

estimateFAVAR.m – Forecast 113 series with a FAVAR

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Clear the workspace and load the data

```
5: clear();
6: close('all');
7: format('compact');
8: d = loadstruct('data.mat');
9: list = fieldnames(d);
```

Display the list of series

Each tseries object (in fact, each model, VAR, FAVAR) can have 'user data' attached to it. The user data can be absolutely anything.

```
15: % Display user data for the 1st variable (whatever it is).
16: u = userdata(d.(list{1}));
17: display(u);
18:
19: % Display the whole list of variables.
20: nlist = numel(list);
21: for i = 1 : nlist
22:     u = userdata(d.(list{i}));
23:     fprintf('%3g. %8s %g\t\t%s\n',i,list{i},u.Transform,u.Descriptor);
24: end
```

```
u =
    VarName: 'SPDJI'
   StartDate: '02-Jan-1951'
    EndDate: '15-Oct-2009'
  NumberObs: 15338
   Frequency: 'D'
DateTimeMod: '15-Oct-2009 21:06:00'
  Magnitude: 0
```

```

DecPrecision: 2
  DiffType: 0
  AggType: 'AVG'
  DataType: 'US$'
  Group: 'S08'
  Source: 'WSJ'
  Descriptor: [1x60 char]
  ShortSource: 'DJ'
  LongSource: 'Dow Jones'
  AccessedFrom: 'HAVER'
  Database: 'DAILY'
  Transform: 1
  DateTimeMod1: 7.3406e+005
  DateTimeMod2: 20091015
1.  SPDJI 1 Stock Price Averages: Dow Jones 30 Industrials, NYSE (Close)
2.  SP500 1 Standard & Poor's 500 Stock Price Index (1941-43=10)
3.  SPWI 1 Wilshire 5000 Price Index [Full Cap] (Dec-31-70=830.27)
4.  PZTEXA 1 Domestic Spot Market Price: West Texas Intermediate, Cushing ($/Barrel)
5.  PZBRT 1 European Free Market Price: Brent Crude Oil ($/Barrel)
6.  FFED 0 Federal Funds [Effective] Rate (% p.a.)
7.  FCM1 0 1-Year Treasury Bill Yield at Constant Maturity (% p.a.)
8.  FCM5 0 5-Year Treasury Note Yield at Constant Maturity (% p.a.)
9.  FCM10 0 10-Year Treasury Note Yield at Constant Maturity (Avg, % p.a.)
10.  FLTG 0 Treasury Bond, Long-Term Composite: Over 10 Years (% p.a.)
11.  FBAA 0 Moody's Seasoned Baa Corporate Bond Yield (% p.a.)
12.  FFP1 0 1-Month Financial Commercial Paper (% per annum)
13.  X112SMC 1 United Kingdom: Spot Exchange Middle Rate, NY Close (Pounds/US$)
14.  X158SMC 1 Japan: Spot Exchange Middle Rate, NY Close (Yen/US$)
15.  BOCGX 0 Phila FRB Bus Outlook: General Activity, Current, Diffusion Index (SA,%)
16.  FTCIL 0 FRB Sr Officers Survey: Banks Tightening C&I Loans to Large Firms (%)
17.  FTCIS 0 FRB Sr Officers Survey: Banks Tightening C&I Loans to Small Firms (%)
18.  FTCRE 0 FRB Sr Loan Off Survey: Tightening Standards for Commercial Real Estate (%)
19.  FTCNMH 0 FRB Sr Loan Survey: Res Mortgages: Net Share, Banks Tightening (Haver Est, %)
20.  IP 1 Industrial Production Index (SA, 2002=100)
21.  IPMFG 1 Industrial Production: Manufacturing [SIC] (SA, 2002=100)
22.  IDI1 0 IP: Diffusion Index: One Month Earlier (%)
23.  IDI3 0 IP: Diffusion Index: 3 Months Earlier (%)
24.  IDI6 0 IP: Diffusion Index: Six Months Earlier (%)
25.  CUT 1 Capacity Utilization: Industry (SA, Percent of Capacity)
26.  CUMFG 1 Capacity Utilization: Manufacturing [SIC] (SA, Percent of Capacity)
27.  LANAGRA 1 All Employees: Total Nonfarm (SA, Thous)
28.  LAPRIVA 1 All Employees: Total Private Industries (SA, Thous)
29.  LACONSA 1 All Employees: Construction (SA, Thous)
30.  LAMANUA 1 All Employees: Manufacturing (SA, Thous)
31.  LRPRIVA 1 Average Weekly Hours: Total Private Industries (SA, Hrs)
32.  LRMANUA 1 Average Weekly Hours: Manufacturing (SA, Hrs)
33.  LE 1 Civilian Employment: Sixteen Years & Over (SA, Thousands)
34.  LEMT20 1 Civilians Employed: Men, 20 Years and Over (SA, Thous.)
35.  LR 1 Civilian Unemployment Rate: 16 yr + (SA, %)
36.  LRM25 1 Civilian Unemployment Rate: Men, 25-54 Years (SA, %)

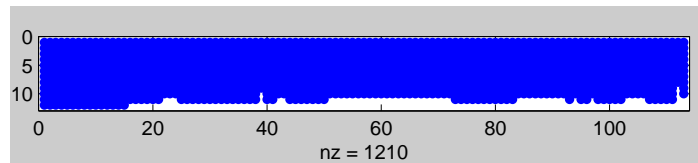
```

37. LUT15WP 1 Unemployed for 15 Weeks and Over: % of Civilian Labor Force (SA, %)
 38. LH 1 Not in the Labor Force: 16 yr + (SA, Thous)
 39. LHELP 1 Index of Help-Wanted Advertising in Newspapers (SA,1987=100)
 40. LICM 1 Initial Claims for Unemployment Insurance, State Programs, Wkly Avg (SA, Thous)
 41. LIUM 1 Insured Unemployment: Continued Claims, State Programs (SA, Thous)
 42. LUEX 1 Unemployment Insurance: Exhaustion Rate (%)
 43. LUD 1 Unemployment Insurance: Average Duration of Benefits (Weeks)
 44. LIURM 1 Insured Unemployment as Percent of Covered Employment (SA, %)
 45. NRST 1 Retail Sales & Food Services (SA, Mil.\$)
 46. NRS 1 Retail Sales: Total (SA, Mil.\$)
 47. NRSXM 1 Retail Sales: Total Excl Motor Vehicle & Parts Dealers (SA, Mil.\$)
 48. TLVDAR 1 Domestic Light Vehicle Sales (SAAR, Mil.Units)
 49. TOSAR 1 Medium & Heavy Truck Sales: 14,001 Lbs GVW and Over (SAAR, Mil.Units)
 50. TDSAR 1 Total Domestic Light Vehicle Retail Sales (SAAR, Mil Units)
 51. NMSDG 1 Manufacturers' Shipments: Durable Goods (SA, Mil.\$)
 52. NMSNG 1 Mfrs' Shipments: Nondurable Goods Industries (SA, Mil.\$)
 53. NMONG 1 Mfrs' New Orders: Nondurable Goods Industries (SA, Mil.\$)
 54. YPM 1 Personal Income (SAAR, Bil.\$)
 55. YPDHM 1 Real Disposable Personal Income (SAAR, Bil.Chn.2005\$)
 56. CBHM 1 Real Personal Consumption Expenditures (SAAR, Bil.Chn.2005\$)
 57. HST 1 Housing Starts (SAAR, Thous.Units)
 58. HPT 1 New Pvt Housing Units Authorized by Building Permit (SAAR, Thous.Units)
 59. HNIUS 1 New 1-Family Houses Sold: United States (SAAR, Thous)
 60. HXIUS 1 Existing 1-Family Home Sales: United States (SAAR, Thous)
 61. HST1 1 Housing Starts: 1 Unit (SAAR, Thous.Units)
 62. HP1 1 Housing Units Authorized: 1-Unit Structures (SAAR, Thous.Units)
 63. CPT 1 Value of Construction Put in Place (SAAR, Mil.\$)
 64. CPV 1 Value of Private Construction Put in Place (SAAR, Mil.\$)
 65. NTI 1 Inventories: Total Business (EOP, SA, Mil.\$)
 66. NMI 1 Mfrs' Inventories: All Manufacturing Industries (EOP, SA, Mil.\$)
 67. NRI 1 Retail Inventories: Total (EOP, SA, Mil.\$)
 68. NRIXM 1 Retail Inventories: Total Excl Motor Vehicle & Parts Dealers (EOP, SA, Mil.\$)
 69. NTR 1 Inventory/Sales Ratio: Total Business (SA)
 70. NMRI 1 Mfrs' Inventory/Sales Ratio: All Manufacturing Industries (SA)
 71. NRR 1 Inv/Sales Ratios: Total Retail (SA)
 72. NRRXM 1 Inv/Sales Ratios: Total Retail Excl Motor Vehicle & Parts Dealers (SA)
 73. NAPMC 0 ISM Mfg: PMI Composite Index (SA, 50+ = Econ Expand)
 74. NAPMNI 0 ISM Mfg: New Orders Index (SA, 50+ = Econ Expand)
 75. NAPMOI 0 ISM Mfg: Production Index (SA, 50+ = Econ Expand)
 76. PMCXBA 0 ISM-Chicago: Business Barometer Index (SA, 50+ = Econ Growth)
 77. PMCXPD 0 ISM-Chicago: Production Index (SA, 50+ = Econ Growth)
 78. CCIN 1 Conference Board: Consumer Confidence (SA, 1985=100)
 79. CCIEN 1 Conference Board: Consumer Expectations (SA, 1985=100)
 80. CSENT 1 University of Michigan: Consumer Sentiment (NSA, Q1-66=100)
 81. CEXP 1 University of Michigan: Consumer Expectations (NSA, Q1-66=100)
 82. PCU 1 CPI-U: All Items (SA, 1982-84=100)
 83. PCUSLFE 1 CPI-U: All Items Less Food and Energy (SA, 1982-84=100)
 84. JCBM 1 PCE: Chain Price Index (SA, 2005=100)
 85. JCXFEBM 1 PCE less Food & Energy: Chain Price Index (SA, 2005=100)
 86. SP3000 1 PPI: Finished Goods (SA, 1982=100)

```

87. SP2000 1 PPI: Intermediate Materials, Supplies and Components (SA, 1982=100)
88. SP1000 1 PPI: Crude Materials for Further Processing (SA, 1982=100)
89. SP3500 1 PPI: Finished Goods less Food and Energy (SA, 1982=100)
90. SP2900 1 PPI: Intermediate Materials less Foods and Energy (SA, 1982=100)
91. JCMTM 1 Market-Based PCE: Total: Chain Price Index (SA, 2005=100)
92. JCMXFEM 1 Market-Based PCE: Excluding Food & Energy: Chain Price Index (SA, 2005=100)
93. CLEVFE0 0 FRB Cleveland Median CPI (SAAR, %chg)
94. PCE1 0 FRB Dallas: Trimmed-Mean 1-month PCE Inflation, Annual Rate (%)
95. PZALL 1 KR-CRB Spot Commodity Price Index: All Commodities (1967=100)
96. PFALL 1 Reuters/Jefferies CRB Futures Price Index: All Commodities (1967=100)
97. PZRAC 1 Refiners' Acquisition Cost of Crude Oil: Composite: DOE ($/BBL)
98. PZTEXF1 1 Light Sweet Crude Oil Futures Price: 1st Expiring Contract Settlement ($/bbl)
99. PZTEXF6 1 Light Sweet Crude Oil Futures Price: 6-Month Contract Settlement ($/bbl)
100. LEPRIVA 1 Average Hourly Earnings: Total Private Industries (SA, $/Hour)
101. NAPMPI 0 ISM: Mfg: Prices Index (NSA, 50+ = Econ Expand)
102. FCM 0 Contract Rates on Commitments: Conventional 30-Yr Mortgages, FHLMC (%)
103. TMBCA 0 Trade Balance, Customs Value (SA, Mil.$)
104. TMXA 1 Exports, f.a.s.: Goods (SA, Mil.$)
105. TMMCA 1 Imports, Customs Value: Goods (SA, Mil.$)
106. TMMA 1 Imports, c.i.f.: Goods (SA, Mil.$)
107. FXTWB 1 Nominal Broad Trade-Weighted Exchange Value of the US$ (Jan-97=100)
108. FXTWM 1 Nominal Trade-Weighted Exch Value of US$ vs Major Currencies (Mar-73=100)
109. FXTWBC 1 Real Broad Trade-Weighted Exchange Value of the US$ (Mar-73=100)
110. FXTWMC 1 Real Trade-Weighted Exch Value of US$ vs Major Currencies (Mar-73=100)
111. X134SMC 1 Germany: Spot Exchange Middle Rate, NY Close (Deutsche Marks/US$)
112. GDPH 1 Real Gross Domestic Product (SAAR, Bil.Chn.2005$)
113. TMBA 3 Trade Balance, c.i.f. (SA, Mil.$)

```



Define dates

```

28: startHist = mm(1991,1);
29: endHist = mm(2009,10);
30: histRange = startHist : endHist;

```

Check the jagged edge

Get the observations for the last 12 months, and display what's available and what's missing.

```

36: Y = db2array(d,list,endHist-11:endHist);
37: spy(~isnan(Y));

```

Estimate a FAVAR

The state-space form of a FAVAR is as follows:

$$\begin{aligned} y_t &= Cx_t + \bar{y} + u_t, \\ x_t &= Ax_{t-1} + Be_t \\ Eu_tu_t' &= \Sigma, \quad Ee_te_t' = \Omega \end{aligned}$$

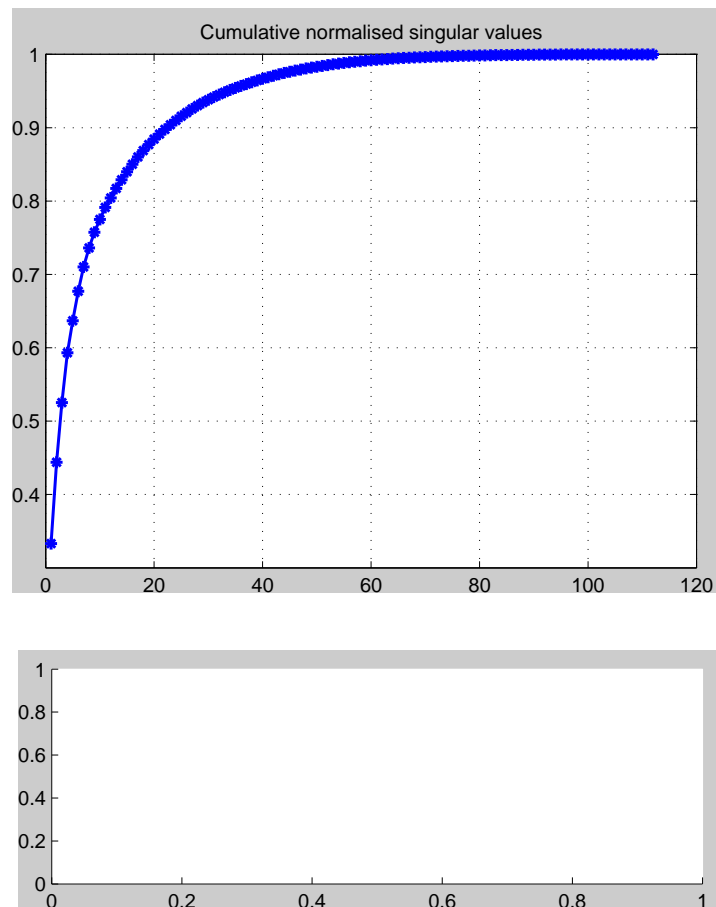
The estimation step, using the `estimate` function, only exploits information in periods where there are all observations available. The factor output series might, therefore, have gaps in them.

The output arguments of the `estimate` function are

- `a` – an estimated FAVAR object,
- `d1` – a database with the original input series,
- `c1` – a database with the common components
- `x1` – a multivariate time series of the estimated factors (with potentially some NaN whenever observations are not available).
- `u1` – a multivariate time series of the idiosyncratic shocks,
- `e1` – a multivariate time series of the factor shocks.

```
64: % * order -- is the number of lags in VAR
65:
66: % Inputs: estimate(f,d,list,range,[x,y],'order',p)
67: % x is the target share of the variance explained by the factors
68: % y is the maximum number of factors that will be used to achieve x
69: % p is the lag order of the VAR in the factors
70:
71: a = FAVAR();
72: [a,d1,c1,x1,u1,e1] = estimate(a,d,list,histRange,[1,4],'order',1);
73: display(a);
```

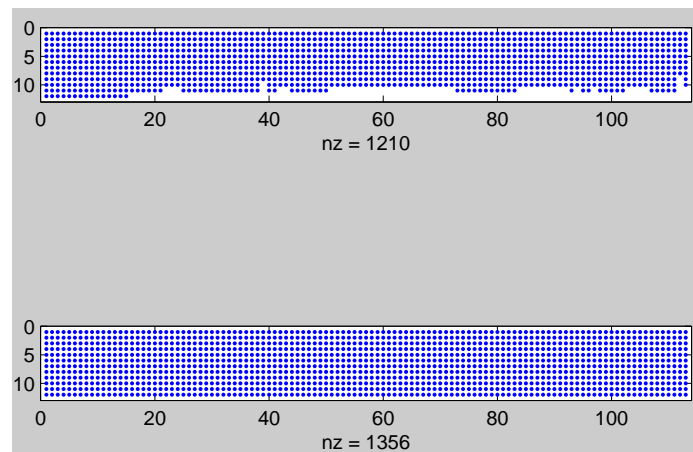
```
a =
FAVAR object 113x4x1x4: 1 parameterisation(s)
user data: empty
```



How much the FAVAR explains

Plot cum sum of singular values.

```
78: s = get(a,'singval');
79: s = cumsum(s);
80: figure();
81: plot(s/s(end),'lineWidth',1.5,'marker','*');
82: grid('on');
83: title('Cumulative normalised singular values');
```

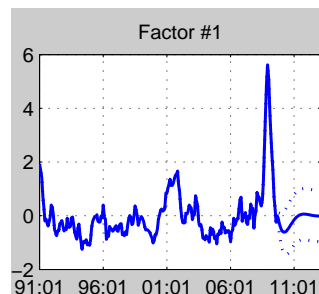


Get the state-space form.

```

87: % Get the state-space matrices.
88: A = get(a,'A*');
89: B = get(a,'B');
90: C = get(a,'C');
91: Omg = get(a,'Omega');
92: Sgm = get(a,'Sigma');

```



Re-filter the historical data

Use the `filter` function just to run a Kalman filter on the historical data, taking the estimated parameters as given, and fill in the missing observations.

```

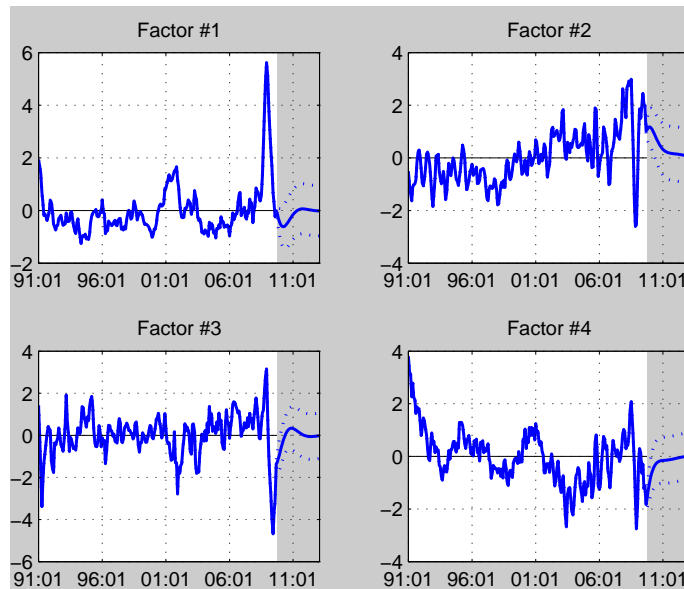
99: [a2,d2,c2,x2,u2,e2] = filter(a,d1,startHist:endHist);
100:
101:
102: % Compare the missing observations in d1 and d2.

```

```

103: figure();
104: subplot(2,1,1);
105: Y1 = db2array(d1,list,endHist-11:endHist);
106: spy(~isnan(Y1));
107: subplot(2,1,2);
108: Y2 = db2array(d2.mean,list,endHist-11:endHist);
109: spy(~isnan(Y2));

```



Forecast with a FAVAR

To produce a forecast, you can either extend the `filter` command beyond the last historical observation, or use the `forecast` function based on the `filter` results. These two yield identical results.

```

116: [a3,d3,c3,x3,u3,e3] = filter(a,d,startHist:endHist+40);
117:
118: [a4,d4,c4,x4,u4,e4] = filter(a,d,histRange);
119: [d5,c5,x5,u5,e5] = forecast(a,x4,endHist+(1:40),d);
120:
121: % Plot the factors.
122: nx = size(x3.mean,2);
123: figure();
124: for i = 1 : nx
125:     subplot(2,2,i);
126:     h = plot([ ...
127:         x3.mean{:,i}, ...
128:         x3.mean{:,i} + x3.std{:,i}, ...

```



```
129:     x3.mean{:,i} - x3.std{:,i}, ...
130:     ],'dateformat','YY:MM','lineWidth',1.5);
131:     set(h(2:3), ...
132:         'color',get(h(1),'color'), ...
133:         'lineStyle',':');
134:     title(sprintf('Factor #%g',i));
135:     grid('on');
136:     highlight(endHist+(1:40));
137:     zeroline();
138: end
```