VECM

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In [1]:
```
#==================================libraries================================#

import numpy as np
import pandas as pd
import statsmodels.api as sm
import matplotlib.pyplot as plt
```

In [2]:
```
#========================loading the data from R package====================#

mydata = sm.datasets.get_rdataset("economics", "ggplot2").data

#view the names of the variables
print(mydata.columns.values)
```

```
['date' 'pce' 'pop' 'psavert' 'uempmed' 'unemploy']
```

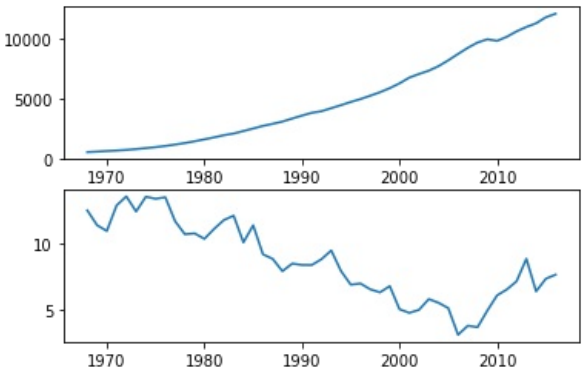
In [3]:
```
#=================Resampling the data to monthly prices====================#

mydata['date'] = pd.to_datetime(mydata['date'])
mydata = mydata.set_index('date')
annualdata = mydata.resample('Y').mean()
print(annualdata)
```

```
                  pce            pop    psavert    uempmed      unemploy
date
1967-12-31    514.466667  199200.333333  12.433333   4.700000   3012.333333
1968-12-31    556.841667  200663.750000  11.333333   4.500000   2797.416667
1969-12-31    603.650000  202648.666667  10.900000   4.441667   2830.166667
1970-12-31    646.725000  204982.333333  12.800000   4.983333   4127.333333
1971-12-31    699.925000  207589.333333  13.475000   6.275000   5021.666667
1972-12-31    768.150000  209837.583333  12.350000   6.108333   4875.833333
1973-12-31    849.583333  211857.166667  13.450000   5.175000   4359.333333
1974-12-31    930.150000  213814.750000  13.300000   5.183333   5173.333333
1975-12-31   1030.558333  215890.666667  13.408333   8.466667   7939.583333
1976-12-31   1147.666667  217999.250000  11.625000   8.141667   7398.166667
1977-12-31   1273.975000  220193.083333  10.658333   7.066667   6966.916667
1978-12-31   1422.250000  222525.416667  10.725000   5.950000   6187.083333
1979-12-31   1585.425000  225002.833333  10.316667   5.583333   6135.333333
1980-12-31   1750.666667  227621.916667  11.058333   6.658333   7670.666667
1981-12-31   1933.941667  229915.666667  11.716667   7.016667   8276.333333
1982-12-31   2071.241667  232127.833333  12.041667   8.750000  10714.916667
1983-12-31   2281.608333  234246.500000  10.050000  10.158333  10693.750000
1984-12-31   2492.333333  236307.250000  11.325000   7.883333   8529.083333
1985-12-31   2712.841667  238415.500000   9.166667   6.933333   8313.416667
1986-12-31   2886.275000  240592.666667   8.825000   6.958333   8245.000000
1987-12-31   3076.275000  242750.750000   7.908333   6.475000   7413.500000
1988-12-31   3330.000000  244967.500000   8.475000   5.950000   6696.583333
1989-12-31   3576.766667  247285.916667   8.375000   5.216667   6523.666667
1990-12-31   3809.000000  250047.416667   8.366667   5.375000   7061.000000
1991-12-31   3943.450000  253391.833333   8.800000   6.866667   8639.833333
1992-12-31   4197.566667  256777.166667   9.450000   8.658333   9611.166667
1993-12-31   4451.983333  260146.416667   7.925000   8.308333   8926.666667
1994-12-31   4720.958333  263324.583333   6.908333   9.125000   7975.500000
1995-12-31   4962.600000  266458.166667   6.991667   8.241667   7406.916667
1996-12-31   5244.600000  269580.666667   6.558333   8.241667   7231.083333
1997-12-31   5536.783333  272822.083333   6.333333   7.933333   6728.666667
1998-12-31   5877.250000  276022.333333   6.800000   6.683333   6203.833333
1999-12-31   6279.083333  279194.916667   5.075000   6.325000   5878.833333
2000-12-31   6762.150000  282295.916667   4.808333   5.933333   5685.083333
2001-12-31   7065.633333  285215.916667   5.033333   6.733333   6829.666667
2002-12-31   7342.683333  288019.000000   5.833333   9.200000   8375.333333
2003-12-31   7723.108333  290733.333333   5.558333  10.175000   8770.333333
2004-12-31   8212.666667  293388.583333   5.158333   9.816667   8139.666667
2005-12-31   8747.133333  296114.916667   3.175000   8.933333   7579.166667
2006-12-31   9260.350000  298929.916667   3.850000   8.225000   6991.250000
2007-12-31   9706.425000  301903.166667   3.741667   8.500000   7073.083333
2008-12-31   9976.333333  304718.000000   4.975000   9.416667   8948.166667
2009-12-31   9842.191667  307373.750000   6.108333  15.675000  14294.500000
2010-12-31  10185.850000  309736.511000   6.550000  21.466667  14807.750000
2011-12-31  10641.125000  311940.749083   7.158333  21.441667  13738.500000
2012-12-31  11006.825000  314163.103750   8.833333  19.166667  12499.166667
2013-12-31  11317.200000  316329.299167   6.408333  16.808333  11457.166667
2014-12-31  11824.025000  318619.452833   7.350000  14.175000   9601.500000
2015-12-31  12120.125000  320159.059500   7.650000  12.400000   8635.750000
```

In [4]:
```
#========================subsetting the data================================#

mydata = annualdata[["pce" , "psavert"]]
```

In [5]:
```
#================================plots=====================================#

plt.figure()

ax = plt.subplot(211)
ax.plot(mydata["pce"])

ax = plt.subplot(212)
ax.plot(mydata["psavert"])
```

Out[5]:
```
[<matplotlib.lines.Line2D at 0x17ec9c6f5e0>]
```



In [6]:
```
#============================lag selection=================================#

from statsmodels.tsa.vector_ar.vecm import select_order

lags = select_order(data = mydata, maxlags = 20, deterministic="ci")
print(lags.summary())
print(lags.aic, lags.bic, lags.fpe, lags.hqic)

# we select 12 lags
```

```
 VECM Order Selection (* highlights the minimums)
=================================================
       AIC         BIC         FPE         HQIC
-------------------------------------------------
0        9.914       10.29   2.030e+04       10.03
1        9.795       10.37   1.820e+04       9.970
2        9.858       10.62   1.975e+04       10.09
3        9.869       10.82   2.065e+04       10.16
4        9.826       10.97   2.083e+04       10.17
5        9.728       11.06   2.045e+04       10.14
6        9.936       11.46   2.826e+04       10.40
7        9.953       11.67   3.398e+04       10.48
8        9.640       11.54   3.178e+04       10.22
9        9.255       11.35   3.135e+04       9.895
10       7.493       9.776       9838.       8.191
11       4.120       6.594       1093.       4.876
12       -inf*       -inf*         inf       -inf*
13      -96.01      -93.16   2.318e-41      -95.14
14      -89.94      -86.89   2.031e-39      -89.01
15      -102.8      -99.53   1.943e-45      -101.8
16      -100.7      -97.25   7.093e-45      -99.63
17      -100.2      -96.62   5.595e-45      -99.13
18      -97.66      -93.85   4.094e-44      -96.50
19      -106.9      -102.9  2.363e-48*      -105.7
20      -104.2      -100.0   2.032e-47      -103.0
-------------------------------------------------
12 12 19 12
```

In [7]:
```
#========================cointegration test=================================#

from statsmodels.tsa.vector_ar.vecm import select_coint_rank

cointest = select_coint_rank(mydata, 0, 12, method="trace", signif= 0.05)
print(cointest.summary())

# we select 1 cointegration relations
```

```
Johansen cointegration test using trace test statistic with 5% significance level
=====================================
r_0 r_1 test statistic critical value
-------------------------------------
  0   2          61.71          15.49
  1   2          1.673          3.841
-------------------------------------
```

In [8]:
```
#================================VECM model=================================#

from statsmodels.tsa.vector_ar.vecm import VECM

vecm_model = VECM(mydata, k_ar_diff = 12, coint_rank = 1, deterministic = 'ci')
```

```
modelfit = vecm_model.fit()
print(modelfit.summary())
```

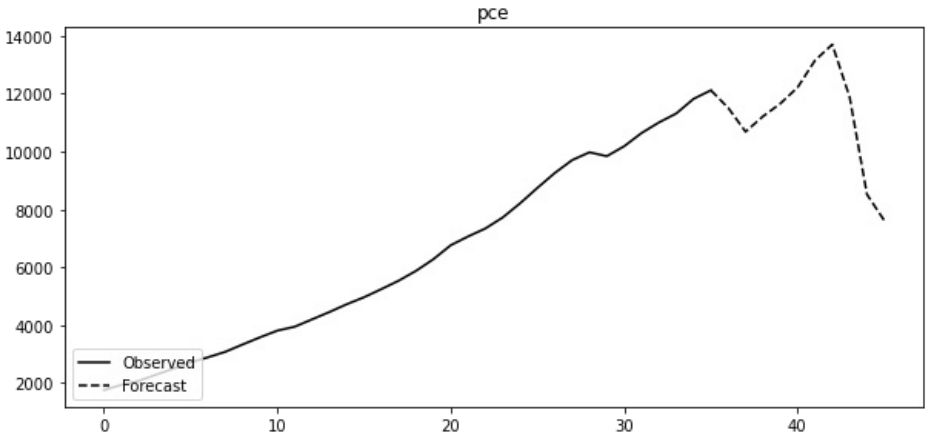
```
Det. terms outside the coint. relation & lagged endog. parameters for equation pce
================================================================================
                   coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
L1.pce          0.1655      0.169      0.978      0.328      -0.166       0.497
L1.psavert     66.9593     24.956      2.683      0.007      18.047     115.872
L2.pce         -0.8143      0.219     -3.723      0.000      -1.243      -0.386
L2.psavert     23.6269     17.984      1.314      0.189     -11.621      58.874
L3.pce         -0.7112      0.221     -3.224      0.001      -1.143      -0.279
L3.psavert     28.0656     14.592      1.923      0.054      -0.534      56.665
L4.pce         -0.4089      0.141     -2.891      0.004      -0.686      -0.132
L4.psavert     19.0218     16.229      1.172      0.241     -12.786      50.830
L5.pce         -0.5055      0.213     -2.368      0.018      -0.924      -0.087
L5.psavert    -32.5523     14.753     -2.206      0.027     -61.468      -3.637
L6.pce         -0.6719      0.188     -3.569      0.000      -1.041      -0.303
L6.psavert    -51.5589     15.639     -3.297      0.001     -82.211     -20.907
L7.pce          0.4663      0.314      1.484      0.138      -0.149       1.082
L7.psavert    -68.6615     16.779     -4.092      0.000    -101.547     -35.776
L8.pce          0.2916      0.287      1.015      0.310      -0.271       0.855
L8.psavert    -12.4937     16.137     -0.774      0.439     -44.121      19.134
L9.pce         -1.4340      0.288     -4.976      0.000      -1.999      -0.869
L9.psavert    -36.5960     14.600     -2.507      0.012     -65.212      -7.980
L10.pce         1.0142      0.303      3.344      0.001       0.420       1.609
L10.psavert   -33.0850     16.398     -2.018      0.044     -65.224      -0.946
L11.pce        -1.0510      0.471     -2.230      0.026      -1.975      -0.127
L11.psavert   -58.8692     13.579     -4.335      0.000     -85.483     -32.255
L12.pce        -1.9491      0.457     -4.261      0.000      -2.846      -1.053
L12.psavert   -29.8472     21.687     -1.376      0.169     -72.352      12.658
Det. terms outside the coint. relation & lagged endog. parameters for equation psavert
================================================================================
                   coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
L1.pce         -0.0076      0.001     -5.243      0.000      -0.011      -0.005
L1.psavert     -0.5534      0.215     -2.574      0.010      -0.975      -0.132
L2.pce          0.0015      0.002      0.816      0.415      -0.002       0.005
L2.psavert     -0.2576      0.155     -1.662      0.096      -0.561       0.046
L3.pce         -0.0047      0.002     -2.450      0.014      -0.008      -0.001
L3.psavert     -0.1465      0.126     -1.165      0.244      -0.393       0.100
L4.pce          0.0071      0.001      5.851      0.000       0.005       0.010
L4.psavert      0.3019      0.140      2.159      0.031       0.028       0.576
L5.pce         -0.0002      0.002     -0.130      0.897      -0.004       0.003
L5.psavert      0.1076      0.127      0.846      0.397      -0.142       0.357
L6.pce          0.0024      0.002      1.460      0.144      -0.001       0.006
L6.psavert      0.4373      0.135      3.245      0.001       0.173       0.701
L7.pce         -0.0059      0.003     -2.168      0.030      -0.011      -0.001
L7.psavert      0.3583      0.145      2.479      0.013       0.075       0.642
L8.pce          0.0094      0.002      3.817      0.000       0.005       0.014
L8.psavert      0.2546      0.139      1.831      0.067      -0.018       0.527
L9.pce          0.0023      0.002      0.941      0.347      -0.003       0.007
L9.psavert      0.7439      0.126      5.913      0.000       0.497       0.990
L10.pce        -0.0100      0.003     -3.810      0.000      -0.015      -0.005
L10.psavert     0.4386      0.141      3.104      0.002       0.162       0.716
L11.pce         0.0059      0.004      1.459      0.144      -0.002       0.014
L11.psavert     1.0276      0.117      8.783      0.000       0.798       1.257
L12.pce        -0.0052      0.004     -1.327      0.185      -0.013       0.002
L12.psavert     0.1464      0.187      0.784      0.433      -0.220       0.513
                Loading coefficients (alpha) for equation pce
================================================================================
                   coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
ec1             0.1137      0.018      6.434      0.000       0.079       0.148
              Loading coefficients (alpha) for equation psavert
================================================================================
                   coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
ec1             0.0001      0.000      0.905      0.365      -0.000       0.000
           Cointegration relations for loading-coefficients-column 1
================================================================================
                   coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
beta.1         1.0000          0          0      0.000       1.000       1.000
beta.2      -939.5824    128.460     -7.314      0.000   -1191.360    -687.805
const       1.463e+04   1893.644      7.725      0.000    1.09e+04    1.83e+04
================================================================================
```

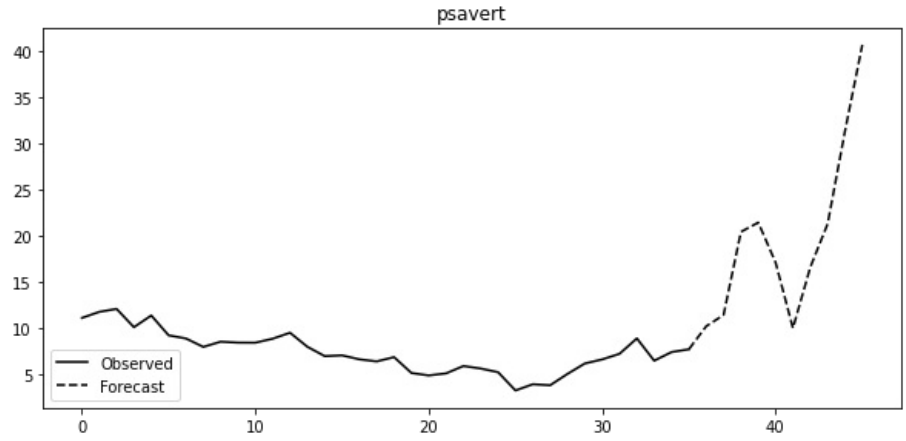
In [9]:

```
#============================forecasting=====================================#

print(modelfit.predict(steps=10))
```

```
[[1.15118139e+04 1.01575219e+01]
 [1.06878488e+04 1.13787053e+01]
 [1.12159436e+04 2.04128371e+01]
 [1.16591077e+04 2.14294977e+01]
 [1.22190876e+04 1.70809221e+01]
 [1.31504450e+04 9.94287748e+00]
 [1.37058097e+04 1.65653263e+01]
 [1.18861348e+04 2.12821936e+01]
 [8.51848150e+03 3.13500634e+01]
 [7.61383834e+03 4.07475730e+01]]
```

In [10]:
```
#==============================forecasted plots==============================#

modelfit.plot_forecast(steps=10, plot_conf_int=False)

#================================END=========================================#
```





In [ ]: