A MATLAB LIBRARY OF TEMPORAL DISAGGREGATION METHODS: SUMMARY

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1 The author thanks Ana Abad, Juan Bógalo and Silvia Rellos for their help.
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 performed 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)

- guerero

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: \( \text{res} = \text{bfl}(Y, ta, d, s) \);

OUTPUT: \( \text{res} \): a structure
  - \( \text{res.meth} \) = 'Boot-Feibes-Lisman';
  - \( \text{res.N} \) = Number of low frequency data
  - \( \text{res.ta} \) = Type of disaggregation
  - \( \text{res.s} \) = Frequency conversion
  - \( \text{res.d} \) = Degree of differencing
  - \( \text{res.y} \) = High frequency estimate
  - \( \text{res.et} \) = Elapsed time

INPUT: \( Y \): \( N \times 1 \) ---> 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


Application:

\[
Y = \text{load('c:\x\td\data\Y.anu');}
\]
\[
\text{res} = \text{bfl}(Y, 1, 1, 12);
\]
\[
\text{tduni_print}(\text{res}, 'td.sal');
\]
\[
\text{tduni_plot(}\text{res});
\]
\[
\text{edit td.sal}
\]
ASCII file containing detailed output:

******************************************************************************
TEMPORAL DISAGREGATION 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


Application:

```matlab
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);
res = tduni_print(res,'sw.sal');
tduni_plot(res);
edit sw.sal
```
**TEMPORAL DISAGGREGATION METHOD: Stram Wei**

<table>
<thead>
<tr>
<th>Number of low-frequency observations</th>
<th>22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency conversion</td>
<td>4</td>
</tr>
<tr>
<td>Number of high-frequency observations</td>
<td>88</td>
</tr>
<tr>
<td>Degree of differencing</td>
<td>1</td>
</tr>
<tr>
<td>Type of disaggregation</td>
<td>sum (flow)</td>
</tr>
</tbody>
</table>

**High frequency series (columnwise):**

<table>
<thead>
<tr>
<th>4792.4658</th>
</tr>
</thead>
<tbody>
<tr>
<td>5015.8665</td>
</tr>
<tr>
<td>.........</td>
</tr>
<tr>
<td>.........</td>
</tr>
<tr>
<td>28880.7153</td>
</tr>
<tr>
<td>28822.8148</td>
</tr>
</tbody>
</table>

**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",
-----------------------------------------------------------------------

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,'
    tduni_plot(res);
    edit td.sal
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
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
-------------------------------------------------------------

distribution and extrapolation of economic time series by related
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 DI SAGGREGATION 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

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<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
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<td>5400.9896</td>
<td>114.8247</td>
<td>5286.1649</td>
<td>5515.8143</td>
<td>112.3095</td>
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<tr>
<td>5311.2409</td>
<td>83.7296</td>
<td>5227.5112</td>
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<tr>
<td>30079.6885</td>
<td>86.7557</td>
<td>29992.9328</td>
<td>30166.4443</td>
<td>-97.4913</td>
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<tr>
<td>25874.7702</td>
<td>86.2867</td>
<td>25788.4835</td>
<td>25961.0569</td>
<td>-43.9249</td>
</tr>
<tr>
<td>29614.4998</td>
<td>116.3242</td>
<td>29498.1756</td>
<td>29730.8240</td>
<td>-16.2417</td>
</tr>
</tbody>
</table>

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

Application:

```matlab
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.tri');
res=fernandez(Y,x,1,4);
zd_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 DI SAGREGATION 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

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>5396.6742</td>
<td>91.6250</td>
<td>5305.0492</td>
<td>5488.2992</td>
<td>-0.0000</td>
<td></td>
</tr>
<tr>
<td>5297.9198</td>
<td>60.8871</td>
<td>5237.0327</td>
<td>5358.8069</td>
<td>2.3349</td>
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</tr>
<tr>
<td>30021.1833</td>
<td>73.6977</td>
<td>29947.4856</td>
<td>30094.8810</td>
<td>920.9566</td>
<td></td>
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<tr>
<td>26022.3844</td>
<td>108.3992</td>
<td>25913.9852</td>
<td>26130.7837</td>
<td>977.8951</td>
<td></td>
</tr>
<tr>
<td>29586.1687</td>
<td>92.9937</td>
<td>29493.1750</td>
<td>29679.1625</td>
<td>1006.3644</td>
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<tr>
<td>28366.5459</td>
<td>140.8431</td>
<td>28225.7028</td>
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<td>1006.3644</td>
<td></td>
</tr>
<tr>
<td>29461.6792</td>
<td>176.5235</td>
<td>29285.1557</td>
<td>29638.2027</td>
<td>1006.3644</td>
<td></td>
</tr>
</tbody>
</table>

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
Application:

```matlab
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 AGGREGATION 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):

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Std. deviation</th>
<th>t-ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>1205.4851</td>
<td>233.5241</td>
<td>5.1621</td>
</tr>
<tr>
<td>0.7910</td>
<td>0.0480</td>
<td>16.4821</td>
</tr>
</tbody>
</table>

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.
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: npx ---> 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
------------------------------------------------------------------------
Application:

```matlab
Y = load('c:\x\td\data\Y.prn');
x = load('c:\x\td\data\x.tri');
res = ssc(Y,x,1,4,1);
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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0946</td>
<td>3.7817</td>
<td>0.2895</td>
</tr>
<tr>
<td>0.6718</td>
<td>0.0049</td>
<td>136.9983</td>
</tr>
</tbody>
</table>

Dynamic parameter: 0.2600

Long-run beta parameters (columnwise):
  1.4792
  0.9078

Truncation remainder: expected y(0):
* Estimate
  * Std. deviation
  * t-ratios

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>310.3328</td>
<td>90.5351</td>
<td>3.4278</td>
</tr>
</tbody>
</table>
```
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

24
Application:

\[
Y = \text{load}('c:\td\data\Y.prn');
\]
\[
x = \text{load}('c:\td\data\x.tri');
\]

% Inputs for td library
% Type of aggregation
\[ta = 1;\]
% Frequency conversion
\[s = 12;\]
% Model for \( w: (0,1,1)(1,0,1) \)
\[\text{rexw.ar\_reg} = [1];\]
\[\text{rexw.d} = 1;\]
\[\text{rexw.ma\_reg} = [1 -0.40];\]
\[\text{rexw.ar\_sea} = [1 0 0 0 0 0 0 0 0 0 0 0 -0.85];\]
\[\text{rexw.bd} = 0;\]
\[\text{rexw.ma\_sea} = [1 0 0 0 0 0 0 0 0 0 0 0 -0.79];\]
\[\text{rexw.sigma} = 4968.716^2;\]
% Model for the discrepancy: \((1,2,0)(1,0,0)\)
% See: Martinez and Guerrero, 1995, Test, 4(2), 359-76.
\[\text{rexd.ar\_reg} = [1 -0.43];\]
\[\text{rexd.d} = 2;\]
\[\text{rexd.ma\_reg} = [1];\]
\[\text{rexd.ar\_sea} = [1 0 0 0 0 0 0 0 0 0 0 0 0.62];\]
\[\text{rexd.bd} = 0;\]
\[\text{rexd.ma\_sea} = [1];\]
\[\text{rexd.sigma} = 76.95^2;\]
% Calling the function: output is loaded in structure res
\[\text{res} = \text{guerrero}(Y, x, ta, s, rexw, rexd);\]
% Calling printing function
% Name of ASCII file for output
\[\text{file\_sal} = 'guerrero.sal';\]
\[\text{output} = 0; \text{ Do not include series}\]
\[\text{td\_print\_G(res, file\_sal, output);}\]
\[\text{edit guerrero.sal;}\]
% Calling graph function
\[\text{td\_plot(res);}\]

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.
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: N x M ---> M series of low frequency data with N observations
x: n x M ---> M series of high frequency data with n observations
z: n x 1 ---> 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
------------------------------------------------------------------------------------------------------------------
Application:

```matlab
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);
edit mtd.sal;
print mtd.print(res,'mtd.sal');
plot 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
```
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:

\[ Y = \text{load('YY.anu')}; \] % Loading low frequency data
\[ x = \text{load('x.tri')}; \] % Loading high frequency data
\[ z = \text{load('z.prn')}; \] % Loading high frequency transversal restriction
\[ \text{res} = \text{denton}(Y,x,z,2,4,1); \]
\[ \text{mtd}\_\text{print(res,'mtd.sal');} \]
\[ \text{edit mtd.sal;} \]
\[ \text{mtd}\_\text{plot(res,z);} \]

ASCII file containing detailed output:

**************************************************************************************
TEMPORAL DI SAGGREGATION 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
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: nx1 ---> 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 innovations
    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 performed 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
----------------------------------------------------------------------------------
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

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>197.8732</td>
<td>197.8732</td>
</tr>
<tr>
<td>127.3900</td>
<td>127.3900</td>
</tr>
<tr>
<td>...........</td>
<td>...........</td>
</tr>
<tr>
<td>137.9397</td>
<td>137.9397</td>
</tr>
<tr>
<td>128.1006</td>
<td>128.1006</td>
</tr>
<tr>
<td>194.9112</td>
<td>194.9112</td>
</tr>
</tbody>
</table>

Elapsed time: 0.3300
APPENDIX: RELATIONSHIPS AMONG FUNCTIONS IN THE LIBRARY

The “X \rightarrow Y” notation means “X function calls Y function”.

- bfl \rightarrow sw
- denton_uni \rightarrow aggreg, bfl
- sw \rightarrow aggreg, aggreg_v, dif, movingsum
- chowlin \rightarrow aggreg
- fernandez \rightarrow aggreg
- litterman \rightarrow aggreg
- ssc \rightarrow aggreg
- guerrero \rightarrow aggreg, calT, numpar, ols(*)
- rossi \rightarrow aggreg, vec, desvec, fernandez, chowlin, litterman
- denton \rightarrow aggreg, aggreg_v, dif, vec, desvec
- difonzo \rightarrow aggreg, dif, vec, desvec
- bal \rightarrow vec, desvec
- td_print \rightarrow tasa, aggreg
- td_print_G \rightarrow tasa, aggreg, mprint(*)
- ...
- td_plot \rightarrow tasa
- tduni_plot \rightarrow temporal_agg

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


