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Software to perform temporal disaggregation of economic time series[1]

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Abstract

In this paper we present a program designed to perform temporal disaggregation of economic time series using a variety of techniques: univariate methods without indicators (Boot-Feibes-Lisman, Stram-Wei), univariate methods with indicators (Denton, Chow-Lin, Fernandez, Litterman, Santos-Cardoso, Guerrero) and multivariate methods with indicators and transversal constraints (Rossi, Denton, Di Fonzo). The program has two main components: a library of functions coded in Matlab and an Excel interface written in Visual Basic. This software is used to compile the Spanish Quarterly National Accounts (production mode) and to perform specific, detailed analysis that ensure the reliability and integrity of data, models and procedures (research mode).

[1] The programs described in this paper have highly benefited from the comments and observations made by J. Bógalo, J.R. Cancelo, L. Navarro, S. Relloso, and by the participants of seminars on temporal disaggregation techniques held at the Instituto Nacional de Estadística, Instituto Gallego de Estadística and Universidad Autónoma de Madrid. The programs are freely available upon request.

1. INTRODUCTION

In this note we present an interface that enables the use of the temporal disaggregation library as described in Quilis (2004) under the Excel environment. Our main aim is that of combining the best features of both programs. On the one hand, the flexibility, power and easiness of modern worksheets has contributed to its *de facto* adoption as a reference for the storage and management of quantitative data-sets under the most varied circumstances, see Honoré and Poulsen (2002). On the other hand, programming languages oriented towards matrix, mathematical and symbolic manipulation enable economies of scale in the production and analysis of the underlying information, see LeSage (1999).

Basically, the interface consist of two main modules: a program which generates and manages a sequence of contextual menus and a linkage function that activates the temporal disaggregation library according to the user's choices, as expressed by means of the corresponding forms. While the first module has been coded in Visual Basic, the second one has been written in the Matlab programming language.

This interface enables using environments in a simple and efficient way, permitting so quantitative analysts in general and, particularly, national accountants to easily integrate the temporal disaggregation techniques into their "tool-boxes". In this sense, it also facilitates the transition from research mode to production mode, see Gatheral et al. (1999) for a detailed description of these issues.

2. DISAGGREGATION METHODS CONSIDERED

The interface allows for both, univariate as well as multivariate temporal disaggregation techniques. Among the first methods one can find these of Boot-Feibes-Lisman (1967), Denton (1971), Fernández (1981), Chow-Lin (1971), Litterman (1983) and Santos-Cardoso (2001) and among the second group, the ones of Rossi (1982), Denton[2] and Di Fonzo (1990). See Di Fonzo (1987, 2002) for a deep analysis of these methods.

Although, the Stram-Wei (1986) and of the Guerrero (1990) methods have not been included due to their special information requisites, they remain directly accessible by means of the basic library through the functions `sw()` and `guerrero()` respectively.

The information-input requirements of the different univariate methods available, as well as the relevant constraints imposed on them have been detailed in the following table:

Table 1: Univariate methods

Method	**Inputs**		**Constraints**		
	Y : Nx1	**x : nxp**			
Boot-Feibes-Lisman	X	-	-	-	N≥3
Denton	X	X	p=1	n=s*N	
Fernandez	X	X	p≥1	n≥s*N	
Chow-Lin	X	X			
Litterman	X	X			
Santos-Cardoso	X	X			

Multivariate methods enable the simultaneous estimation of a set of high-frequency data which have to satisfy a transversality condition. The information structure is summarized in the following table:

Table 2: Multivariate methods

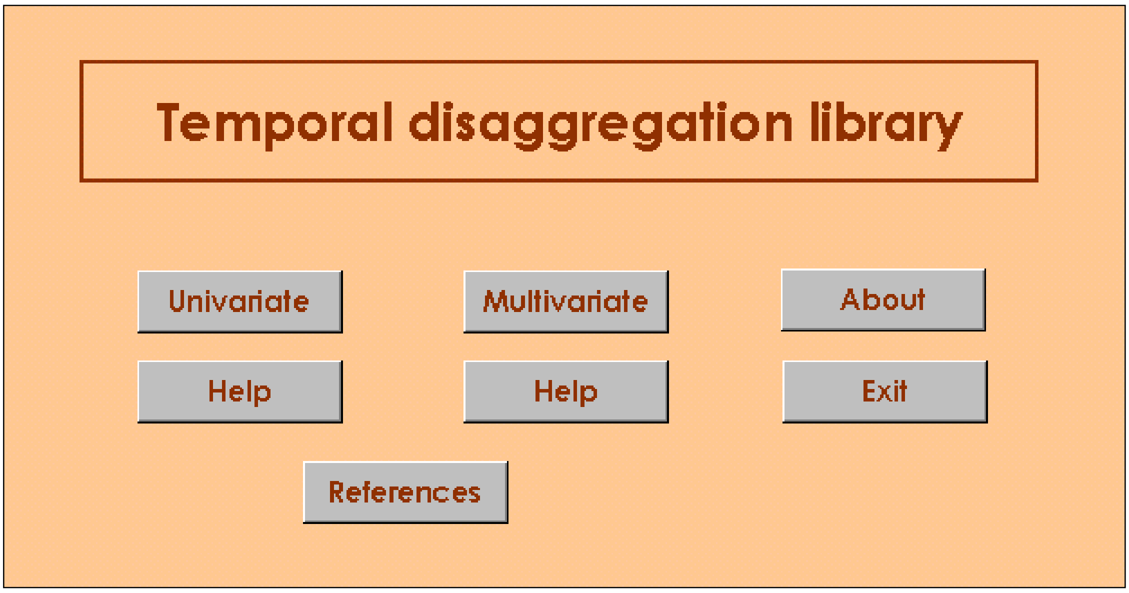
Method	**Inputs**			**Constraints**	
	Y : NxM	**x : nxm**	**z : nzx1**		
Rossi	X	X	X	m=M	n=nz=s*N
Denton	X	X	X		
Di Fonzo	X	X	X	m≥M	n≥nz≥s*N

[2] The extension to the multivariate case of the Denton method is described in Di Fonzo (1994) and in Di Fonzo and Marini (2003).

3. STRUCTURE OF THE CONTEXTUAL MENUS

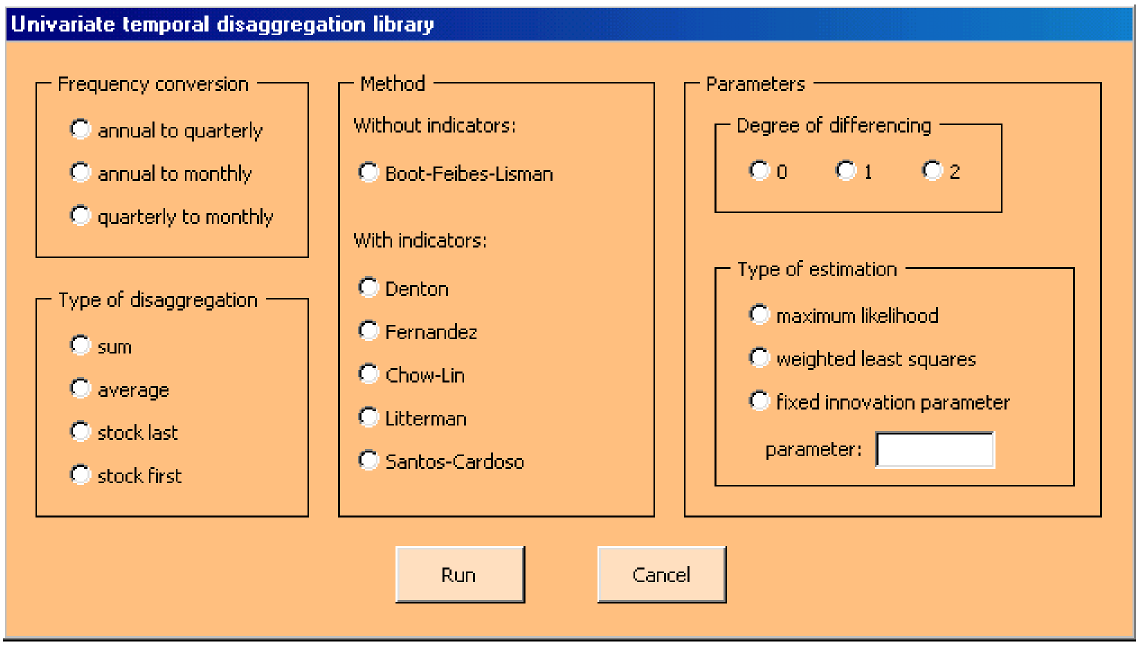
The initial menu allows selecting the type of temporal disaggregation technique: univariate or multivariate. It also grants access to specific information on the interface and on the Matlab library.

Figure 1: Initial Menu



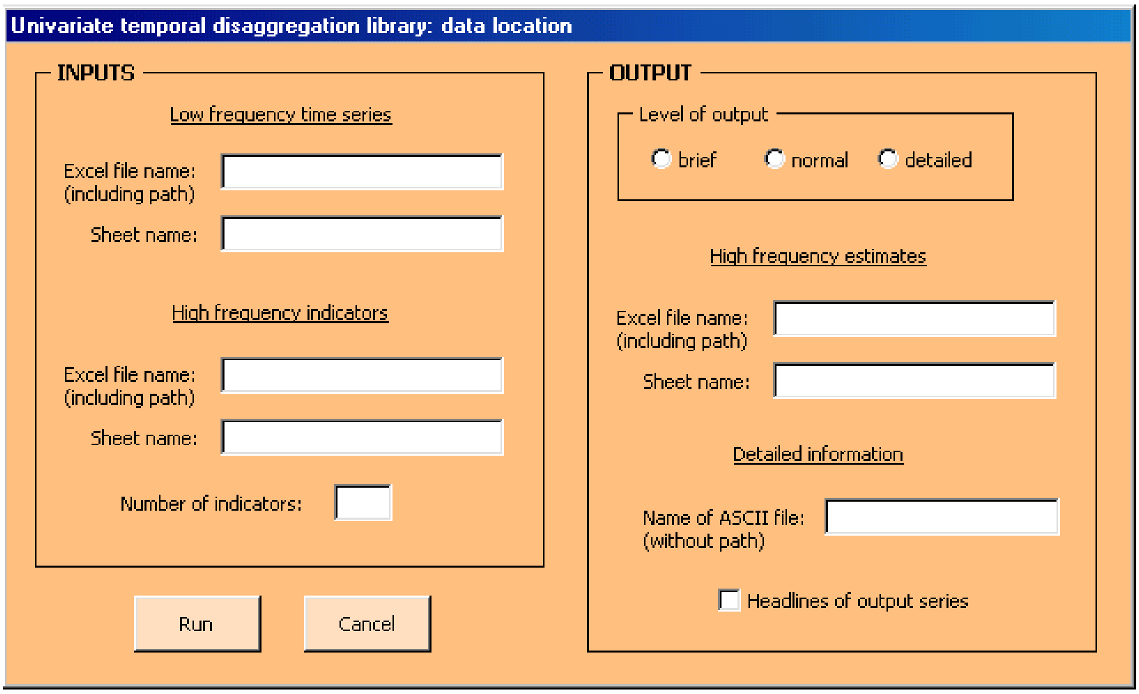
As a next step, in the univariate case, the user is asked to select the specific temporal disaggregation method to be employed and the corresponding required parameters. The menu itself will highlight the pertinent fields (i.e., "degree of differencing " if the Denton method is selected). The user has also to determine the frequency conversion procedure (i.e., annual to quarterly) as well as the nature of the transversal constraint (i.e., a flow's distribution implies the summation of high-frequency data in order to obtain low-frequency ones).

Figure 2: Menu for the univariate temporal disaggregation.



The format of the output-file containing the relevant information, the determination of its level of detail and directory path are chosen in the next contextual menu:

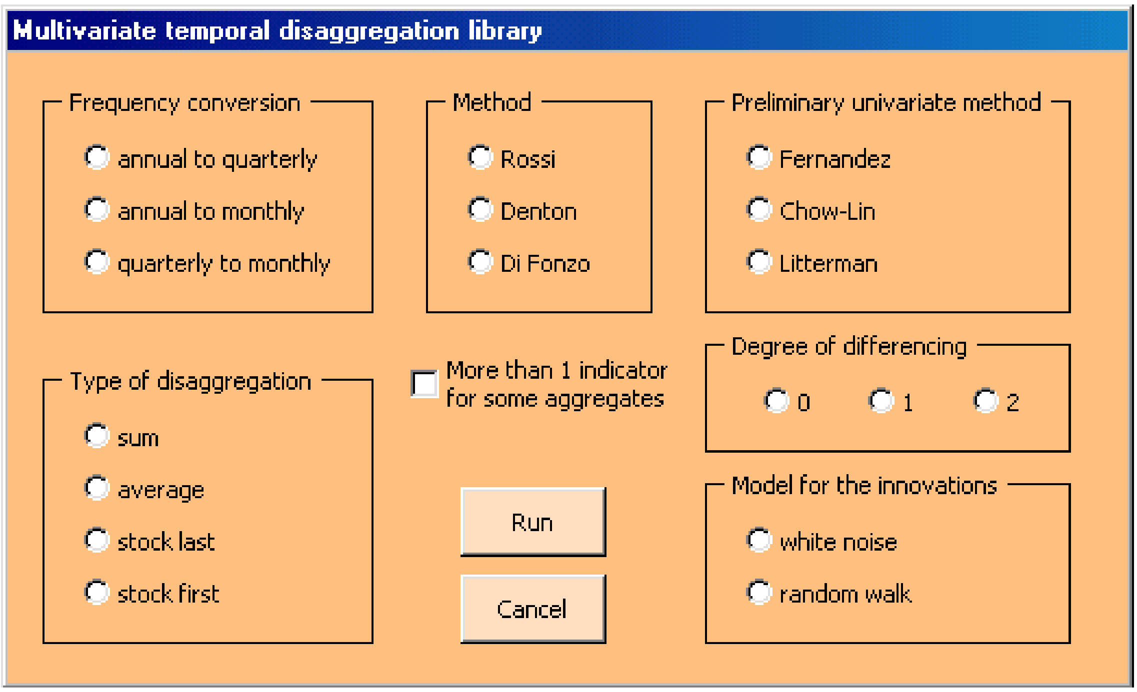
Figure 3: Menu for the format and for the presentation of information. Univariate case.



The output-file can adopt three different formats: summarized, normal and detailed. In the first case, the output consists only in the high-frequency estimates. In the second, the estimation is accompanied by (if the method chosen permits doing so) its standard deviation, its intervals ±sigma and its residual series. Finally, if the user chooses the detailed mode, the output will consist in the normal output plus an ASCII-file containing the results of the estimated model and diverse diagnostic checks.

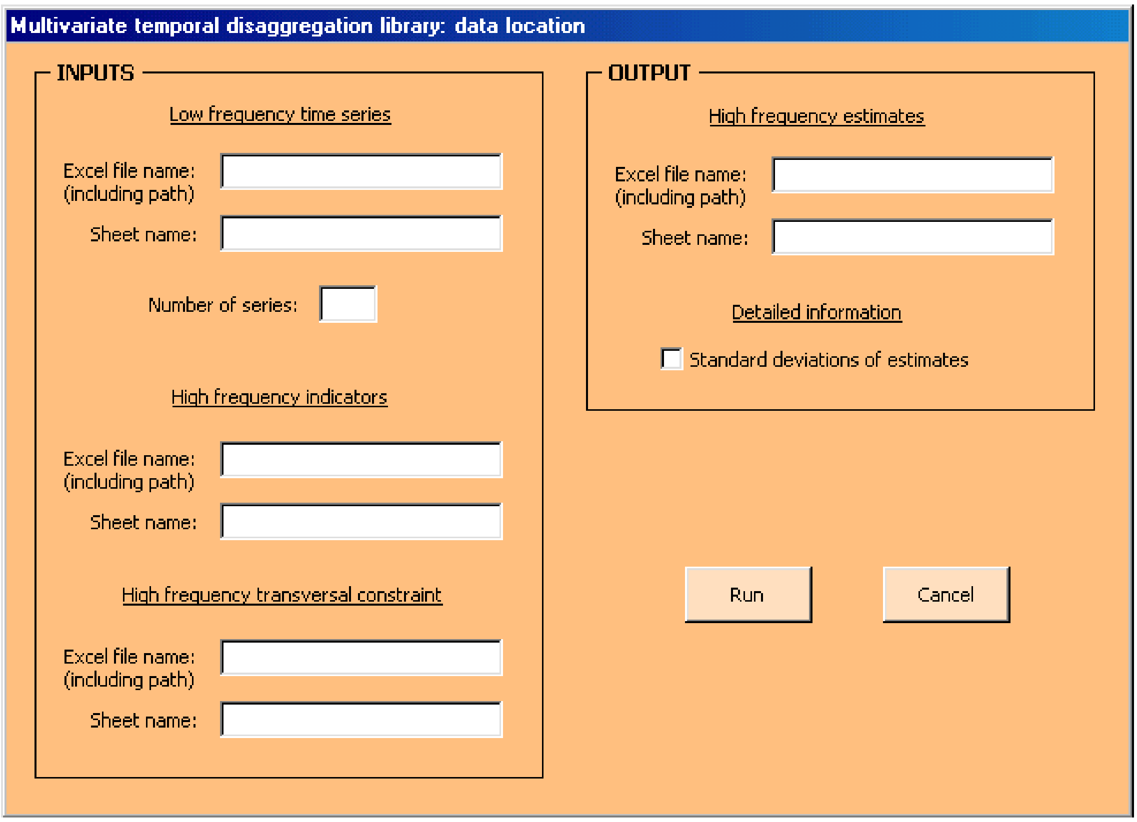
The scheme followed in the multivariate case is similar to the one described above. In the first place, the method, as well as its relevant parameters are selected:

Figure 4: Menu for the multivariate temporal disaggregation.



The selection of the relevant information and of the directory path of the output-file is carried out in the following menu:

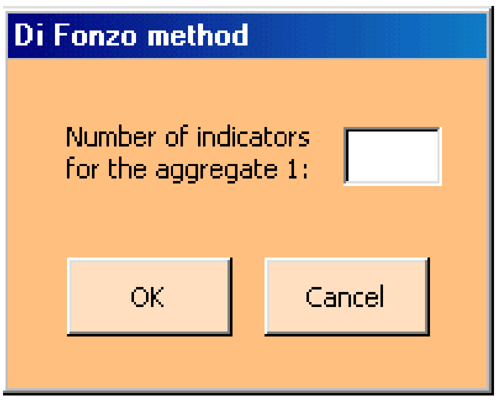
Figure 5: Menu for the format and for the presentation of information. Multivariate case



Note that the series acting as the transversal constraint constitutes a critical (exogenous) input of the information set that has to be provided to the program. Optionally, the output can be accompanied by the standard errors of the high-frequency estimates.

Finally, in case the Di Fonzo method has been selected and various indicators are available for each low-frequency series, then a supplementary menu will be activated. In this menu the user must indicate the number of indicators available for each variable to be temporally disaggregated.

Figure 6: Special contextual menu for the Di Fonzo method.



Appendix A: Univariante case: additional information

. All the files of the system (Matlab.m functions, documents in pdf format, and this Excel file) must be allocated in the same directory, **c:\td**

. An additional directory, **c:\td\output**, must be created, to store an ASCII file that holds the information of the **detailed** output (model, parameters, correlations, etc.), when this option is selected

. It is essential to have access to **Excel**, **Matlab**, and its **Excel Link** toolbox must be operative

. Both Excel and Matlab must be active during execution, and Matlab must be activated through Excel (via Excel Link)

. Restrictions on input data:

- all the input series must be columnwise. The output series will also be columnwise arranged
- an empty row must mark the end of input data
- the series to be disaggregated must have a minimum of **3** observations
- indicators must form a compact matrix (i.e., without empty columns among them)
- all the indicators must have the same number of observations

. Restrictions related to methods:

- the Boot-Feibes-Lisman method does not use indicators; the Denton method requires only 1 indicator; the remaining methods require at least 1 indicator
- the Denton method requires that **n=s*N**; the remaining methods with indicator require that **n>=s*N** (**n** is the number of observations of the high-frequency indicator, **s** is the frequency conversion, and **N** is the number of observations of the low-frequency series)
- the Chow-Lin, Litterman, and Santos-Cardoso methods allow to set the innovation parameter; the value of this parameter must lie between **-1** and **1**, both excluded

. Output is written in the selected sheet, beginning in the selected initial cell. This cell marks the upper left corner of the data matrix formed by: estimate (**brief** output) or estimate, standard error, lower bound (estimate - s.e.), upper bound (estimate + s.e.) and residuals (**normal** and **detailed** output)

. When the output **normal** or **detailed** is selected, the option **Headlines** writes the names of the output series in the line corresponding to the selected cell; data are written from the next line on

. Due to their intrinsic characteristics, the methods of Boot-Feibes-Lisman (BFL) and Denton do not generate standard errors, lower and upper limits, and BFL neither residuals. In order to preserve a common format for tabulation purposes, the interface fills this series with zeros, in **normal** and **detailed** output options

Appendix B: Multivariante case: additional information

. All the files of the system (Matlab.m functions, documents in pdf format, and this Excel file) must be allocated in the same directory, **c:\td**

. It is essential to have access to **Excel**, **Matlab**, and its **Excel Link** toolbox must be operative

. Both Excel and Matlab must be active during execution, and Matlab must be activated through Excel (via Excel Link)

. Restrictions on input data:

- all the input series must be columnwise. The output series will also be columnwise arranged

- an empty row must mark the end of input data

- all the series to be disaggregated must have the same number of observations, with a minimum of **3**

- indicators must form a compact matrix (i.e., without empty columns among them)

- indicators must be arranged in the same order that the low frequency series

- all the indicators must have the same number of observations

- the transversal constraint must be just **1** series

. Restrictions related to methods:

- the methods of Rossi and Denton require that **m=M**; the Di Fonzo method requires that **m>=M** (**m** is the number of indicators, **M** is the number of aggregates); so, in the first case just **1** indicator is allowed for each aggregate, and in the last case each aggregate can have **more than 1** indicator

- the methods of Rossi and Denton require that **n=nz=s*N**; the Di Fonzo method requires that **n>=nz>=s*N** (**n** is the number of observations of the indicators, **nz** is the number of observations of the transversal constraint, **s** is the frequency conversion, **N** is the number of observations of the aggregates); so, extrapolation is allowed only in the last case, with or without binding contemporaneous constraint

. Output is written in the selected sheet, beginning in the selected initial cell. This cell marks the upper left corner of the data matrix formed by estimate series, **in the same order** of the input aggregates

. If **detailed information** option in selected, the Di Fonzo method writes a matrix with the standard error of estimates, on the right side of the matrix with the estimates series, and in the same order. Due to their intrinsic characteristics, the methods of Rossi and Denton do not generate this kind of matrix.

Appendix C: A Matlab temporal disaggregation library

In this appendix we describe the syntax of all the functions contained in the temporal disaggregation library, including those not available through the Excel interface, e.g., `guerrero()`.

C.1. BOOT-FEIBES-LISMAN

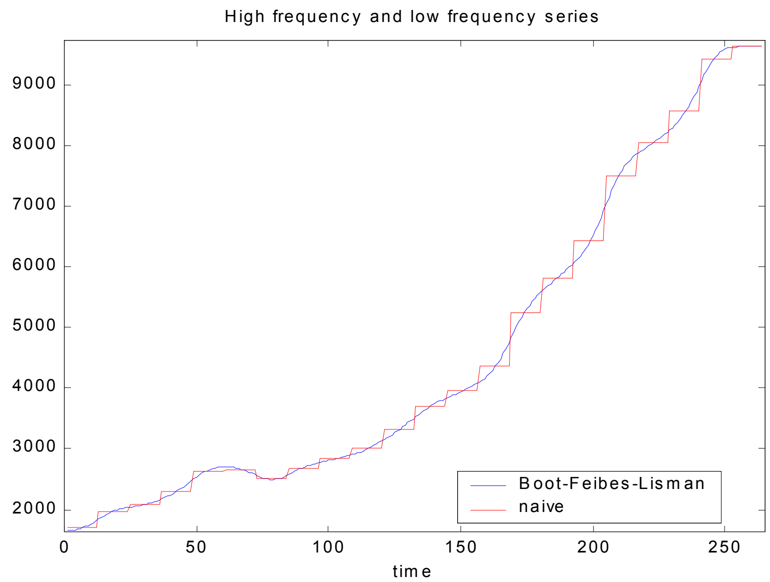
```
PURPOSE: Temporal disaggregation using the Boot-Feibes-Lisman method
---------------------------------------------------------------------
SYNTAX: res=bfl(Y,ta,d,s);
---------------------------------------------------------------------
OUTPUT: res: a structure
     res.meth  = 'Boot-Feibes-Lisman';
     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
```



C.2. STRAM-WEI

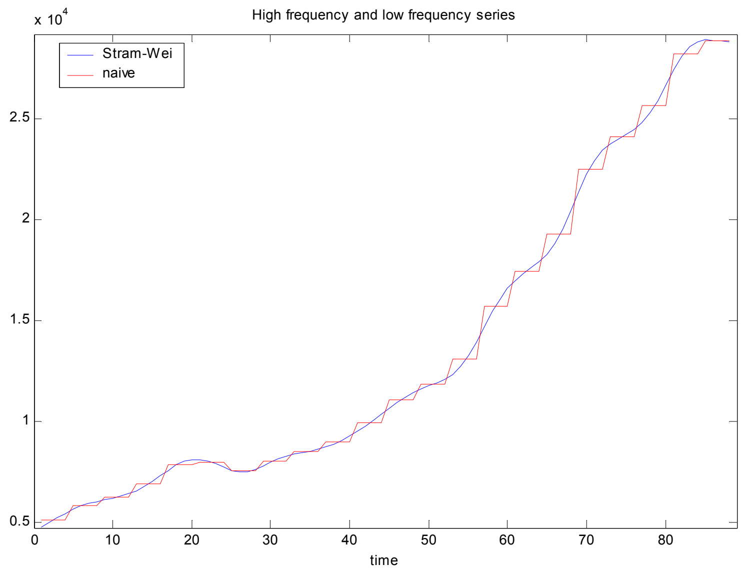
```
PURPOSE: Temporal disaggregation using the Stram-Wei method.
---------------------------------------------------------------------
SYNTAX: res = sw(Y,ta,d,s,v);
---------------------------------------------------------------------
OUTPUT: res: a structure
       res.meth  = 'Stram-Wei';
       res.N     = 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
```



C.3. DENTON

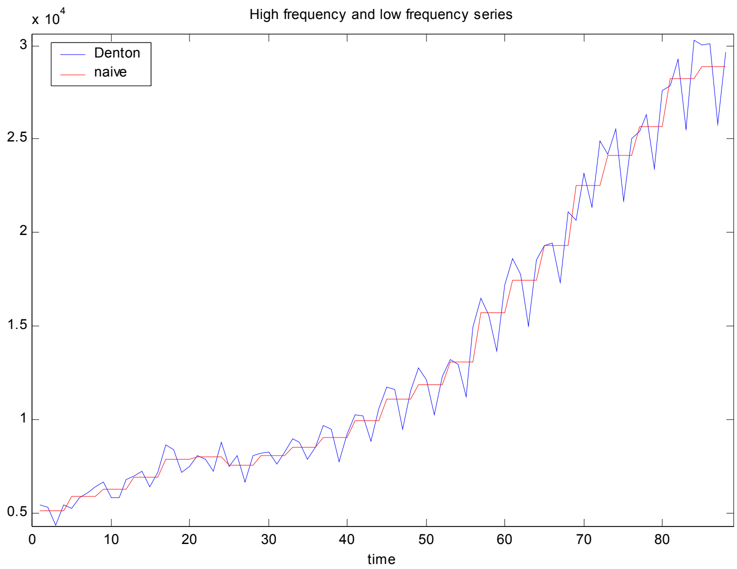
```
PURPOSE: Temporal disaggregation using the Denton method
---------------------------------------------------------------------
SYNTAX: res=denton_uni(Y,x,ta,d,s);
---------------------------------------------------------------------
OUTPUT: res: a structure
        res.meth  = 'Denton';
        res.N     = 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.
```

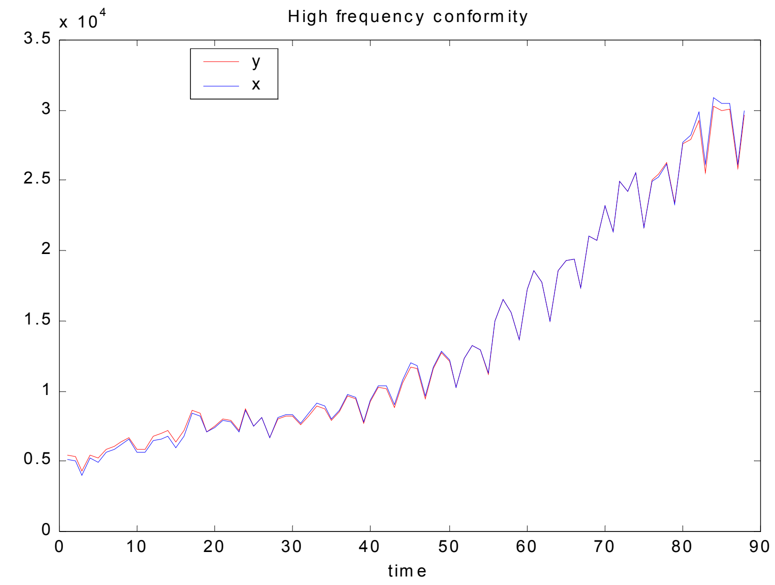
Application:

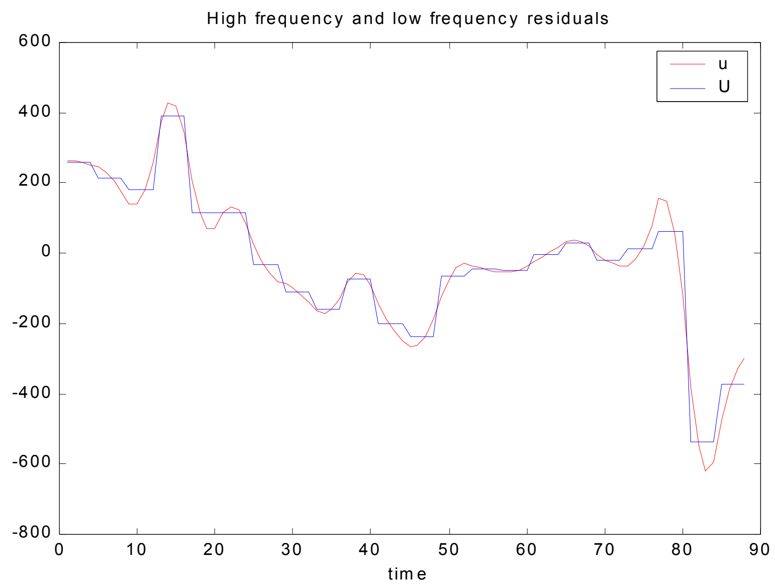
```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.ind');
res=denton_uni(Y,x,1,1,4);
tduni_print(res,'td.sal');
tduni_plot(res);
edit td.sal
```

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
y
x
time


High frequency and low frequency residuals
u
U
time

```
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.
```

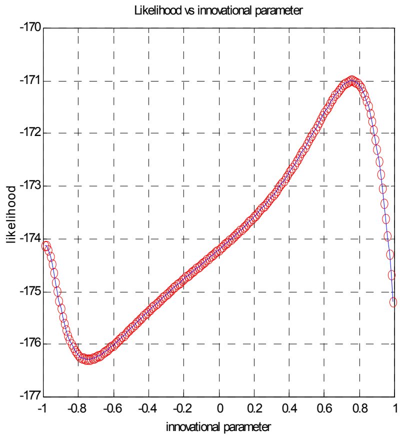
Application:

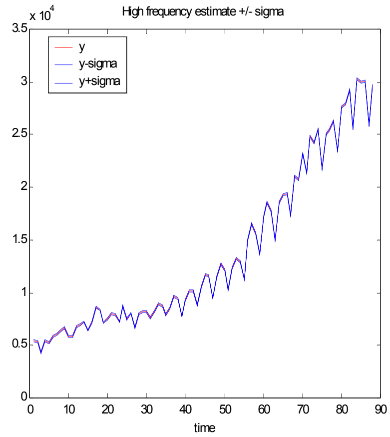
```
Y=load('c:\x\td\data\Y.prn');
x=load('c:\x\td\data\x.ind');
res=chowlin(Y,x,1,4,1);
td_print(res,'td.sal',1);      % op1=1: series are printed in ASCII file
td_plot(res);
edit td.sal
```

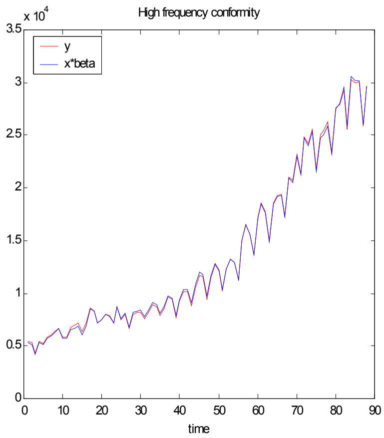
ASCII file containing detailed output:

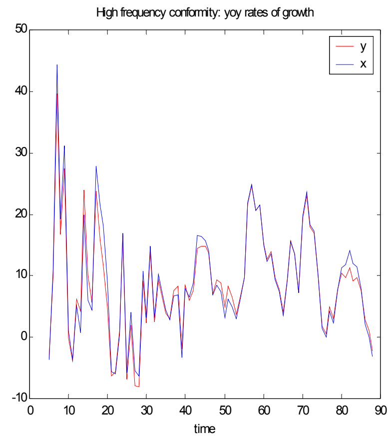
```
 ****************************************************
 TEMPORAL DISAGGREGATION METHOD: Chow-Lin
 ****************************************************
---------------------------------------------------
 Number of low-frequency observations :   22
 Frequency conversion                 :    4
 Number 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
 ----------------------------------------------------
```

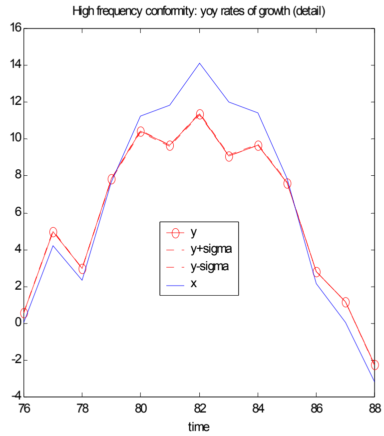
```
High frequency series (columnwise):
   * Estimate
   * Std. deviation
   * 1 sigma lower limit
   * 1 sigma upper limit
   * Residuals
 ----------------------------------------------------
  5400.9896         114.8247        5286.1649       5515.8143       112.3095
  5311.2409          83.7296        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
```

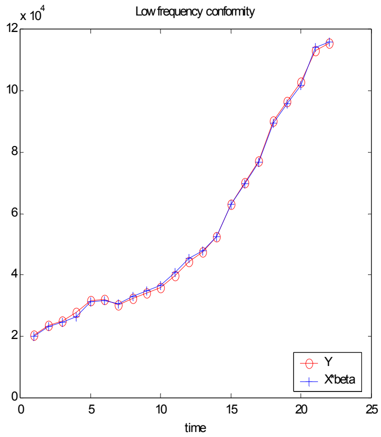


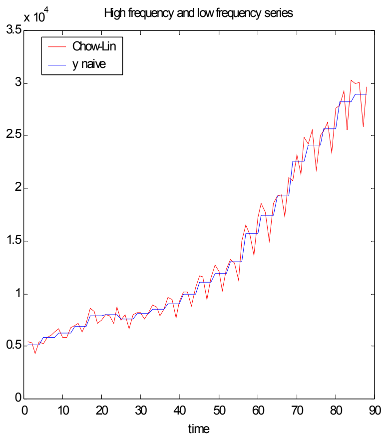


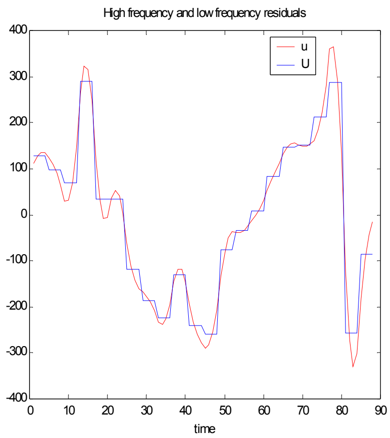












A variant to be applied with a fixed innovational parameter:

```
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);
------------------------------------------------------------
```

C.5. FERNANDEZ

```
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.

C.6. 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.

C.7. SANTOS SILVA-CARDOSO

```
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);
```

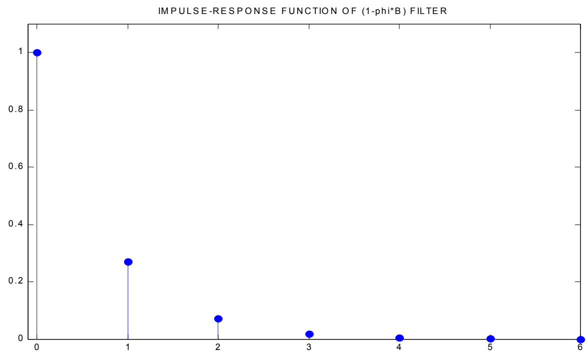
ASCII file containing detailed output:

```
****************************************************
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);

C.8. 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.

C.9. ROSSI

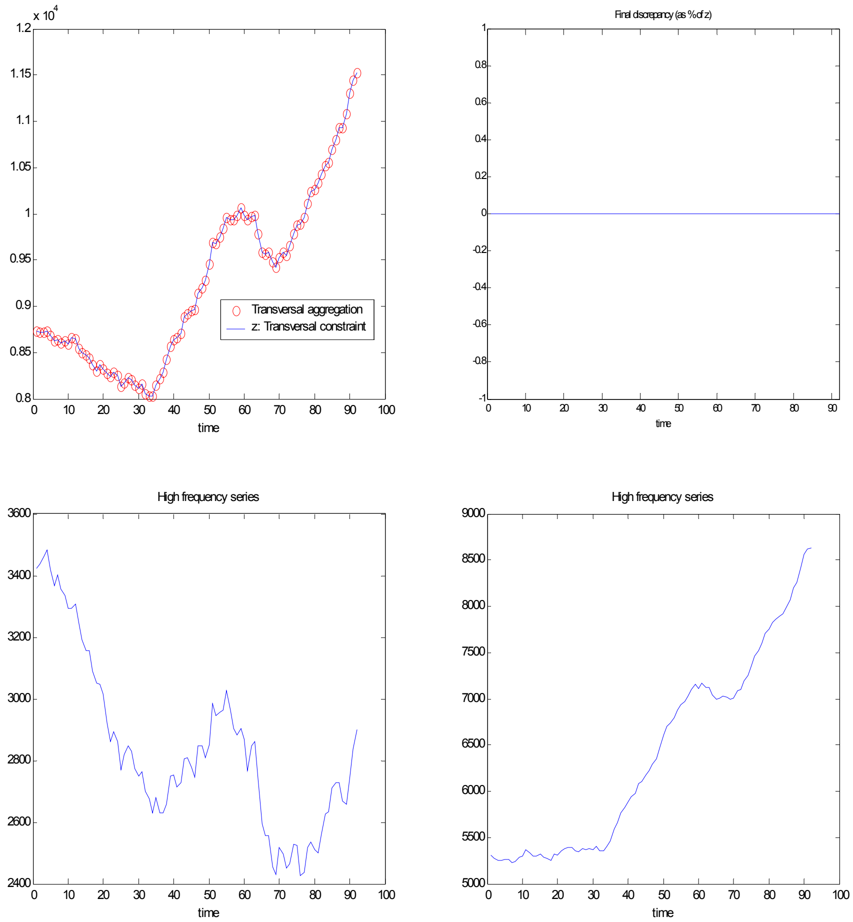
```
function res = rossi(Y,x,z,ta,s,type);
PURPOSE: Multivariate temporal disaggregation with transversal constraint
---------------------------------------------------------------------------
SYNTAX: res = rossi(Y,x,z,ta,s,type);
---------------------------------------------------------------------------
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
```


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

C.10. MULTIVARIATE DENTON

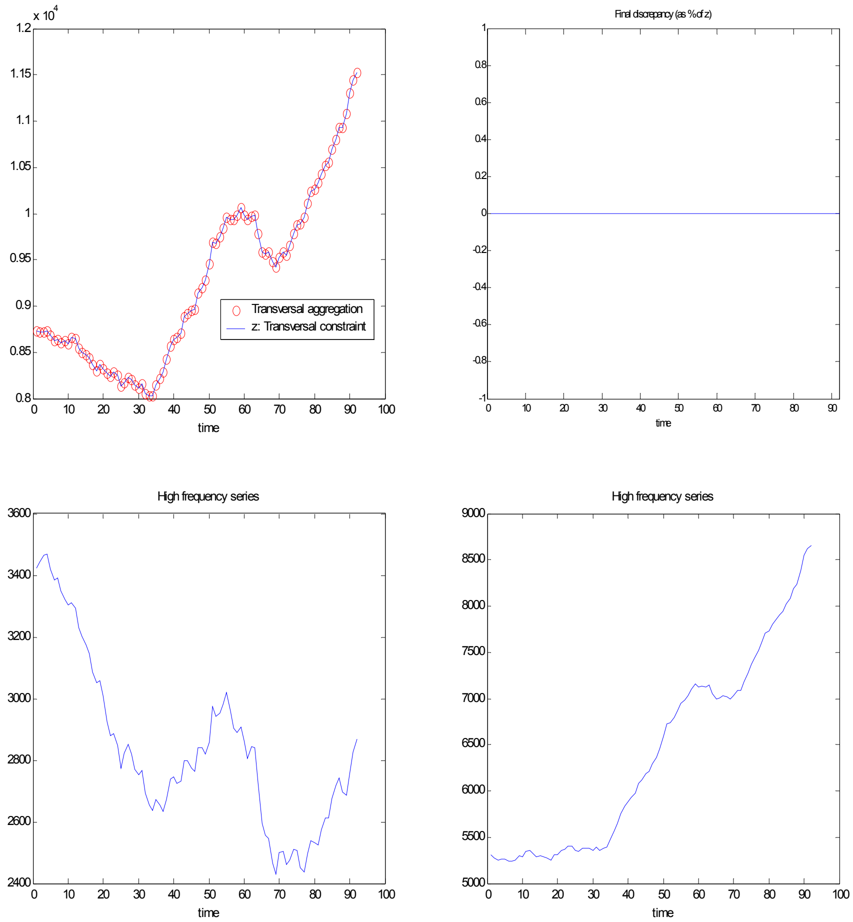
```
function res = denton(Y,x,z,ta,s,d);
PURPOSE: Multivariate temporal disaggregation with transversal constraint
---------------------------------------------------------------------------
SYNTAX: res = denton(Y,x,z,ta,s,d);
---------------------------------------------------------------------------
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

```
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.
```

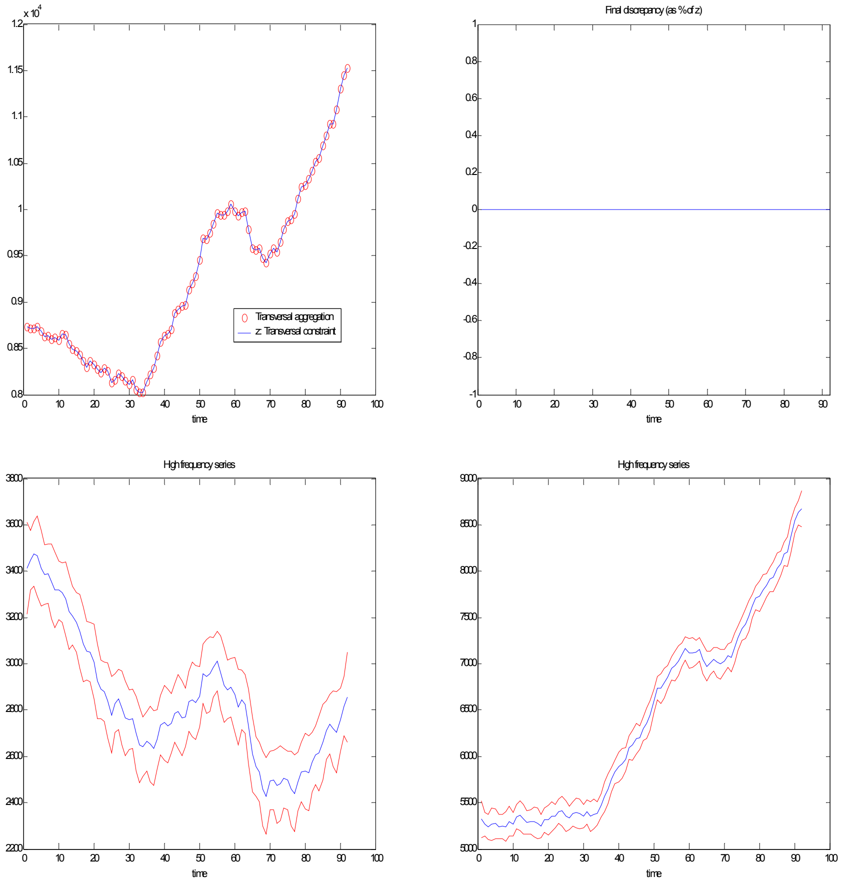
Application:

```
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 D: Additional notes

This release[3] 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

[3] Sequence of releases: First version: December, 2002. Second version: November, 2003.This version: August, 2004.

APPENDIX E: 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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