

SAS® Proc STATESPACE and the forecasting of Bureau of Labor Statistics JOLT and Diffusion Index

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ABSTRACT

To anticipate trends in retention Kronos' Hiring Solution divisions utilizes Bureau of Labor Statistics published job statistics of hires, separations and job openings available on the internet at <http://www.bls.gov/jlt/home.htm> or for raw data that we utilize at the ftp site; <ftp://ftp.bls.gov/pub/time.series/jt/>. We also utilize the BLS statistic of job diffusion for Total Private Non-Farm payrolls available at <http://www.bls.gov/webapps/legacy/cesbtab7.htm>. Job diffusion is a measure of job creation compared to job destruction.

Since there are several time series that are related we forecast the BLS time series for hiring, separation and job openings using a state space model. The state space model is appropriate for jointly modeling and forecasting several related time series that have dynamic interactions. By taking into account the autocorrelations among the whole set of variables, the state space model may give better forecasts than methods that model each series separately.

INTRODUCTION

To assist our customers review and anticipate trends in retention we utilize Bureau of Labor Statistics published job statistics of hires, separations and job openings available on the internet at <http://www.bls.gov/jlt/home.htm> or for raw data that we utilize at the ftp site; <ftp://ftp.bls.gov/pub/time.series/jt/>. We also utilize the BLS statistic of job diffusion for Total Private Non-Farm payrolls available at <http://www.bls.gov/webapps/legacy/cesbtab7.htm>. Job diffusion is a measure of job creation compared to job destruction. It is indexed from zero to 100 where values under 50 represent job destruction and values over 50 represent job creation.

The Bureau of Labor Statistics (BLS) is the principal fact-finding agency for the Federal Government in the broad field of labor economics and statistics. The BLS is an independent national statistical agency that collects, processes, analyzes, and disseminates essential statistical data to the American public, the U.S. Congress, other Federal agencies, State and local governments, business, and labor. The BLS also serves as a statistical resource to the Department of Labor.

The basic BLS data contains 25 industrial groupings and four types of data; rates and levels. The 'level' refers to the count or thousands of hires/separations/job openings. The 'rates' refers to the level plus employed divided by employed. We focus on two industrial groupings from the wealth of data for the four time series of BLS Jobs statistics; Total Private (Non-Farm) and Retail Industry. We focus on these two groupings as most of our clients are retail customers and total private non-farm provides overall guidance in job markets and both of these industry groupings are seasonally stable and thus provide good forecasts.

Since there are several time series that are related we forecast the BLS time series for hiring, separation and job openings using a state space model. The state space model is appropriate for jointly modeling and forecasting several related time series that have dynamic interactions. By taking into account the autocorrelations among the whole set of variables, the state space model may give better forecasts than methods that model each series separately.

STATE SPACE MODELS

State space models characterize a multivariate time series through secondary variables, some of which may not be observable. The secondary variables are referred to as the state vector and this state vector summarizes the present and past values of the time series pertinent to the forecasting. The observed time series are expressed as linear combinations of these state variables. State space models are also called a Markovian representation or a canonical representation of a multivariate time series process.

The state space model provides diverse forms of stochastic models. When the dimensions of the predictor space are finite, a Gaussian multivariate stationary time series can be written in a state space form. According to Akaike

(1974) any autoregressive moving average (ARMA) process has a state space representation and any state space process can be expressed in an ARMA form.

SAS PROC STATESPACE®

SAS® PROC STATESPACE procedure is based on Akaike (1976). The form of the state space model used by the. The model is defined by the following state transition formulation:

$$z_{t+1} = F * z_t + G * (e_{t+1})$$

The matrix F is called the transition matrix and is referred to as the state transition equation with size $s \times s$ coefficients and it determines the dynamic nature of the model. The matrix G is called the input matrix is a matrix of $s \times r$ coefficient and determines the variance structure of the transition equation. In model identification, the first r rows and columns of G are set to an $r \times r$ identity matrix. The random error input vector e_t , sometimes called the innovation vector or shock vector, is a sequence of independent normally distributed random vectors of dimension r with mean 0 and covariance matrix.

State space models usually include a measurement or observation equation giving the observed values x_t as a function of the state vector z_t . In SAS ® PROC STATESPACE the measurement equation is merely an extraction of the first r components of the state vector and is always includes the observed values x_t in the state vector z_t .

In summary:

x_t is an observation vector of dimension r.

z_t is a state vector of dimension s, whose first r elements are x_t and whose last s-r elements are conditional prediction of future x_t .

$$\text{where } x_t = [I_r \ 0] z_t$$

F is the $s \times s$ transition matrix.

G is the $s \times r$ input matrix with the I_r (identity matrix) forming the first r rows and columns.

e_t are independent normally distributed random vectors of dimension r with mean **0** and a covariance matrix.

HOW SAS PROC STATESPACE® WORKS

The SAS ® PROC STATESPACE procedure is designed following the modeling strategy proposed by Akaike (1976). The strategy employed considers the canonical correlation analysis for the automatic identification of the state space model.

Akaike (1976) recommends first fitting a sequence of unrestricted vector autoregressive models and computes Akaike's information criterion (AIC) for each model. Using sample autocovariance matrices and the Yule-Walker equations to model the vector autoregressive models and the order of the VAR model producing the smallest Akaike information criterion is chosen as the order (number of lags into the past) to use in the canonical correlation analysis.

Through the selected order the elements of the state vector selected via a series of canonical correlation analyses of the observed autocovariance matrices. This analysis computes the sample canonical correlations of the past with an increasing number of steps into the future. Variables that yield insignificant correlations are excluded from further consideration and those that yield significant correlations are added to the state vector. Another information criterion proposed by Akaike is used to evaluate the importance of the correlation. When specifying the state vector explicitly the model identification steps are omitted.

After identification of the state vector, the state space model is fit to the data. The estimated of the parameters is done by approximate maximum likelihood for the free parameters in the F, G and covariance matrix. By default, and except for identifiability requirements, the F and G matrices are unrestricted,. And, optionally, conditional least-squares estimates can be computed and restrictions imposed on elements of the F and G matrices.

Using the Kalman filtering technique forecasts are produced after the parameters are estimated and from the fitted state space model. In the presence of differencing the forecasts are integrated to produce forecasts from the original input variables.

ANALYSIS OF BLS JOB STATISTICS

After downloading the BLS series data from the FTP website, we use SAS to load and combine the data for state space modeling. The only filtering we do is to limit our forecasting to the data that is not seasonally adjusted and to select and model only the Total Private and Retail industrial groupings of the BLS data. Our forecasting approach consists of the following:

- 1) Forecast the rates of hires, separations and job openings for each grouping separately
- 2) Forecast the levels of hires, separations and job openings for each grouping separately
- 3) Forecast the diffusion levels considering the hires, separations and job openings for Total Private industry grouping. The only diffusion level from BLS of interest to us is Total Private Non-Farm.

For PROC STATESPACE we need to create stationary time series. This is easily done with the 2 industrial groupings; both show significant annual seasonality that can be remedied with a lag of 12 and these industrial groupings show ongoing month over month growth which is remedied using a lag of 1. This differencing is accomplished within the STATESPACE procedure with the "(1,12)" specification following the variables included in the model. Retail and total private industries follow strong seasonality and therefore a lag of 12 for the annual seasonality. We output the data for use in graphing the subsequent forecasts and in the analysis we request a 12 month forecast from the modeling.

PROC STATESPACE automatically selects the appropriate models, fits the differenced data for F and G described above for forecasting, and forecasts as requested the months into the future. The output from SAS's PROC STATESPACE is rather voluminous and can be provided upon request. Here we will show only the transition matrix F and the interpretation along with graphical forecasts for Job Statistics.

SAS PROC STATESPACE® SET UP FOR BLS DATA

SAS PROC STATESPACE® provides (as all SAS® procedures) many SAS PROC STATESPACE procedure options. The options fall into the following categories; printing, input data, preliminary autoregressive models, canonical correlations analysis, state space estimation and forecasting options. Given the monthly definition of the BLS data series, we found the following parameter set up to be intuitive and natural implementation. Interpretation of the parameter settings is given below the SAS ® code.

```
proc statespace
    data=work.subset_jolt_x          out=work.pred
    lead=12                          interval=month
    LAGMAX=12  ARMAX=12  NOCENTER    DIMMAX=12  cancorr;
by industry_text;
label hire_level="Hire Level"
      totsep_level="Separation Level"
      jobop_level="Job Open Level";
var hire_level(1,12) totsep_level(1,12) jobop_level(1,12);
id month_id;
run;
```

Interpretation of SAS PROC STATESPACE® of the parameter settings

- a) data=work.subset_jolt_x → the input dataset
- b) out=work.pred → output dataset for forecast
- c) lead=12 → number of months forecasted into the future. (default is 0 or none) This is a Forecast setting.
- d) interval=month → Specifies the time interval between observations. Used in conjunction with the ID variable to check that the input data are in order and have no missing periods. This is a Forecast setting.
- e) LAGMAX=12 → Input dataset parameter to calculate the sample autocovariance. BLS data is highly seasonal so the 12 months lag is natural. (The

- default is 10) This is an Input parameter setting.
- f) ARMAX=12 → part of the preliminary autoregressive model this is used to select autoregressive lags to be evaluated and selected for forecasting. (The default is 10) This is a Preliminary Autoregressive parameter. An ARMAX=6 is used in our SAS PROC STATESPACE implementation for the forecasting of the BLS Diffusion index.
 - g) NOCENTER → Works with LAGMAX and prevents subtraction of the sample mean from the input series (after any specified differencing). This is an Input parameter setting
 - h) DIMMAX=12 → Upper dimension of the state vector in the canonical correlation analysis. (Again the default is 10)
 - i) CANCELL → Prints the canonical correlations and information criteria for the candidate state vectors considered.
 - j) PASTMIN=6 → Specifies the number of minimum lags to include in the canonical correlations. Used in our SAS PROC STATESPACE implementation for the forecasting of the BLS Diffusion index.

JOLT (JOB OPENINGS AND LABOR TURNOVER) DATA LOADING

Load the JOLT (job openings and labor turnover) data series and relevant data dimensions is easy and fast using SAS® PROC IMPORT after setting up a library for the loaded data. But in order to use the data some of the loaded data variable names are renamed in the SAS® PROC DATASETS. After merging in each of the relevant data dimension sources of data element types, rate level codes region and seasonality codes a level (how many) and a rates (relatively how much) data set are created for each type of the three series; hiring, total separations and job openings.

```
libname SAS_jolt "S:\stratall\Analytics Research Projects\SAS Libraries";

%let JT_industry="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.industry";
%let JT_dataelement="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.dataelement";
%let JT_ratelevel="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.ratelevel";
%let JT_region="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.region";
%let JT_seasonal="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.seasonal";
%let JT_footnote="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.footnote";
%let JT_current="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.data.0.Current";
%let JT_all="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.data.1.AllItems";
%let JT_series="S:\stratall\Analytics Research Projects\Bureau of Labor
Statistics BLS\JT Files\jt.series";
```

```
PROC IMPORT OUT= SAS_jolt.JT_industry
```

```

DATAFILE= &JT_industry DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

PROC IMPORT OUT= SAS_jolt.JT_dataelement
DATAFILE= &JT_dataelement DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

PROC IMPORT OUT= SAS_jolt.JT_ratelevel
DATAFILE= &JT_ratelevel DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

PROC IMPORT OUT= SAS_jolt.JT_region
DATAFILE= &JT_region DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

PROC IMPORT OUT= SAS_jolt.JT_seasonal
DATAFILE= &JT_seasonal DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

PROC IMPORT OUT= SAS_jolt.JT_footnote
DATAFILE= &JT_footnote DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

PROC IMPORT OUT= SAS_jolt.JT_current
DATAFILE= &JT_current DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

PROC IMPORT OUT= SAS_jolt.JT_all
DATAFILE= &JT_all DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES; DATAROW=2;
RUN;

PROC IMPORT OUT= SAS_jolt.JT_series
DATAFILE= &JT_series DBMS=DLM REPLACE; DELIMITER='09'x; GETNAMES=YES;
DATAROW=2; RUN;

proc datasets library=sas_jolt;
  modify jt_footnote;
    rename      footnote_code=footnote_codes;
  modify jt_dataelement;
    rename      display_level= data_display_level
              selectable= data_selectable
              sort_sequence= data_sort_sequence;
  modify jt_industry;
    rename      display_level= ind_display_level
              selectable= ind_selectable
              sort_sequence= ind_sort_sequence;
  modify jt_ratelevel;
    rename      display_level= rate_display_level
              selectable= rate_selectable
              sort_sequence= rate_sort_sequence;
  modify jt_region;
    rename      display_level= regn_display_level
              selectable= regn_selectable
              sort_sequence= regn_sort_sequence;

run;
quit;

```

```

proc sort data=sas_jolt.jt_series; by industry_code;run;
proc sort data=sas_jolt.jt_industry; by industry_code;run;

data sas_jolt.jt_series2;
merge sas_jolt.jt_series (in=inseries) sas_jolt.jt_industry;
by industry_code; if inseries;
run;

proc datasets library=sas_jolt; delete jt_series; run; quit;

proc sort data=sas_jolt.jt_series2; by region_code;run;
proc sort data=sas_jolt.jt_region; by region_code;run;

data sas_jolt.jt_series3;
merge sas_jolt.jt_series2 (in=inseries) sas_jolt.jt_region;
by region_code; if inseries;
run;

proc datasets library=sas_jolt; delete jt_series2; run; quit;

proc sort data=sas_jolt.jt_series3; by dataelement_code;run;
proc sort data=sas_jolt.jt_dataelement; by dataelement_code;run;

data sas_jolt.jt_series4;
merge sas_jolt.jt_series3 (in=inseries) sas_jolt.jt_dataelement;
by dataelement_code; if inseries;
run;

proc datasets library=sas_jolt; delete jt_series3; run; quit;

proc sort data=sas_jolt.jt_series4; by ratelevel_code;run;
proc sort data=sas_jolt.jt_ratelevel; by ratelevel_code;run;

data sas_jolt.jt_series5;
merge sas_jolt.jt_series4 (in=inseries) sas_jolt.jt_ratelevel;
by ratelevel_code; if inseries;
run;

proc datasets library=sas_jolt; delete jt_series4; run; quit;

proc sort data=sas_jolt.jt_series5; by footnote_codes;run;
proc sort data=sas_jolt.jt_footnote; by footnote_codes;run;

data sas_jolt.jt_series_all;
merge sas_jolt.jt_series5 (in=inseries) sas_jolt.jt_footnote;
by footnote_codes;
if inseries;
rename footnote_text = series_footnote_text ;
rename footnote_codes = series_footnote_code;
run;

proc datasets library=sas_jolt; delete jt_series5; run; quit;

proc sort data=sas_jolt.jt_all; by footnote_codes;run;
proc sort data=sas_jolt.jt_footnote; by footnote_codes; run;

data sas_jolt.jt_all1;

```

```

merge sas_jolt.jt_all (in=inseries) sas_jolt.jt_footnote;
by footnote_codes;
if inseries;
rename footnote_text = all_footnote_text;
rename footnote_codes = all_footnote_code;
run;

proc sort data=sas_jolt.jt_all1; by series_id year period;run;
proc sort data=sas_jolt.jt_series_all; by series_id; run;

data sas_jolt.jt_all_x;
merge sas_jolt.jt_all1 (in=inall) sas_jolt.jt_series_all;
by series_id;
if inall;
retain series_seq;
if first.series_id then series_seq=1; else series_seq=series_seq+1;
run;

proc datasets library=sas_jolt; delete jt_all1; run; quit;

data work.jt_hire_level      (rename=(value=hire_level))
      work.jt_hire_rate      (rename=(value=hire_rate))
      work.jt_totsep_level  (rename=(value=totsep_level))
      work.jt_totsep_rate   (rename=(value=totsep_rate))
      work.jt_jobop_level   (rename=(value=jobop_level))
      work.jt_jobop_rate    (rename=(value=jobop_rate));
set sas_jolt.jt_all_x;
keep industry_code industry_text month_id value;
period_id= substr(period,2,2)*1;
dayof=1;
if period_id>12 then delete;
Month_id = mdy(period_id,dayof,year);
drop period_id dayof;

if seasonal eq "U";
if industry_code in (100000,110099,230000,300000,320000,340000,
                    400000,420000,440000,480099,510000,510099,520000,530000,540099,
                    600000,610000,620000,700000,710000,720000,810000,900000,910000,920000);
if dataelement_code in ("HI","TS","JO");

if dataelement_code eq "HI" then
  if ratelevel_code eq "L" then output work.jt_hire_level;
  else output work.jt_hire_rate;
  ELSE
if dataelement_code eq "TS" then
  if ratelevel_code eq "L" then output work.jt_totsep_level;
  else output work.jt_totsep_rate;
  ELSE
if dataelement_code eq "JO" then
  if ratelevel_code eq "L" then output work.jt_JOBOP_level;
  else output work.jt_JOBOP_rate;
  ELSE DELETE;
RUN;

```

DIFFUSION INDEX DATA LOADING

Loading the BLS Diffusion Index data series is a little trickier. Using the data provided through BLS's data extraction process an MS Excel® spreadsheet of history is maintained and then saved to a comma separated file

for easy reading into SAS. Occasionally the BLS will update the methodology used to create the series and they will 'recast' or recreate the history. The data will be resaved as needed and MS Excel® provides a simple interface for maintaining the database of the BLS Diffusion Index.

```
PROC IMPORT OUT= WORK.JT_diff
  DATAFILE= "S:\stratall\Analytics Research Projects\Bureau of Labor Statistics
  BLS\DiffusionINDEXIN.csv" DBMS=CSV REPLACE; GETNAMES=YES; DATAROW=2; RUN;
```

```
data work.JT_diff;
  SET jt_diff;
  length industry_code 8.;
  length industry_text $51.;
  industry_code = 100000;
  industry_text = "Total Private";
  month_id = mdy(monthnum,1,yearnum);
  drop monthnum period yearnum series_id;
run;
```

```
proc sort data=work.jt_hire_level; by industry_code month_id; run;
proc sort data=work.jt_hire_rate; by industry_code month_id; run;
proc sort data=work.jt_totsep_level; by industry_code month_id; run;
proc sort data=work.jt_totsep_rate; by industry_code month_id; run;
proc sort data=work.jt_jobop_level; by industry_code month_id; run;
proc sort data=work.jt_jobop_rate; by industry_code month_id; run;
proc sort data=work.jt_diff; by industry_code month_id; run;
```

```
data sas_jolt.jt_all2 ;
merge work.jt_hire_level      work.jt_hire_rate
       work.jt_totsep_level   work.jt_totsep_rate
       work.jt_jobop_level    work.jt_jobop_rate work.jt_diff;
by industry_code month_id;
label hire_rate="Hire Rate";
label totsep_rate="Separation Rate";
label jobop_rate="Job Opening Rate";
label hire_level="Hire Level";
label totsep_level="Separation Level";
label jobop_level="Job Opening Level";
label diff_12mth="12 Month Diffusion";
label industry_text="Industry";
hire_rate_lag1 = lag(hire_rate);
hire_level_lag1 = lag(hire_level);
run;
```

SAS® CODE FOR SAS PROC STATESPACE® AND BLS DATA

Once the data is squished together into one data set we can begin the use of SAS PROC STATESPACE®. The SAS® code uses the steps below uses the following logic:

- 1) Using macro variables set the minimum and maximum dates for plotting (yes, we use SAS PROC GPLOT®). These have to be changed relative to each month the process is run and the BLS data has been updated.
- 2) Create a dataset with BLS Total Private and Retail Industry data only.
- 3) Using SAS ODS ® open two files, one that's an rich text (RTF) and one that a PDF
 - a) In RTF's the SAS ODS ® output can be easily copied/pasted

- b) We find PDFs handle SAS ODS® graphs better than RTFs
- 4) Execute SAS PROC STATESPACE® on JOLT Levels (number of...) data
 - 5) Plot JOLT history and forecast from SAS PROC STATESPACE®
 - 6) Execute SAS PROC STATESPACE® on JOLT Rates (relative number of...) data
 - 7) Plot JOLT history and forecast from SAS PROC STATESPACE®
 - 8) Execute SAS PROC STATESPACE® on JOLT Rates and 12 Month Diffusion Index data
 - 9) Plot 12 Months Diffusion Index history and forecast from SAS PROC STATESPACE®
 - 10) At the end make sure to close the rtf and pdf files while re-opening the listing output.

```

data _null_;
  call symput('keydate', '01Jun2009'd);
  call symput('mindate', '01Jun2004'd);
  call symput('minDIFdate', '01Jun2001'd);
  call symput('maxdate', '01Jun2009'd);
run;

proc sort data=sas_jolt.jt_all2;  by industry_text month_id; run;
data work.subset_jolt_x;
  set sas_jolt.jt_all2;
  where industry_code in (100000, 440000);
run;

ods listing close;
ods rtf file='\\file1\mjetton$\My SAS Files\9.1\BLS_statespace1.rtf';
ods pdf file='\\file1\mjetton$\My SAS Files\9.1\BLS_Graphs.pdf';

title 'Forecast of BLS Stats' height=1;

proc statespace data=work.subset_jolt_x
  out=work.pred lead=12
  interval=month
  LAGMAX=12
  ARMAX=12
  NOCENTER
  DIMMAX=12
  cancorr;
  by industry_text;
  label hire_level="Hire Level"
        totsep_level="Separation Level"
        jobop_level="Job Open Level";
  var hire_level(1,12) totsep_level(1,12) jobop_level(1,12);
  id month_id;
run;

symbol1 i=needle;
symbol2 i=needle;
symbol3 i=needle;
axis1 label=(angle=0 h=1 color=black 'Month') minor=NONE;
axis2 label=(angle=90 h=1 color=black 'Level (Thousands)');

data work.pred_scrubbed;
  set work.pred;
  if month_id lt &keydate then

```

```

do; for1=.;for2=.;for3=.; end;
label for1="Forecast of Hire Level";
label for2="Forecast of Separation Level";
label for3="Forecast of Job Opening Level";
run;

proc gplot data=work.pred_scrubbed;
title2 'Forecast of Next 12 Months' height=.1;
title3 'LEVELS' height=.1;
by industry_text;
where month_id > &mindate;
format month_id MONYY5.;
format hire_level comma6.0;
format totsep_level comma6.0;
format jobop_level comma6.0;
symbol1 color=green interpol=spline
        width=0.5 value=triangle
        height=0.5;
symbol2 color=purple interpol=spline line=2
        width=3 value=circle
        height=0.5;
symbol3 color=red interpol=spline
        width=0.5 value=square
        height=0.5;
symbol4 color=magenta interpol=spline line=2
        width=3 value=square
        height=0.5;
symbol5 color=black interpol=spline
        width=0.5 value=square
        height=0.5;
symbol6 color=yellow interpol=spline line=2
        width=3 value=square
        height=0.5;
legend1 label=(position=bottom justify=center);
plot hire_level * month_id
      for1 * month_id
      totsep_level * month_id
      for2 * month_id
      jobop_level * month_id
      for3 * month_id
      /grid overlay legend=legend1 haxis=axis1 vaxis=axis2;

run;
quit;

title 'Forecast of BLS Statistics';

proc statespace data=work.subset_jolt_x
out=work.pred_rates
lead=12
interval=month
LAGMAX=12
ARMAX=12
NOCENTER
DIMMAX=12
cancorr;
by industry_text;

```

```

label hire_rate="Hire Rate" totsep_rate="Separation Rate" jobop_rate="Job Open
Rate";
var hire_rate(1,12) totsep_rate(1,12) jobop_rate(1,12);
id month_id;
run;

axis2 label=(angle=90 h=1 color=black 'Rate');

data work.pred_scrubbed_rates;
set work.pred_rates;
if month_id lt &keydate then
  do; for1=.;for2=.;for3=.; end;
label for1="Forecast of Hire Rate";
label for2="Forecast of Separation Rate";
label for3="Forecast of Job Opening Rate";
run;

proc gplot data=work.pred_rates;
title2 'Forecast 12 Months' height=.1;
title3 'RATES' height=.1;
  by industry_text;
where month_id > &mindate;
format month_id monyy5.;
format hire_rate comma3.1;
format totsep_rate comma3.1;
format jobop_rate comma3.1;
label for1="Forecast of Hire Rate";
label for2="Forecast of Separation Rate";
label for3="Forecast of Job Opening Rate";
symbol1 color=green interpol=spline
  width=0.5 value=triangle
  height=0.5;
symbol2 color=green interpol=spline line=2
  width=1 value=circle
  height=0.5;
symbol3 color=red interpol=spline
  width=0.5 value=square
  height=0.5;
symbol4 color=red interpol=spline line=2
  width=1 value=square
  height=0.5;
symbol5 color=black interpol=spline
  width=0.5 value=square
  height=0.5;
symbol6 color=black interpol=spline line=2
  width=1 value=square
  height=0.5;
legend1 label=(position=bottom justify=center);
plot hire_rate * month_id
  for1 * month_id
  totsep_rate * month_id
  for2 * month_id
  jobop_rate * month_id
  for3 * month_id
  /grid overlay legend=legend1 haxis=axis1 vaxis=axis2;
run;
quit;

```

```

data work.subset_jolt_xx;
  set sas_jolt.jt_all2;
  where industry_code = 100000;
run;

proc statespace data=work.subset_jolt_xx
  out=work.pred_diff
  lead=12
  interval=month
  LAGMAX=12
  ARMAX=6
  NOCENTER
  DIMMAX=12
  pastmin=6
  cancorr;
by industry_text;
label hire_rate="Hire Rate"
  totsep_rate="Separation Rate"
  jobop_rate="Job Open Rate"
  diff_12mth="Diffusion 12 Mth";
var hire_rate(1,12) totsep_rate(1,12) jobop_rate(1,12) diff_12mth(1,12) ;
  id month_id;
run;

axis1 label=(angle=0 h=1 color=black 'Month') minor=NONE ;
axis2 order=(0 to 100 by 10) label=(angle=90 h=1 color=black 'Diffusion');

data work.pred_scrubbed_diff;
set work.pred_diff;
if month_id lt &keydate then
  do; for1=.;for2=.;for3=.;for4=.; end;
  upp_for4 = for4+2*std4;
  lwr_for4 = for4-2*std4;
  label for4="Forecast of 12 Mth Diffusion";
  label upp_for4="+2 STD of Forecast";
  label lwr_for4="-2 STD of Forecast";
run;

proc gplot data=work.pred_scrubbed_diff;
title2 'Forecast 12 Months' height=.1;
title3 'DIFFUSION' height=.1;
  by industry_text;
where month_id > &mindifdate;
format month_id monyy5.;
symbol1 color=green interpol=spline
  width=1 value=triangle
  height=0.5;
symbol2 color=purple interpol=spline line=2
  width=1 value=circle
  height=0.5;
legend1 label=(position=bottom justify=center);
plot diff_12mth * month_id
  for4 * month_id
  /grid overlay legend=legend1 haxis=axis1 vaxis=axis2;
run;
quit;

```

```
ods rtf close;  
ods pdf close;  
ods listing;
```

CONCLUSIONS

The Bureau of Labor Statistics time series data with the seasonality and trending are a natural pairing for playing with SAS PROC STATESPACE® for the interpretation of the retail job and total job market. The easy access provided by the BLS to a wealth of data and the SAS® tool set provide a great learning environment for practitioners and educators.

BLS Retail Industry Hiring and Separation Rates and Levels forecasting depends only upon prior period value after being de-trended for a 1 month and 12 month lags. Retail Job Opening Rate and Level models depend upon prior period value and the error in the prediction of prior period Job Openings.

BLS Total Private Industry Hiring, Separation and Job Opening Rates and Levels forecasting depend upon prior period value after being de-trended for a 1 month and 12 month lags. Job Openings are an indicator of Hiring Rates and Levels in the state space models.

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<http://www.bls.gov/jlt/home.htm>

<ftp://ftp.bls.gov/pub/time.series/jt/>

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