In [ ]:

Introduction to Statsmodels

Statsmodels is a Python module that provides classes and functions for the estimation of many different statistical models, as well as for conducting statistical tests, and statistical data exploration. An extensive list of result statistics are available for each estimator. The results are tested against existing statistical packages to ensure that they are correct. The package is released under the open source Modified BSD (3-clause) license. The online documentation is hosted at statsmodels.org.

The reason we will cover it for use in this course, is that you may find it very useful later on when discussing time series data (typical of quantitative financial analysis).

Let's walk through a very simple example of using statsmodels!

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:
```
# You can safely ignore the warning:
#  Please use the pandas.tseries module instead. from pandas.core import datetools
import statsmodels.api as sm
```

In [3]:
```
df = sm.datasets.macrodata.load_pandas().data
```

In [4]:
```
print(sm.datasets.macrodata.NOTE)
```

```
::
    Number of Observations - 203

    Number of Variables - 14

    Variable name definitions::

        year      - 1959q1 - 2009q3
        quarter   - 1-4
        realgdp   - Real gross domestic product (Bil. of chained 2005 US$,
                    seasonally adjusted annual rate)
        realcons  - Real personal consumption expenditures (Bil. of chained
                    2005 US$, seasonally adjusted annual rate)
        realinv   - Real gross private domestic investment (Bil. of chained
                    2005 US$, seasonally adjusted annual rate)
        realgovt  - Real federal consumption expenditures & gross investment
                    (Bil. of chained 2005 US$, seasonally adjusted annual rate)
        realdpi   - Real private disposable income (Bil. of chained 2005
                    US$, seasonally adjusted annual rate)
        cpi       - End of the quarter consumer price index for all urban
                    consumers: all items (1982-84 = 100, seasonally adjusted).
        m1        - End of the quarter M1 nominal money stock (Seasonally
                    adjusted)
        tbilrate  - Quarterly monthly average of the monthly 3-month
                    treasury bill: secondary market rate
        unemp     - Seasonally adjusted unemployment rate (%)
        pop       - End of the quarter total population: all ages incl. armed
                    forces over seas
        infl      - Inflation rate (ln(cpi_{t}/cpi_{t-1}) * 400)
        realint   - Real interest rate (tbilrate - infl)
```

In [5]:
```
df.head()
```

Out[5]:

	year	quarter	realgdp	realcons	realinv	realgovt	realdpi	cpi	m1	tbilrate	unemp	pop	infl	realint
0	1959.0	1.0	2710.349	1707.4	286.898	470.045	1886.9	28.98	139.7	2.82	5.8	177.146	0.00	0.00
1	1959.0	2.0	2778.801	1733.7	310.859	481.301	1919.7	29.15	141.7	3.08	5.1	177.830	2.34	0.74
2	1959.0	3.0	2775.488	1751.8	289.226	491.260	1916.4	29.35	140.5	3.82	5.3	178.657	2.74	1.09
3	1959.0	4.0	2785.204	1753.7	299.356	484.052	1931.3	29.37	140.0	4.33	5.6	179.386	0.27	4.06
4	1960.0	1.0	2847.699	1770.5	331.722	462.199	1955.5	29.54	139.6	3.50	5.2	180.007	2.31	1.19

In [6]:
```
index = pd.Index(sm.tsa.datetools.dates_from_range('1959Q1', '2009Q3'))
```

In [7]:
```
df.index = index
```

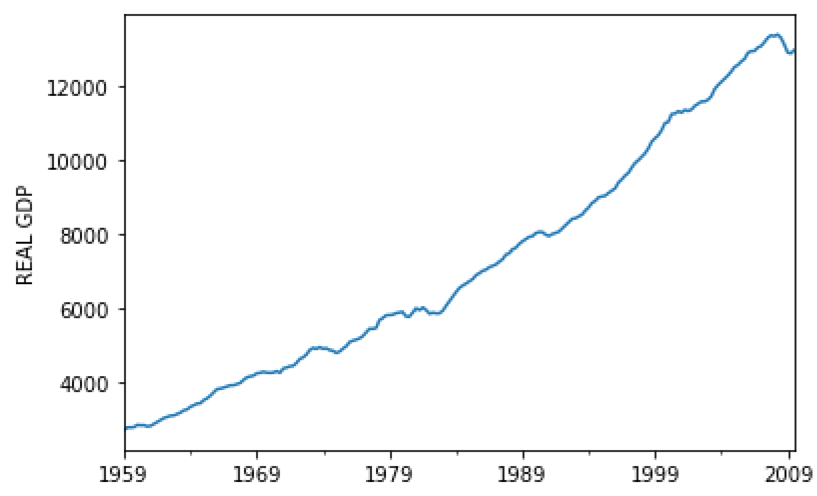
In [8]:
```
df.head()
```

Out[8]:

	year	quarter	realgdp	realcons	realinv	realgovt	realdpi	cpi	m1	tbilrate	unemp	pop	infl	realint
1959-03-31	1959.0	1.0	2710.349	1707.4	286.898	470.045	1886.9	28.98	139.7	2.82	5.8	177.146	0.00	0.00
1959-06-30	1959.0	2.0	2778.801	1733.7	310.859	481.301	1919.7	29.15	141.7	3.08	5.1	177.830	2.34	0.74
1959-09-30	1959.0	3.0	2775.488	1751.8	289.226	491.260	1916.4	29.35	140.5	3.82	5.3	178.657	2.74	1.09
1959-12-31	1959.0	4.0	2785.204	1753.7	299.356	484.052	1931.3	29.37	140.0	4.33	5.6	179.386	0.27	4.06
1960-03-31	1960.0	1.0	2847.699	1770.5	331.722	462.199	1955.5	29.54	139.6	3.50	5.2	180.007	2.31	1.19

In [11]:
```
df['realgdp'].plot()
plt.ylabel("REAL GDP")
```

Out[11]:
```
Text(0, 0.5, 'REAL GDP')
```



Using Statsmodels to get the trend

The Hodrick-Prescott filter separates a time-series y_t into a trend τ_t and a cyclical component ζt

$$y_t = \tau_t + \zeta_t$$

The components are determined by minimizing the following quadratic loss function

$$\min_{\tau} \sum_t^T \zeta_t^2 + \lambda \sum_{t=1}^T \left[(\tau_t - \tau_{t-1}) - (\tau_{t-1} - \tau_{t-2}) \right]^2$$

In [12]:
```
# Tuple unpacking
gdp_cycle, gdp_trend = sm.tsa.filters.hpfilter(df.realgdp)
```

In [13]:
```
gdp_cycle
```

Out[13]:
```
1959-03-31     39.511915
1959-06-30     80.088532
1959-09-30     48.875455
1959-12-31     30.591933
1960-03-31     64.882667
                 ...
2008-09-30    102.018455
2008-12-31   -107.269472
2009-03-31   -349.047706
2009-06-30   -397.557073
2009-09-30   -333.115243
Name: realgdp_cycle, Length: 203, dtype: float64
```

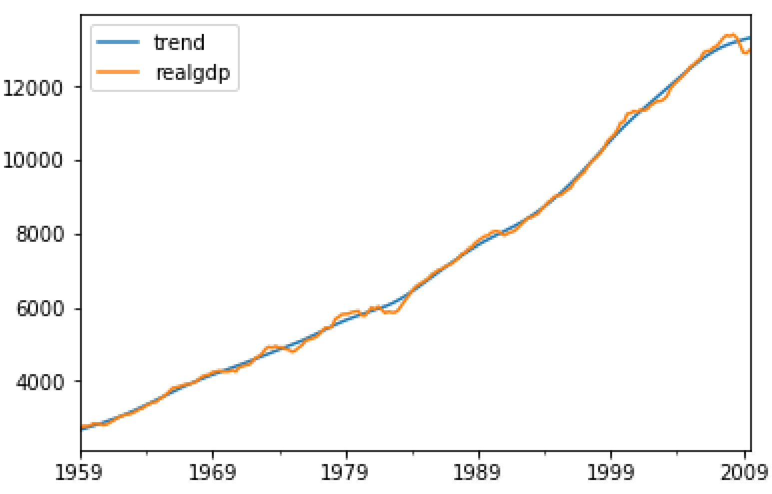
In [29]:
```
type(gdp_cycle)
```

Out[29]:
```
pandas.core.series.Series
```

In [14]:
```
df["trend"] = gdp_trend
```

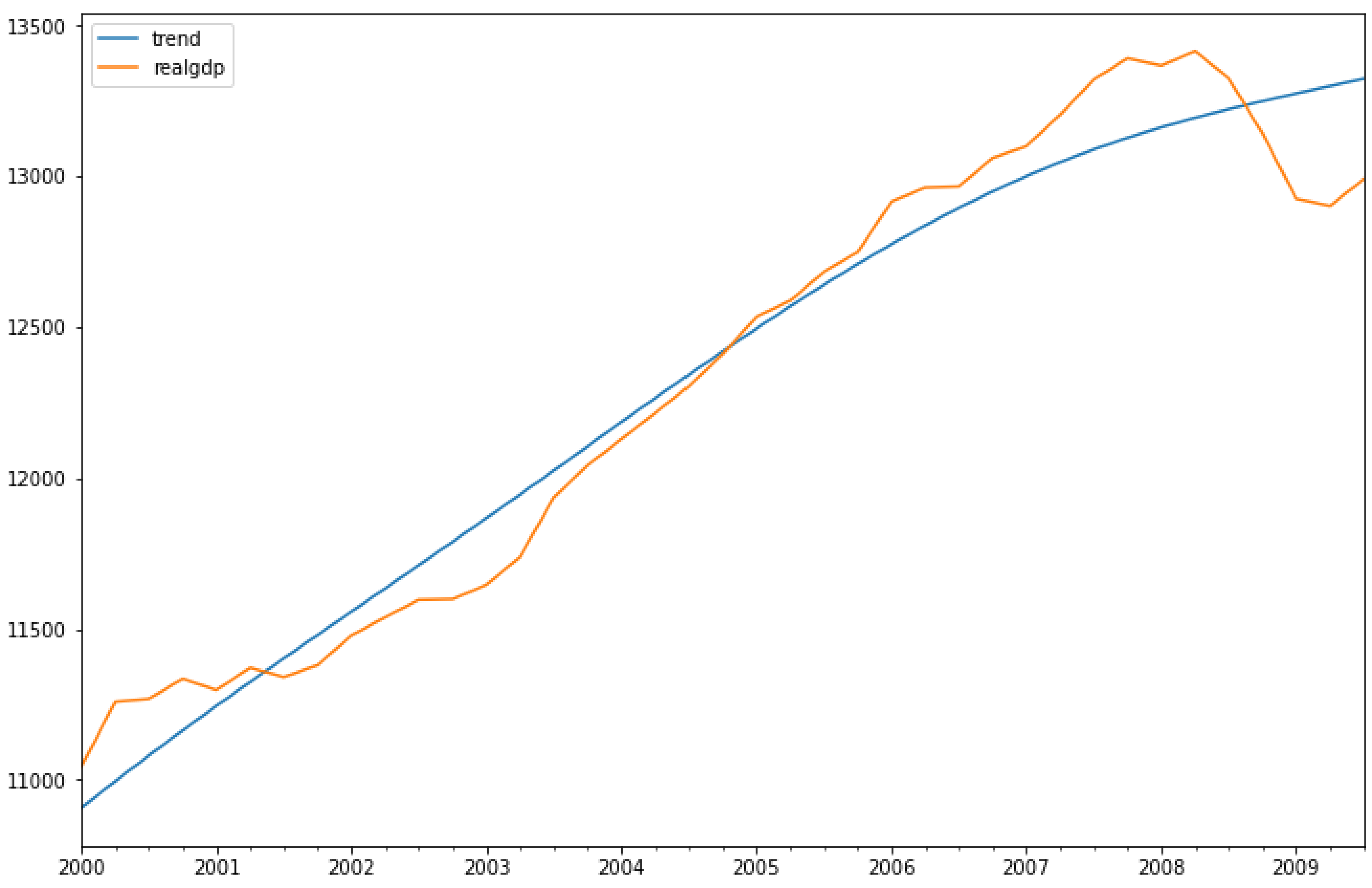
In [37]:
```
df[['trend','realgdp']].plot()
```

Out[37]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x21b98541080>
```



In [15]:
```
df[['trend','realgdp']]["2000-03-31":].plot(figsize=(12,8))
```

Out[15]:
```
<AxesSubplot:>
```



Great job!