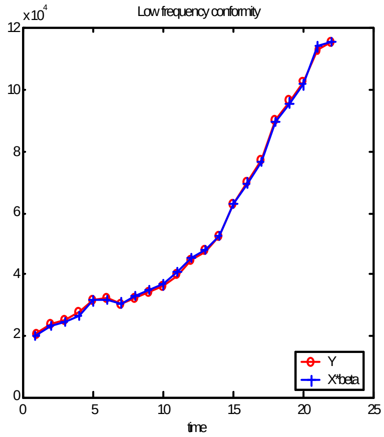
ASCII file containing detailed output:

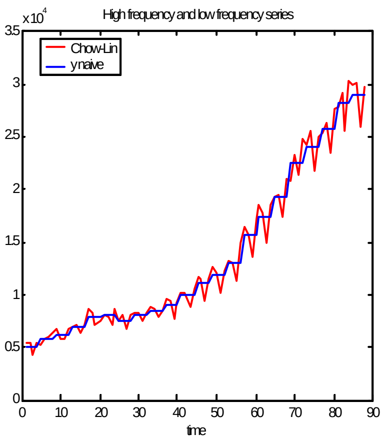
```
 ****************************************************
 TEMPORAL DISAGGREGATION METHOD: Chow-Lin
 ****************************************************
-----------------------------------------------------
 Number of low-frequency observations :   22
 Frequency conversion                 :    4
 Number of high-frequency observations:   88
 Number of extrapolations             :    0
 Number of indicators (+ constant)    :    2
 -----------------------------------------------------
 Type of disaggregation: sum (flow).
 -----------------------------------------------------
 Estimation method: Maximum likelihood.
 -----------------------------------------------------
 Beta parameters (columnwise):
   * Estimate
   * Std. deviation
   * t-ratios
 -----------------------------------------------------
  215.4518        111.7079          1.9287
    0.9828          0.0069        142.0272
 -----------------------------------------------------
 Innovational parameter:   0.7600
 -----------------------------------------------------
 AIC:  10.0340
 BIC:  10.1828
 -----------------------------------------------------
 Low-frequency correlation
  - levels     : 0.9998
  - yoy rates  : 0.9617
 -----------------------------------------------------
 High-frequency correlation
  - levels     : 0.9998
  - yoy rates  : 0.9812
 -----------------------------------------------------
 High-frequency volatility of yoy rates
  - estimate   : 8.4282
  - indicator  : 9.0226
  - ratio      : 0.9341
 -----------------------------------------------------
```

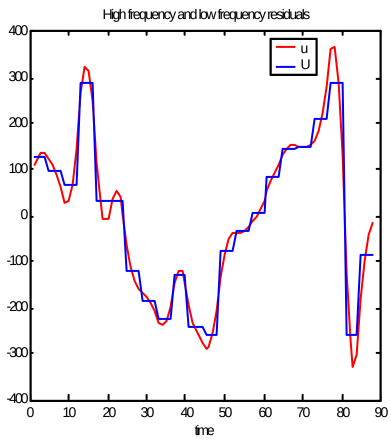
```
High frequency series (columnwise):
   * Estimate
   * Std. deviation
   * 1 sigma lower limit
   * 1 sigma upper limit
   * Residuals
 ---------------------------------------------------
  5400.9896        114.8247       5286.1649       5515.8143       112.3095
  5311.2409         83.7296       5227.5112       5394.9705       128.7034
  .........         .......       .........       .........       ........
  .........         .......       .........       .........       ........
  .........         .......       .........       .........       ........
 30079.6885         86.7557      29992.9328      30166.4443       -97.4913
 25874.7702         86.2867      25788.4835      25961.0569       -43.9249
 29614.4998        116.3242      29498.1756      29730.8240       -16.2417
 ---------------------------------------------------
 ---------------------------------------------------
 Elapsed time:    1.8100
```











A variant to be applied with a fixed innovational parameter:

PURPOSE: Temporal disaggregation using the Chow-Lin method
rho parameter is fixed (supplied by the user)

SYNTAX: res=chowlin_fix(Y,x,ta,s,type,rho);

----

6. FERNÁNDEZ

```
PURPOSE: Temporal disaggregation using the Fernandez method
---------------------------------------------------------
SYNTAX: res=fernandez(Y,x,ta,s);
---------------------------------------------------------
OUTPUT: res: a structure
          res.meth    ='Fernandez';
          res.ta      = type of disaggregation
          res.type    = method of estimation
          res.N       = nobs. of low frequency data
          res.n       = nobs. of high-frequency data
          res.pred    = number of extrapolations
          res.s       = frequency conversion between low and high freq.
          res.p       = number of regressors (including intercept)
          res.Y       = low frequency data
          res.x       = high frequency indicators
          res.y       = high frequency estimate
          res.y_dt    = high frequency estimate: standard deviation
          res.y_lo    = high frequency estimate: sd - sigma
          res.y_up    = high frequency estimate: sd + sigma
          res.u       = high frequency residuals
          res.U       = low frequency residuals
          res.beta    = estimated model parameters
          res.beta_sd = estimated model parameters: standard deviation
          res.beta_t  = estimated model parameters: t ratios
          res.aic     = Information criterion: AIC
          res.bic     = Information criterion: BIC
---------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
       x: nxp ---> matrix of high frequency indicators (without intercept)
       ta: type of disaggregation
           ta=1 ---> sum (flow)
           ta=2 ---> average (index)
           ta=3 ---> last element (stock) ---> interpolation
           ta=4 ---> first element (stock) ---> interpolation
       s: number of high frequency data points for each low frequency data points
           s= 4 ---> annual to quarterly
           s=12 ---> annual to monthly
           s= 3 ---> quarterly to monthly
---------------------------------------------------------
LIBRARY: aggreg
---------------------------------------------------------
SEE ALSO: chowlin, litterman, td_plot, td_print
---------------------------------------------------------
REFERENCE: Fernández, R.B.(1981)"Methodological note on the
estimation of time series", Review of Economic and Statistics,
vol. 63, n. 3, p. 471-478.
```

Application:

```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.tri');
res=fernandez(Y,x,1,4);
td_print(res,'td.sal',1);      % op1=1: series are printed in ASCII file
td_plot(res);
edit td.sal
```

ASCII file containing detailed output:

```
****************************************************
TEMPORAL DISAGGREGATION METHOD: Fernandez
****************************************************
----------------------------------------------------
Number of low-frequency observations :   22
Frequency conversion                 :    4
Number of high-frequency observations:   90
Number of extrapolations             :    2
Number of indicators (+ constant)    :    2
----------------------------------------------------
Type of disaggregation: sum (flow).
----------------------------------------------------
Estimation method: Maximum likelihood.
----------------------------------------------------
Beta parameters (columnwise):
  * Estimate
  * Std. deviation
  * t-ratios
----------------------------------------------------
 564.9834        195.9404          2.8834
   0.9360          0.0292         32.0284
----------------------------------------------------
Innovational parameter:   1.0000
----------------------------------------------------
AIC:   9.6079
BIC:   9.7567
----------------------------------------------------
Low-frequency correlation
 - levels     : 0.9998
 - yoy rates  : 0.9617
----------------------------------------------------
High-frequency correlation
 - levels     : 0.9997
 - yoy rates  : 0.9817
----------------------------------------------------
High-frequency volatility of yoy rates
 - estimate   : 8.3477
 - indicator  : 9.1506
 - ratio      : 0.9123
----------------------------------------------------
```

```
High frequency series (columnwise):
  * Estimate
  * Std. deviation
  * 1 sigma lower limit
  * 1 sigma upper limit
  * Residuals
----------------------------------------------------
 5396.6742        91.6250       5305.0492       5488.2992        -0.0000
 5297.9198        60.8871       5237.0327       5358.8069         2.3349
 .........        .......       .........       .........         ......
 .........        .......       .........       .........         ......
 .........        .......       .........       .........         ......
30021.1833        73.6977      29947.4856      30094.8810       920.9566
26022.3844       108.3992      25913.9852      26130.7837       977.8951
29586.1687        92.9937      29493.1750      29679.1625      1006.3644
----------------------------------------------------
28366.5459       140.8431      28225.7028      28507.3889      1006.3644
29461.6792       176.5235      29285.1557      29638.2027      1006.3644
----------------------------------------------------
Elapsed time:   0.0500
```

Graphs are the same than in the Chow-Lin case, except that the first one (objective function vs innovational parameter) is not generated.

7. LITTERMAN

```
PURPOSE: Temporal disaggregation using the Litterman method
---------------------------------------------------------
SYNTAX: res=litterman(Y,x,ta,s,type);
---------------------------------------------------------
OUTPUT: res: a structure
        res.meth    ='Litterman';
        res.ta      = type of disaggregation
        res.type    = method of estimation
        res.N       = nobs. of low frequency data
        res.n       = nobs. of high-frequency data
        res.pred    = number of extrapolations
        res.s       = frequency conversion between low and high freq.
        res.p       = number of regressors (including intercept)
        res.Y       = low frequency data
        res.x       = high frequency indicators
        res.y       = high frequency estimate
        res.y_dt    = high frequency estimate: standard deviation
        res.y_lo    = high frequency estimate: sd - sigma
        res.y_up    = high frequency estimate: sd + sigma
        res.u       = high frequency residuals
        res.U       = low frequency residuals
        res.beta    = estimated model parameters
        res.beta_sd = estimated model parameters: standard deviation
        res.beta_t  = estimated model parameters: t ratios
        res.rho     = innovational parameter
        res.aic     = Information criterion: AIC
        res.bic     = Information criterion: BIC
        res.val     = Objective function used by the estimation method
        res.r       = grid of innovational parameters used by the estimation method
---------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
       x: nxp ---> matrix of high frequency indicators (without intercept)
       ta: type of disaggregation
          ta=1 ---> sum (flow)
          ta=2 ---> average (index)
          ta=3 ---> last element (stock) ---> interpolation
          ta=4 ---> first element (stock) ---> interpolation
       s: number of high frequency data points for each low frequency data points
          s= 4 ---> annual to quarterly
          s=12 ---> annual to monthly
          s= 3 ---> quarterly to monthly
       type: estimation method:
          type=0 ---> weighted least squares
          type=1 ---> maximum likelihood
---------------------------------------------------------
LIBRARY: aggreg
---------------------------------------------------------
SEE ALSO: chowlin, fernandez, td_plot, td_print
---------------------------------------------------------
REFERENCE: Litterman, R.B. (1983a) "A random walk, Markov model
for the distribution of time series", Journal of Business and
```

Economic Statistics, vol. 1, n. 2, p. 169-173.

Application:

```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.tri');
res=litterman(Y,x,1,4,0);
td_print(res,'td.sal',0); % op1=0: series are not printed in ASCII file
td_plot(res);
edit td.sal
```

ASCII file containing detailed output:

```
****************************************************
TEMPORAL DISAGGREGATION METHOD: Litterman
****************************************************
----------------------------------------------------
Number of low-frequency observations :   22
Frequency conversion                 :    4
Number of high-frequency observations:   90
Number of extrapolations             :    2
Number of indicators (+ constant)    :    2
----------------------------------------------------
Type of disaggregation: sum (flow).
----------------------------------------------------
Estimation method: Weighted least squares.
----------------------------------------------------
Beta parameters (columnwise):
  * Estimate
  * Std. deviation
  * t-ratios
----------------------------------------------------
 1205.4851        233.5241          5.1621
    0.7910          0.0480         16.4821
----------------------------------------------------
Innovational parameter:   0.9700
----------------------------------------------------
AIC:   7.9478
BIC:   8.0966
----------------------------------------------------
Low-frequency correlation
 - levels     : 0.9998
 - yoy rates  : 0.9617
----------------------------------------------------
High-frequency correlation
 - levels     : 0.9994
 - yoy rates  : 0.9735
----------------------------------------------------
High-frequency volatility of yoy rates
 - estimate   : 7.6249
 - indicator  : 9.1506
 - ratio      : 0.8333
----------------------------------------------------
Elapsed time:   2.5300
```

A variant to be applied with a fixed innovational parameter:

```
PURPOSE: Temporal disaggregation using the Litterman method
        mu parameter is fixed (supplied by the user)
-----------------------------------------------------------
SYNTAX: res=litterman_fix(Y,x,ta,s,type,mu);
```

Graphical output contains the same information than in the Chow-Lin case.

8. SANTOS SILVA-CARDOSO (ssc)

```
function res=ssc(Y,x,ta,s,type)
PURPOSE: Temporal disaggregation using the dynamic Chow-Lin method
            proposed by Santos Silva-Cardoso (2001).
------------------------------------------------------------
SYNTAX: res=ssc(Y,x,ta,s,type);
------------------------------------------------------------
OUTPUT: res: a structure
      res.meth          ='Santos Silva-Cardoso';
      res.ta            = type of disaggregation
      res.type          = method of estimation
      res.N             = nobs. of low frequency data
      res.n             = nobs. of high-frequency data
      res.pred          = number of extrapolations
      res.s             = frequency conversion between low and high freq.
      res.p             = number of regressors (+ intercept)
      res.Y             = low frequency data
      res.x             = high frequency indicators
      res.y             = high frequency estimate
      res.y_dt          = high frequency estimate: standard deviation
      res.y_lo          = high frequency estimate: sd - sigma
      res.y_up          = high frequency estimate: sd + sigma
      res.u             = high frequency residuals
      res.U             = low frequency residuals
      res.gamma         = estimated model parameters (including y(0))
      res.gamma_sd      = estimated model parameters: standard deviation
      res.gamma_t             = estimated model parameters: t ratios
      res.rho           = dynamic parameter phi
      res.beta          = estimated model parameters (excluding y(0))
      res.beta_sd       = estimated model parameters: standard deviation
      res.beta_t        = estimated model parameters: t ratios
      res.aic           = Information criterion: AIC
      res.bic           = Information criterion: BIC
      res.val           = Objective function used by the estimation method
      res.r          = grid of dynamic parameters used by the estimation method
      res.et            = elapsed time
------------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
      x: nxp ---> matrix of high frequency indicators (without intercept)
      ta: type of disaggregation
         ta=1 ---> sum (flow)
         ta=2 ---> average (index)
         ta=3 ---> last element (stock) ---> interpolation
         ta=4 ---> first element (stock) ---> interpolation
      s: number of high frequency data points for each low frequency data points
         s= 4 ---> annual to quarterly
         s=12 ---> annual to monthly
         s= 3 ---> quarterly to monthly
      type: estimation method:
         type=0 ---> weighted least squares
         type=1 ---> maximum likelihood
------------------------------------------------------------
```

LIBRARY: aggreg

SEE ALSO: chowlin, litterman, fernandez, td_plot, td_print

REFERENCE: Santos, J.M.C. y Cardoso, F.(2001) "The Chow-Lin method using dynamic models",Economic Modelling, vol. 18, p. 269-280.

Application:

```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.tri');
res=ssc(Y,x,1,4,1);
td_print(res,'td.sal',0);
edit td.sal;
% Calling graph function
td_plot(res);
```

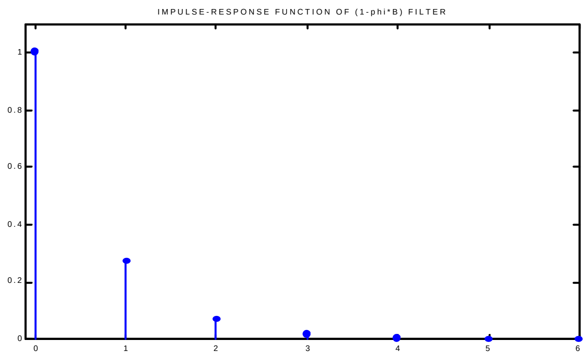
ASCII file containing detailed output:

```
****************************************************
TEMPORAL DISAGGREGATION METHOD: Santos Silva-Cardoso
****************************************************

----------------------------------------------------
Number of low-frequency observations :   32
Frequency conversion                 :    4
Number of high-frequency observations:  128
Number of extrapolations             :    0
Number of indicators (+ constant)    :    2
----------------------------------------------------
Type of disaggregation: sum (flow).
----------------------------------------------------
Estimation method: Maximum likelihood.
----------------------------------------------------
Beta parameters (columnwise):
  * Estimate
  * Std. deviation
  * t-ratios
----------------------------------------------------
   1.0946          3.7817          0.2895
   0.6718          0.0049        136.9983
----------------------------------------------------
Dynamic parameter:   0.2600
----------------------------------------------------
Long-run beta parameters (columnwise):
    1.4792
    0.9078
----------------------------------------------------
Truncation remainder: expected y(0):
  * Estimate
  * Std. deviation
  * t-ratios
----------------------------------------------------
 310.3328         90.5351          3.4278
```

```
 ---------------------------------------------------
 AIC:   5.2524
 BIC:   5.3898
 ---------------------------------------------------
 Low-frequency correlation
  - levels      : 0.9994
  - yoy rates   : 0.8561
 ---------------------------------------------------
 High-frequency correlation
  - levels      : 0.9993
  - yoy rates   : 0.8881
 ---------------------------------------------------
 High-frequency volatility of yoy rates
  - estimate    : 2.0592
  - indicator   : 2.3430
  - ratio       : 0.8789
 ---------------------------------------------------
```

Graphical output contains the same information than in the Chow-Lin case and includes a plot of the implied impulse-response function:



A variant to be applied with a fixed innovational parameter:

PURPOSE: Temporal disaggregation using the Santos Silva-Cardoso method
Phi parameter is fixed (supplied by the user)

SYNTAX: res=ssc_fix(Y,x,ta,s,type,phi);

9. GUERRERO

```
function res=guerrero(Y,x,ta,s,rexw,rexd);
PURPOSE: ARIMA-based temporal disaggregation: Guerrero method
------------------------------------------------------------
SYNTAX: res=guerrero(Y,x,ta,s,rexw,rexd);
------------------------------------------------------------
OUTPUT: res: a structure
     res.meth    ='Guerrero';
     res.ta      = type of disaggregation
     res.N       = nobs. of low frequency data
     res.n       = nobs. of high-frequency data
     res.pred    = number of extrapolations
     res.s       = frequency conversion between low and high freq.
     res.p       = number of regressors (+ intercept)
     res.Y       = low frequency data
     res.x       = high frequency indicators
     res.w       = scaled indicator (preliminary hf estimate)
     res.y1      = first stage high frequency estimate
     res.y       = final high frequency estimate
     res.y_dt    = high frequency estimate: standard deviation
     res.y_lo    = high frequency estimate: sd - sigma
     res.y_up    = high frequency estimate: sd + sigma
     res.delta   = high frequency discrepancy (y1-w)
     res.u       = high frequency residuals (y-w)
     res.U       = low frequency residuals (Cu)
     res.beta    = estimated parameters for scaling x
     res.k       = statistic to test compatibility
     res.et      = elapsed time
------------------------------------------------------------
INPUT: Y: Nx1 ---> vector of low frequency data
     x: nxp ---> matrix of high frequency indicators (without intercept)
     ta: type of disaggregation
        ta=1 ---> sum (flow)
        ta=2 ---> average (index)
        ta=3 ---> last element (stock) ---> interpolation
        ta=4 ---> first element (stock) ---> interpolation
     s: number of high frequency data points for each low frequency data points
        s= 4 ---> annual to quarterly
        s=12 ---> annual to monthly
        s= 3 ---> quarterly to monthly
     rexw, rexd ---> a structure containing the parameters of ARIMA model
        for indicator and discrepancy, respectively (see calT function)
------------------------------------------------------------
LIBRARY: aggreg, calT, numpar, ols
------------------------------------------------------------
SEE ALSO: chowlin, litterman, fernandez, td_print, td_plot
------------------------------------------------------------
REFERENCE: Guerrero, V. (1990) "Temporal disaggregation of time
series: an ARIMA-based approach", International Statistical
Review, vol. 58, p. 29-46.
```

Application:

```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.tri');
% --------------------------------------------
% Inputs for td library
% Type of aggregation
ta=1;
% Frequency conversion
s=12;
% Model for  w: (0,1,1)(1,0,1)
rexw.ar_reg = [1];
rexw.d  = 1;
rexw.ma_reg = [1 -0.40];
rexw.ar_sea = [1 0 0 0 0 0 0 0 0 0 0 0 -0.85];
rexw.bd = 0;
rexw.ma_sea = [1 0 0 0 0 0 0 0 0 0 0 0 -0.79];
rexw.sigma = 4968.716^2;
% Model for the discrepancy: (1,2,0)(1,0,0)
% See: Martinez and Guerrero, 1995, Test, 4(2), 359-76.
rexd.ar_reg = [1 -0.43];
rexd.d  = 2;
rexd.ma_reg = [1];
rexd.ar_sea = [1 0 0 0 0 0 0 0 0 0 0 0 0.62];
rexd.bd = 0;
rexd.ma_sea = [1];
rexd.sigma = 76.95^2;
% Calling the function: output is loaded in structure res
res=guerrero(Y,x,ta,s,rexw,rexd);
% Calling printing function
% Name of ASCII file for output
file_sal='guerrero.sal';
output=0; % Do not include series
td_print_G(res,file_sal,output);
edit guerrero.sal;
% Calling graph function
td_plot(res);
```

ASCII file containing detailed output:

```
 ****************************************************
 TEMPORAL DISAGGREGATION METHOD: Guerrero
 ****************************************************

 ----------------------------------------------------
 Number of low-frequency observations :    5
 Frequency conversion                 :   12
 Number of high-frequency observations:   60
 Number of extrapolations             :    0
 Number of indicators (+ constant)    :    2
 ----------------------------------------------------
 Type of disaggregation: sum (flow).
----------------------------------------------------
 Estimation method: BLUE.
----------------------------------------------------
 Beta parameters (columnwise):
```

```
   * Estimate
   * Std. deviation
   * t-ratios
 -----------------------------------------------------
219988.6766      974531.6756          4.4299
  1723.8723       6174.6540          3.5819
 -----------------------------------------------------
 AIC:   7.5245
 BIC:   7.3683
 -----------------------------------------------------
Low-frequency correlation (Y,X)
  - levels     : 0.9003
  - yoy rates  : 0.9973
 -----------------------------------------------------
High-frequency correlation (y,x)
  - levels     : 0.9289
  - yoy rates  : 0.9835
 -----------------------------------------------------
High-frequency volatility of yoy rates
  - estimate   : 3.6623
  - indicator  : 6.2899
  - ratio      : 0.5823
 -----------------------------------------------------
High-frequency correlation (y,x*beta)
  - levels     : 0.9289
  - yoy rates  : 0.9832
 -----------------------------------------------------
 Compatibility test:
  - k :   0.9526
 -----------------------------------------------------

  ARIMA model for scaled indicator:

 ( 0  1   1  ) ( 1  0   1  )

  - Regular AR operator:

  1.0000

 - Regular MA operator:

  1.0000 -0.4000

 - Seasonal AR operator:
 1.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000 -0.8500

 - Seasonal MA operator:
 1.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000 -0.7900

-----------------------------------------------------
 ARIMA model for discrepancy :

 ( 1   2   0  ) ( 1   0   0  )

  - Regular AR operator:

  1.0000 -0.4300

 - Regular MA operator:

  1.0000
```

```
 - Seasonal AR operator:
 1.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.6200
 - Seasonal MA operator:
  1.0000
---------------------------------------------------
 Elapsed time:   0.4400
```

Graphical output contains the same information than in the Chow-Lin case.

10. MULTIVARIATE ROSSI

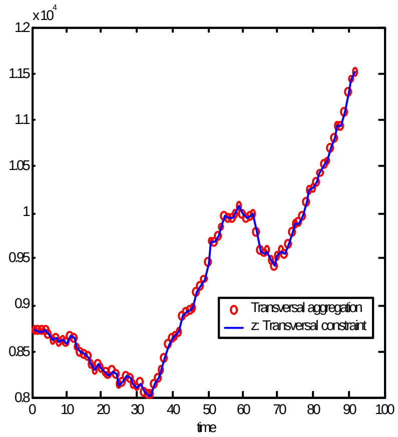
```
function res = rossi(Y,x,z,ta,s,type);
PURPOSE: Multivariate temporal disaggregation with transversal constraint
------------------------------------------------------------------------
SYNTAX: res = rossi(Y,x,z,ta,s,type);
------------------------------------------------------------------------
OUTPUT: res: a structure
        res.meth  = 'Multivariate Rossi';
        res.N     = Number of low frequency data
        res.n     = Number of high frequency data
        res.pred  = Number of extrapolations (=0 in this case)
        res.ta    = Type of disaggregation
        res.s     = Frequency conversion
        res.y     = High frequency estimate
        res.et    = Elapsed time
-------------------------------------------------------------------
INPUT: Y:     NxM ---> M series of low frequency data with N observations
       x:     nxM ---> M series of high frequency data with n observations
       z:     nx1 ---> high frequency transversal constraint
       ta: type of disaggregation
          ta=1 ---> sum (flow)
          ta=2 ---> average (index)
          ta=3 ---> last element (stock) ---> interpolation
          ta=4 ---> first element (stock) ---> interpolation
       s: number of high frequency data points for each low frequency data points
          s= 4 ---> annual to quarterly
          s=12 ---> annual to monthly
          s= 3 ---> quarterly to monthly
       type: univariate temporal disaggregation procedure used to compute
       preliminary estimates
          type = 1 ---> Fernandez
          type = 2 ---> Chow-Lin
          type = 3 ---> Litterman
-------------------------------------------------------------------
LIBRARY: aggreg, vec, desvec, fernandez, chowlin, litterman
-------------------------------------------------------------------
SEE ALSO: denton, difonzo, mtd_print, mtd_plot
-------------------------------------------------------------------
REFERENCE: Rossi, N. (1982) "A note on the estimation of disaggregate
time series when the aggregate is known", Review of Economics and Statistics,
vol. 64, n. 4, p. 695-696.
di Fonzo, T. (1994) "Temporal disaggregation of a system of
time series when the aggregate is known: optimal vs. adjustment methods",
INSEE-Eurostat Workshop on Quarterly National Accounts, Paris, december.
```

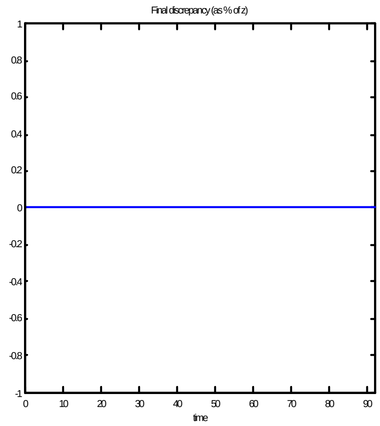
Application:

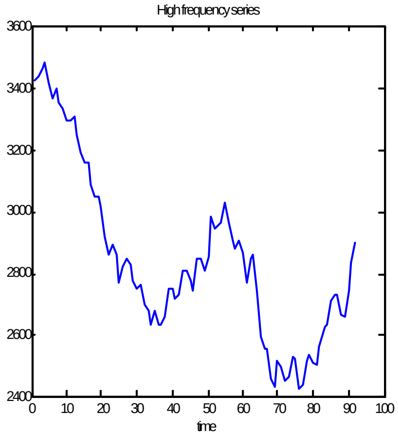
```
Y=load('YY.anu'); % Loading low frequency data
x=load('x.tri'); % Loading high frequency data
z=load('z.prn'); % Loading high frequency transversal restriction
res=rossi(Y,x,z,2,4,1);
mtd_print(res,'mtd.sal');
edit mtd.sal;
mtd_plot(res,z);
```

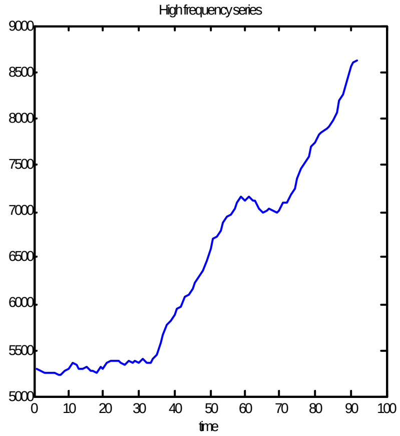
ASCII file containing detailed output:

```
 *******************************************************
 TEMPORAL DISAGGREGATION METHOD: Multivariate Rossi
 *******************************************************
 -------------------------------------------------------
 Number of low-frequency observations  :   23
 Frequency conversion                  :    4
 Number of high-frequency observations :   92
 Number of extrapolations             :    0
 -------------------------------------------------------
 Type of disaggregation: average (index).
 -------------------------------------------------------
 Preliminary univariate disaggregation:  Fernandez
 -------------------------------------------------------
 High frequency series (columnwise):
   * Point estimate
 -------------------------------------------------------
 3424.2881  5311.2720
 3436.0588  5280.4786
 .........  .........
 .........  .........
 .........  .........
 2835.1833  8614.4139
 2899.5740  8625.9809
-------------------------------------------------------
Elapsed time:   1.2600
```


x10^4
Transversal aggregation
z: Transversal constraint
time


Final discrepancy (as % of z)
time


High frequency series
time


High frequency series
time

11. MULTIVARIATE DENTON

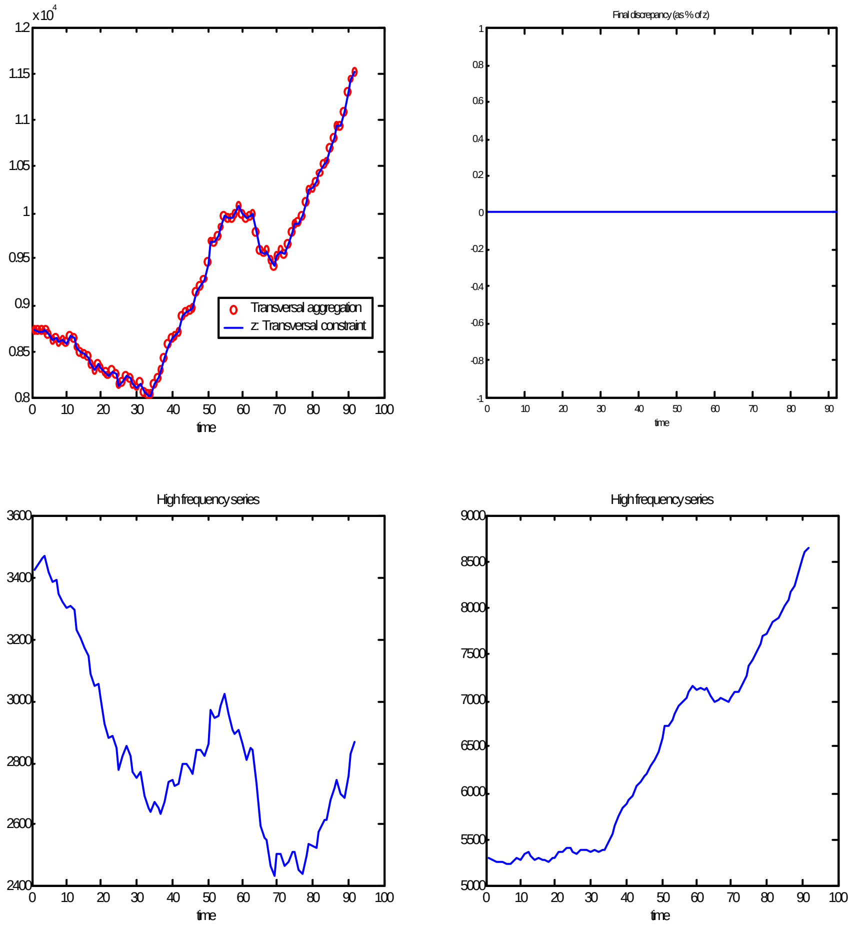
```
function res = denton(Y,x,z,ta,s,d);
PURPOSE: Multivariate temporal disaggregation with transversal constraint
------------------------------------------------------------------------
SYNTAX: res = denton(Y,x,z,ta,s,d);
------------------------------------------------------------------------
OUTPUT: res: a structure
      res.meth  = 'Multivariate Denton';
      res.N     = Number of low frequency data
      res.n     = Number of high frequency data
      res.pred  = Number of extrapolations (=0 in this case)
      res.ta    = Type of disaggregation
      res.s     = Frequency conversion
      res.d     = Degree of differencing
      res.y     = High frequency estimate
      res.et    = Elapsed time
------------------------------------------------------------------
INPUT: Y: NxM ---> M series of low frequency data with N observations
     x: nxM ---> M series of high frequency data with n observations
     z: nzx1 ---> high frequency transversal constraint
     ta: type of disaggregation
        ta=1 ---> sum (flow)
        ta=2 ---> average (index)
        ta=3 ---> last element (stock) ---> interpolation
        ta=4 ---> first element (stock) ---> interpolation
     s: number of high frequency data points for each low frequency data points
        s= 4 ---> annual to quarterly
        s=12 ---> annual to monthly
        s= 3 ---> quarterly to monthly
     d: objective function to be minimized: volatility of ...
        d=0 ---> levels
        d=1 ---> first differences
        d=2 ---> second differences
------------------------------------------------------------------
LIBRARY: aggreg, aggreg_v, dif, vec, desvec
------------------------------------------------------------------
SEE ALSO: difonzo, mtd_print, mtd_plot
------------------------------------------------------------------
REFERENCE: di Fonzo, T. (1994) "Temporal disaggregation of a system of
time series when the aggregate is known: optimal vs. adjustment methods",
INSEE-Eurostat Workshop on Quarterly National Accounts, Paris, december
```

Application:

```
Y=load('YY.anu'); % Loading low frequency data
x=load('x.tri'); % Loading high frequency data
z=load('z.prn'); % Loading high frequency transversal restriction
res=denton(Y,x,z,2,4,1);
mtd_print(res,'mtd.sal');
edit mtd.sal;
mtd_plot(res,z);
```

ASCII file containing detailed output:

```
 *******************************************************
 TEMPORAL DISAGGREGATION METHOD: Multivariate Denton
 *******************************************************
 -------------------------------------------------------
 Number of low-frequency observations  :   23
 Frequency conversion                  :    4
 Number of high-frequency observations :   92
 Number of extrapolations              :    0
 -------------------------------------------------------
 Degree of differencing                :    1
 Type of disaggregation: average (index).
 -------------------------------------------------------
 High frequency series (columnwise):
   * Point estimate
 -------------------------------------------------------
 3752.9096  4982.6505
 3459.3681  5257.1693
 .........  .........
 .........  .........
 .........  .........
 2757.8458  8545.8074
 2825.1411  8624.4561
 2867.5816  8657.9733
-------------------------------------------------------
Elapsed time:   0.2800
```


x 10^4
Transversal aggregation
z: Transversal constraint
time
Final discrepancy (as % of z)
time
High frequency series
time
High frequency series
time

12. DI FONZO

```
function res = difonzo(Y,x,z,ta,s,type,f);
PURPOSE: Multivariate temporal disaggregation with transversal constraint
------------------------------------------------------------------------------
SYNTAX: res = difonzo(Y,x,z,ta,s,type,f);
------------------------------------------------------------------------------
OUTPUT: res: a structure
        res.meth  = 'Multivariate di Fonzo';
        res.N     = Number of low frequency data
        res.n     = Number of high frequency data
        res.pred  = Number of extrapolations
        res.ta    = Type of disaggregation
        res.s     = Frequency conversion
        res.type  = Model for high frequency innovations
        res.beta  = Model parameters
        res.y     = High frequency estimate
        res.d_y   = High frequency estimate: std. deviation
        res.et    = Elapsed time
------------------------------------------------------------------------------
INPUT: Y: NxM  ---> M series of low frequency data with N observations
   x: nxm  ---> m series of high frequency data with n observations, m>=M see (*)
       z: nzx1 ---> high frequency transversal constraint with nz obs.
       ta: type of disaggregation
          ta=1 ---> sum (flow)
          ta=2 ---> average (index)
          ta=3 ---> last element (stock) ---> interpolation
          ta=4 ---> first element (stock) ---> interpolation
       s: number of high frequency data points for each low frequency data points
          s= 4 ---> annual to quarterly
          s=12 ---> annual to monthly
          s= 3 ---> quarterly to monthly
       type: model for the high frequency innvations
          type=0 ---> multivariate white noise
          type=1 ---> multivariate random walk
(*) Optional:
       f: 1xM ---> Set the number of high frequency indicators linked to
                each low frequency variable. If f is explicitly included,
                the high frequency indicators should be placed in
                consecutive columns
------------------------------------------------------------------------------
NOTE: Extrapolation is automatically performed when n>sN.
      If n=nz>sN restricted extrapolation is applied.
      Finally, if n>nz>sN extrapolation is perfomed in constrained
      form in the first nz-sN observatons and in free form in
      the last n-nz observations.
------------------------------------------------------------------------------
LIBRARY: aggreg, dif, vec, desvec
------------------------------------------------------------------------------
SEE ALSO: denton, mtd_print, mtd_plot
------------------------------------------------------------------------------
REFERENCE: di Fonzo, T. (1990) "The estimation of M disaggregate time
series when contemporaneous and temporal aggregates are known", Review
of Economics and Statistics, vol. 72, n. 1, p. 178-182.
```

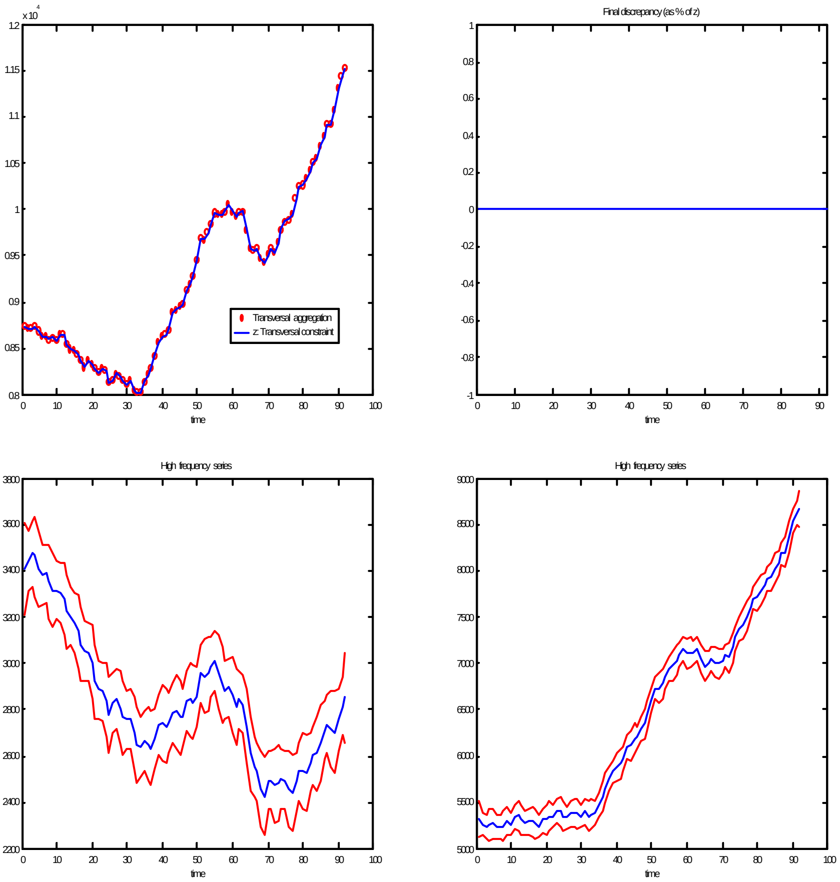
Application:

```
Y=load('YY.anu'); % Loading low frequency data
x=load('x.tri'); % Loading high frequency data
z=load('z.prn'); % Loading high frequency transversal restriction
res = difonzo(Y,x,z,2,4,1);
mtd_print(res,'mtd.sal');
edit mtd.sal;
mtd_plot(res,z);
```

ASCII file containing detailed output:

```
*******************************************************
TEMPORAL DISAGGREGATION METHOD: Multivariate di Fonzo
*******************************************************
-------------------------------------------------------
Number of low-frequency observations  :   23
Frequency conversion                  :    4
Number of high-frequency observations :   92
Number of extrapolations            :     0
-------------------------------------------------------
Model for the innovations: random walk.
Type of disaggregation: average (index).
-------------------------------------------------------
High frequency series (columnwise):
  * Point estimate
-------------------------------------------------------
3413.3839  5322.1762
3447.4092  5269.1282
.........  .........
.........  .........
.........  .........
2758.4657  8545.1875
2817.9882  8631.6090
2856.1605  8669.3944
```

```
-----------------------------------------------------
 High frequency series (columnwise):
   * Std. desviation
 -----------------------------------------------------
  197.8732   197.8732
  127.3900   127.3900
  .........  .........
  .........  .........
  .........  .........
  137.9397   137.9397
  128.1006   128.1006
  194.9112   194.9112
-----------------------------------------------------
Elapsed time:   0.3300
```



APPENDIX: RELATIONSHIPS AMONG FUNCTIONS IN THE LIBRARY

The "X → Y" notation means "X function calls Y function".

- bfl → sw
- denton_uni → aggreg, bfl
- sw → aggreg, aggreg_v, dif, movingsum

- chowlin → aggreg
- fernandez → aggreg
- litterman → aggreg
- ssc → aggreg
- guerrero → aggreg, calT, numpar, **ols**(*)

- rossi → aggreg, vec, desvec, fernandez, chowlin, litterman
- denton → aggreg, aggreg_v, dif, vec, desvec
- difonzo → aggreg, dif, vec, desvec

- bal → vec, desvec
- td_print → tasa, aggreg
- td_print_G → tasa, aggreg, **mprint**(*)
-
- td_plot → tasa
- tduni_plot → temporal_agg

(*) From James Lesage's *Econometric Toolbox*

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