CHAPTER-3

A. OBJECTIVE

In this chapter, we will learn the following:

1. We will introduce some new set of macroeconomic definitions which will help us to develop our "macroeconomic language"
2. We will develop some new set of techniques (mainly statistical) to analyze time series behavior (data for a long period of time) of some key macroeconomic variables such as consumption, investment, unemployment.
3. We will decompose the time series behavior of various macroeconomic variables and analyze them separately.
4. We will highlight some of the macroeconomic objectives of our macro model building process and comment on the success and failures of achieving those objectives.
5. Finally, we will try to match the behavior of various macroeconomic variables (Consumption, Investment, unemployment, labor productivity) to aggregate economic activity (GDP).

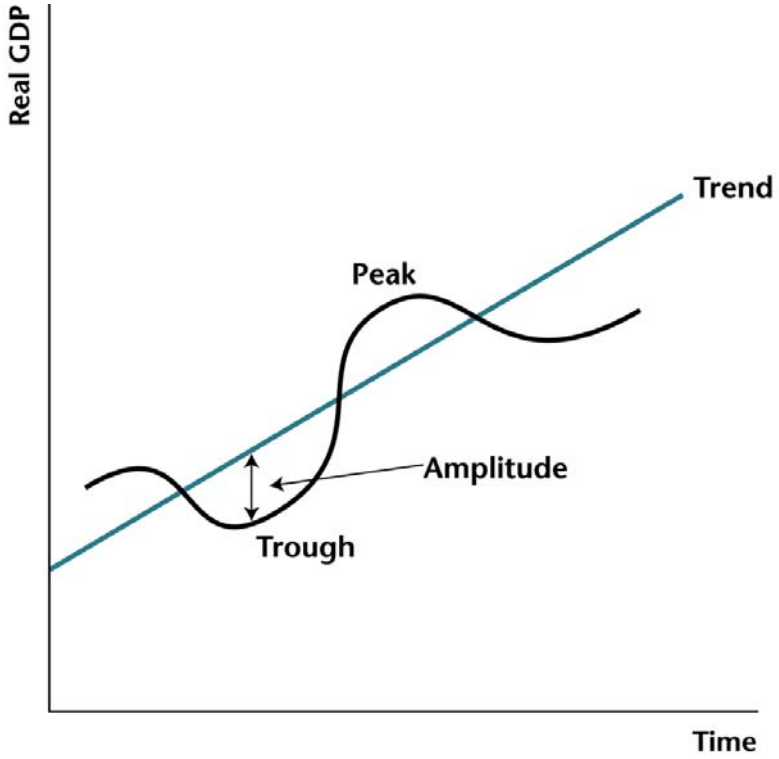
B. GDP: GROWTH VS CYCLES

- GDP is just a measure of aggregate economic activity
- We will decompose the time series behavior of GDP into two components:

1) **Trend**: it is the average growth rate of GDP.
2) **Cycles**: it is the fluctuation or deviation from the trend. A cycle has three interesting properties:
    - **Peaks:** it is the boom part of the cycle.
    - **Troughs:** it is the recession part of the cycle
    - **Amplitude:** it is the maximum deviation from the trend

Muhammad Rahman
Indiana University
Bloomington

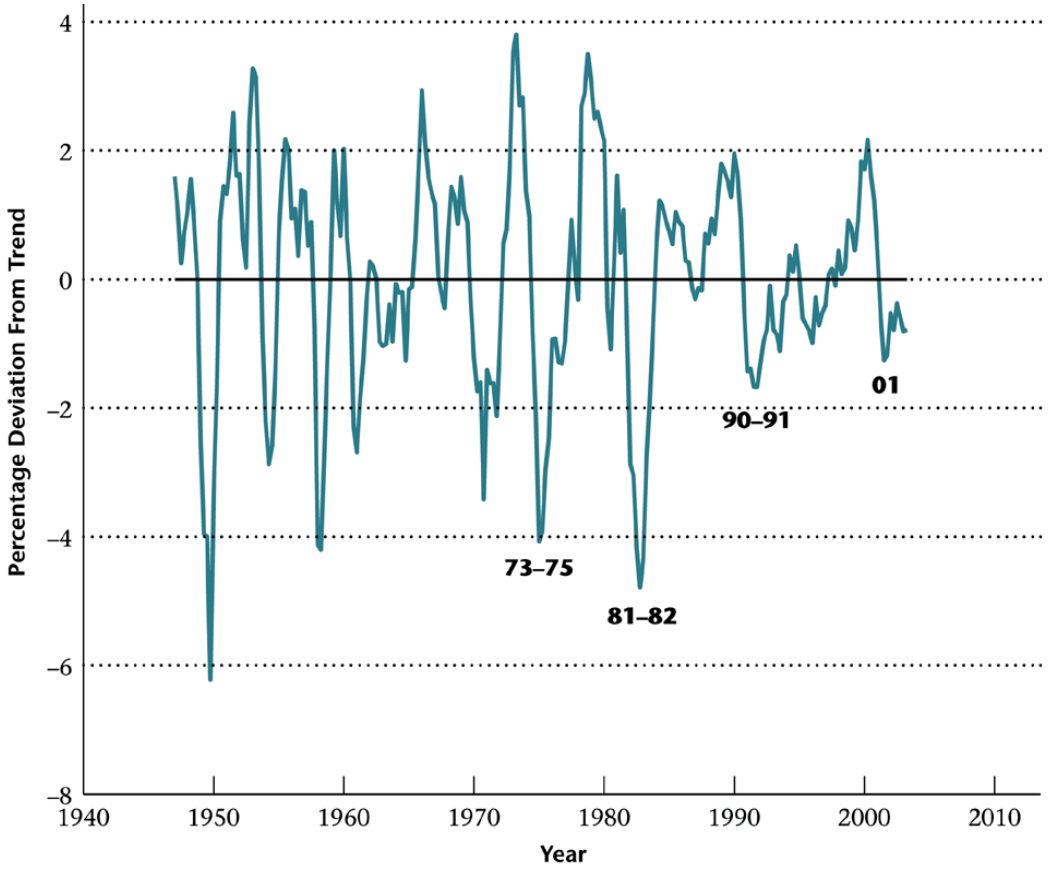
Figure 3.1 Idealized Business Cycles



- The number of peaks that occur in real GDP per year is known as the **frequency** of the business cycle
- Deviation from trend in real GDP is known as **Persistence.**
- Time series behavior of the deviation from the trend in real GDP has the following features:
  1) Deviation is persistent but choppy.
  2) There is no regularity in the amplitude of the fluctuations.
  3) There is no regularity about the frequency of fluctuations or cycles.

Muhammad Rahman
Indiana University
Bloomington

Figure 3.2 Percentage Deviations from Trend in Real GDP from 1947--2003



C. CORRELATION AND COMOVEMENT

- **Variance** is a measure of the volatility/fluctuation of the time series.
- **Covariance** is a measure of the relative volatility of one variable with respect to another.
- Macro variables fluctuate together in strong regular pattern.
- **Correlation** is a measure of this relationship. It is defined as follows:

  Correlation Coefficient = $\rho_{xy} = \frac{Cov(x,y)}{\sqrt{Var(x)*Var(y)}}$

Also it should be noted, $-1 \le \rho_{xy} \le 1$, where,

1) $\rho_{xy} = 1$, perfect positive correlation, **Pro-Cyclical**

2) $\rho_{xy} = -1$, perfect negative correlation, **Countercyclical**

3) $\rho_{xy} = 0$, no correlation /uncorrelated, **Acyclical**

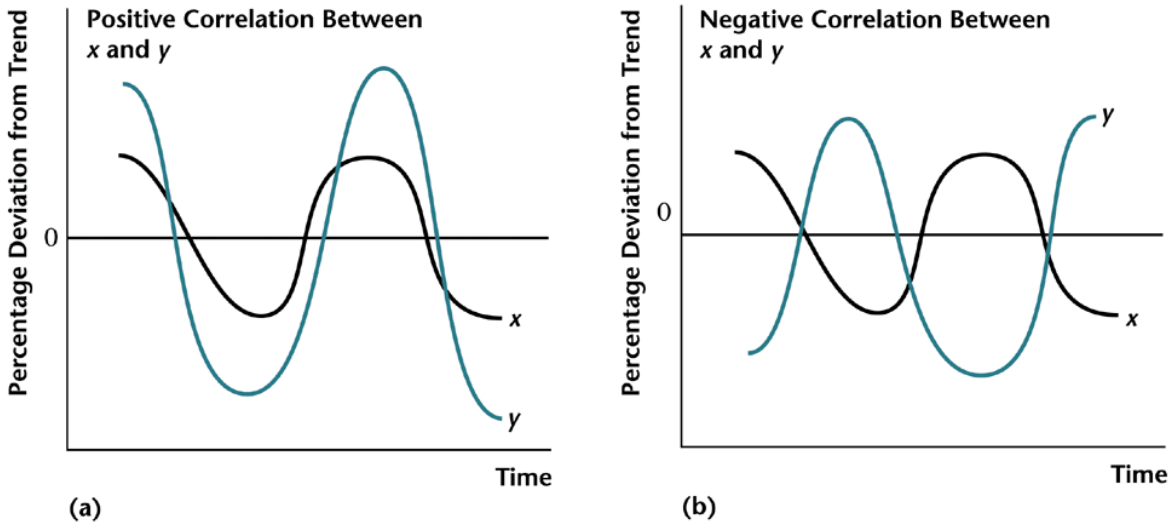
- **Standard Deviation**: It is defined as SD= $\sqrt{VARIANCE}$
  It is the most popular measure of variability (volatility) of macroeconomic variables.

D. GRAPHICAL ANYLYSIS OF MACROECONOMIC VARIABLES

We will use two graphical tools to analyze the long term behavior of variables macroeconomic variables:

1) **Time series Plots:** We will measure time by the horizontal axis and different variables by the vertical axis. This is the most popular graph to analyze co movements among different variables. This is very convenient for analyzing **Trend** in variables.

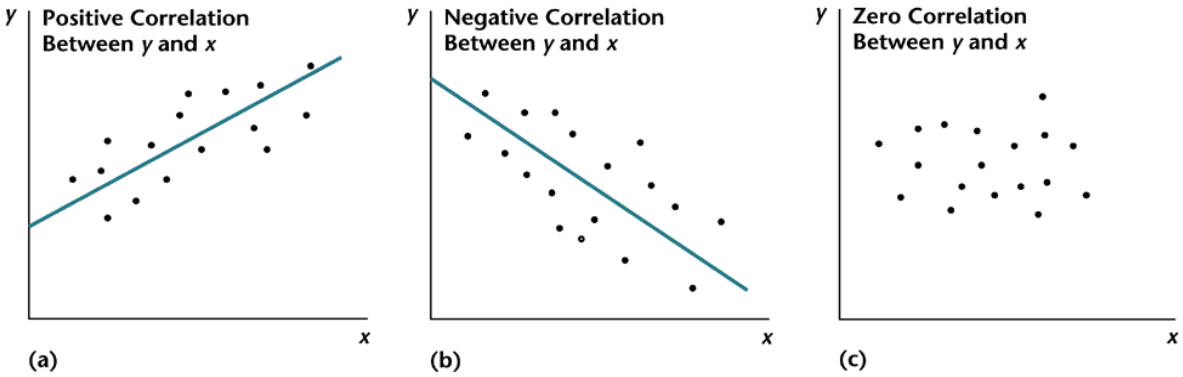
Figure 3.3 Time Series Plots of x and y



Muhammad Rahman
Indiana University
Bloomington

2) **Scatter plots:** We can measure one variable X by the horizontal axis and another variable Y by the vertical axis. Each point in the scatter plot will then be an observation on X and Y for some point of time**. This is not convenient for analyzing Trend**

Figure 3.4 Correlations between Variables y and x



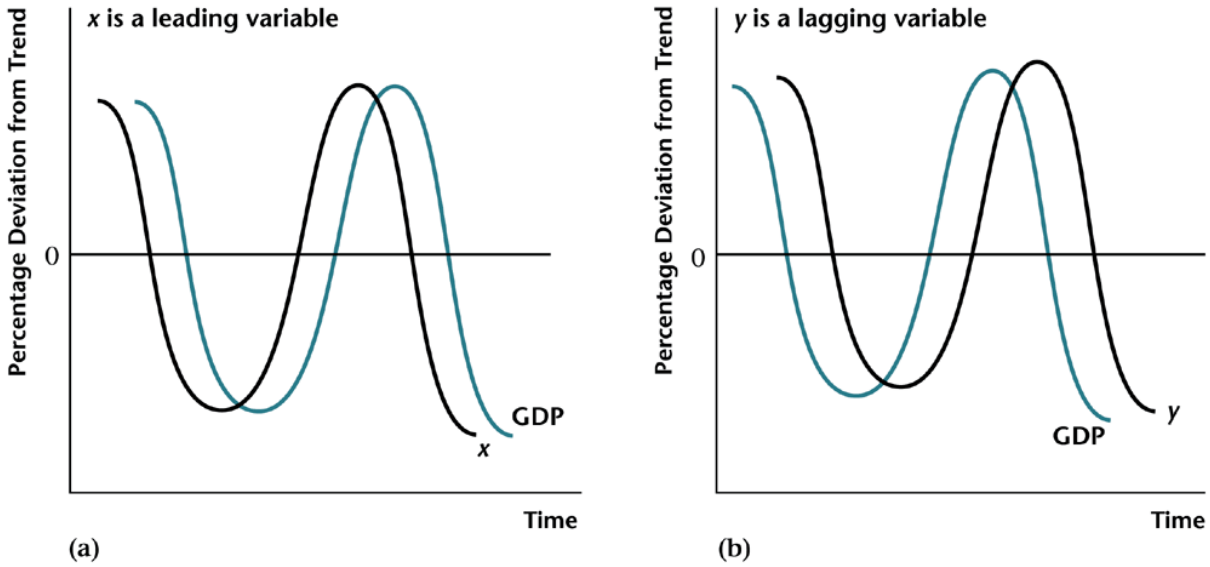
E. DEFINITIONS OF TIME SERIES VARIABLES BASED ON COMOVEMENT

While analyzing time series comovements of macroeconomic variables, it important to identify which variable causes the other variable to change. This gives three types of variables:

1) **Leading variable**: if variable X is useful in predicting the path of GDP, then variable X is called a leading variable.
2) **Lagging variable**: If GDP is useful in predicting the path of a variable X, then X is the lagging variable.
3) **Coincident variable**: A variable that is neither a leading nor a lag variable to real GDP.

Muhammad Rahman
Indiana University
Bloomington

Figure 3.7 Leading and Lagging Variables



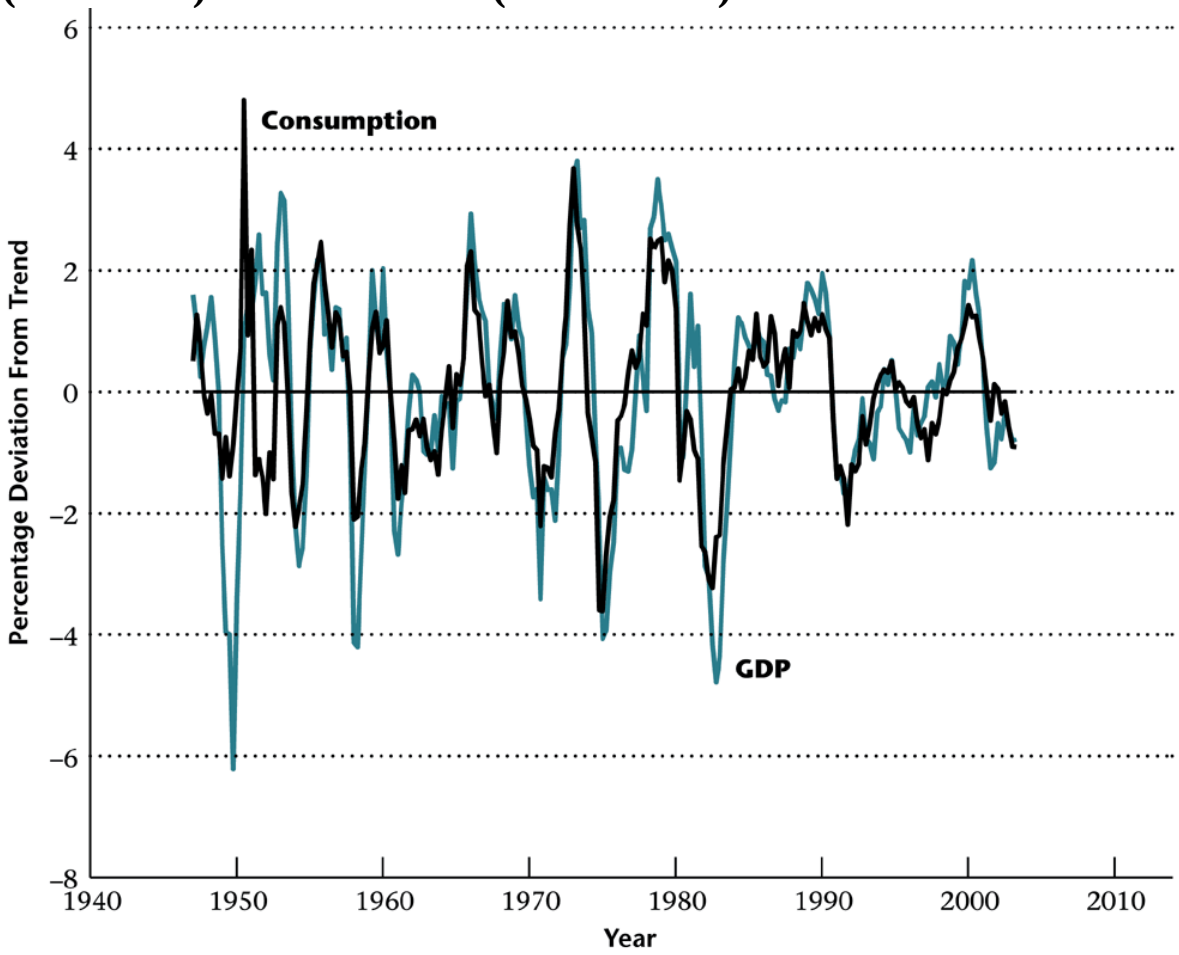
Muhammad Rahman
Indiana University
Bloomington

F. TIMESERIES BEHAVIOR OF VARIOUS COMPONENTS OF GDP

1) Consumption

Real Consumption is procyclical, coincident and less variable than real GDP.

Figure 3.9 Percentage Deviations from Trend in Real Consumption (black line) and Real GDP (colored line)

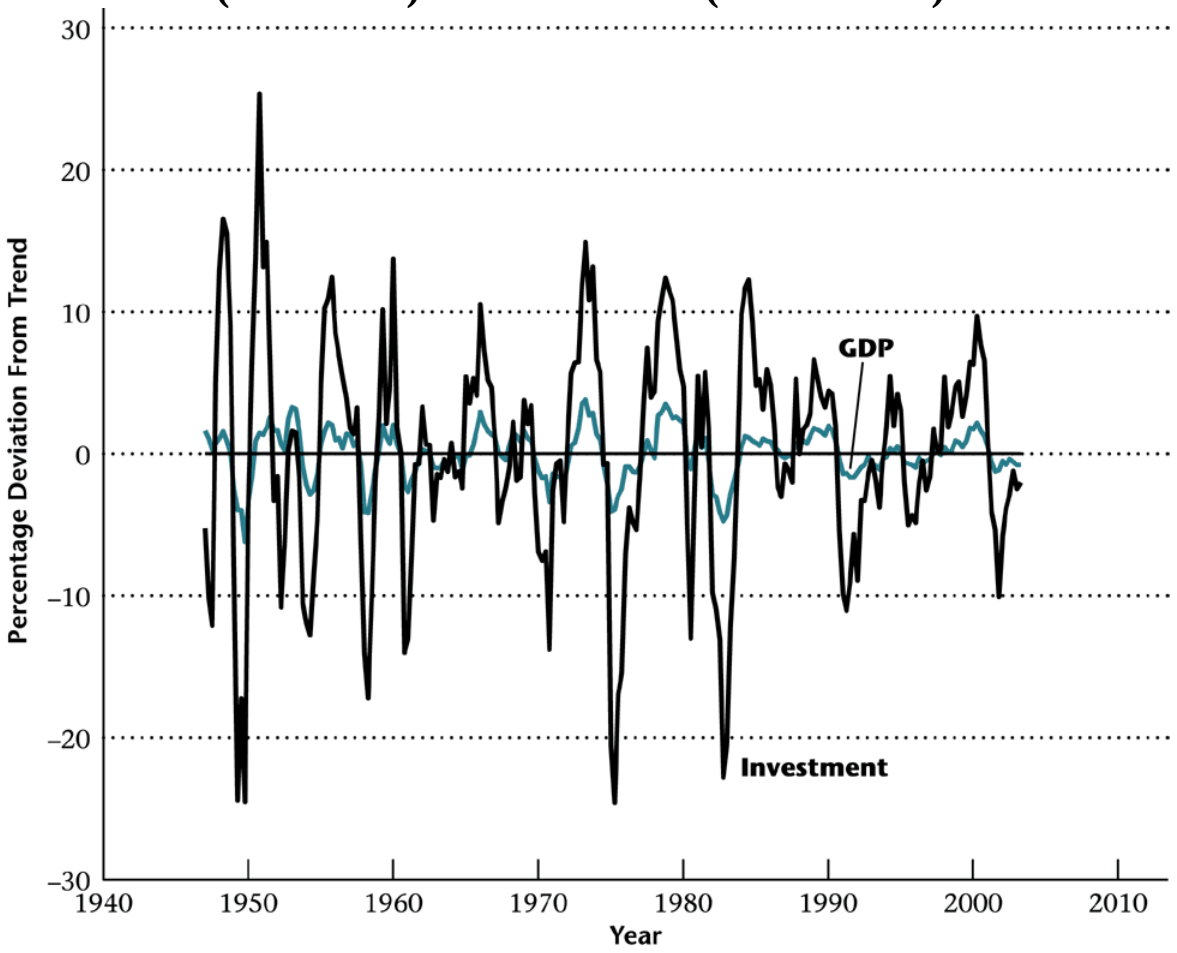


Muhammad Rahman
Indiana University
Bloomington

2) Investment

Real investment is procyclical, coincident and more volatile than GDP.

Figure 3.10 Percentage Deviations from Trend in Real Investment (black line) and Real GDP (colored line)



Muhammad Rahman
Indiana University
Bloomington

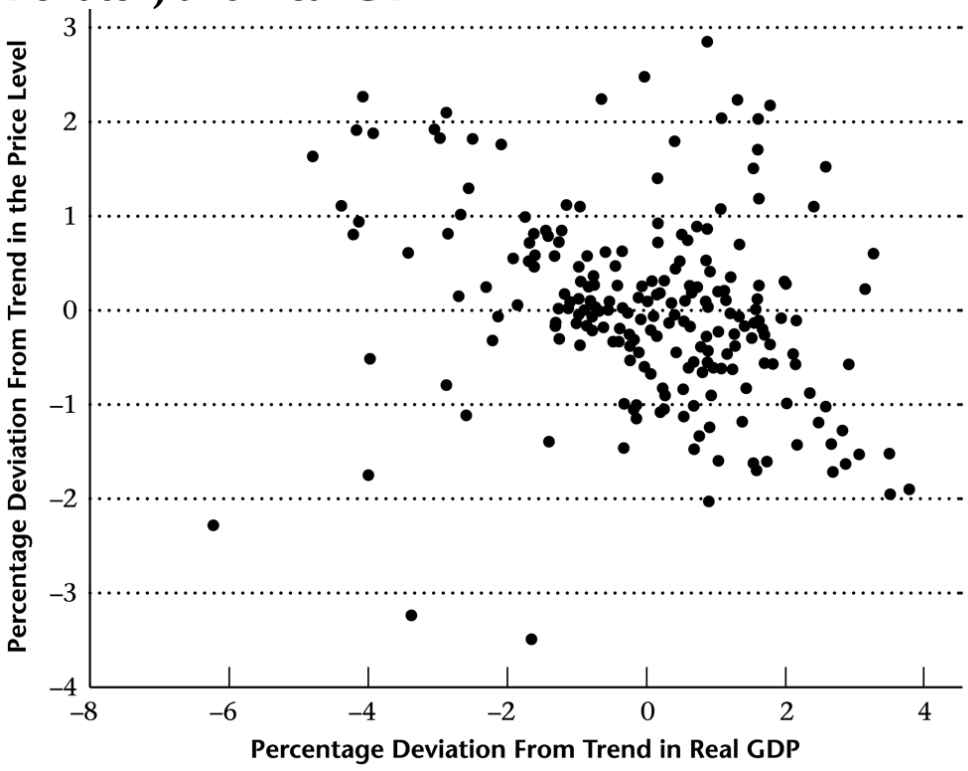
G. TWO VERY SPECIAL TIME SERIES BEHAVIOUR

So far, we have only looked at the time series behavior of real variables. There are two very important time series behaviors among nominal variables. They are as follows:

1) Philips Curve

- A Philips curve shows co movement between **inflation** and **unemployment**.
- **Unemployment** is assumed to be **counter cyclical**(when GDP is high, unemployment is low)
- "Philips" assumed a **negative** relationship between inflation and unemployment.
- Therefore, the "Philips curve" implies a **positive** relationship between **inflation** and **GDP**.
- In real data, we see a "**Reversed Philips curve relation**".

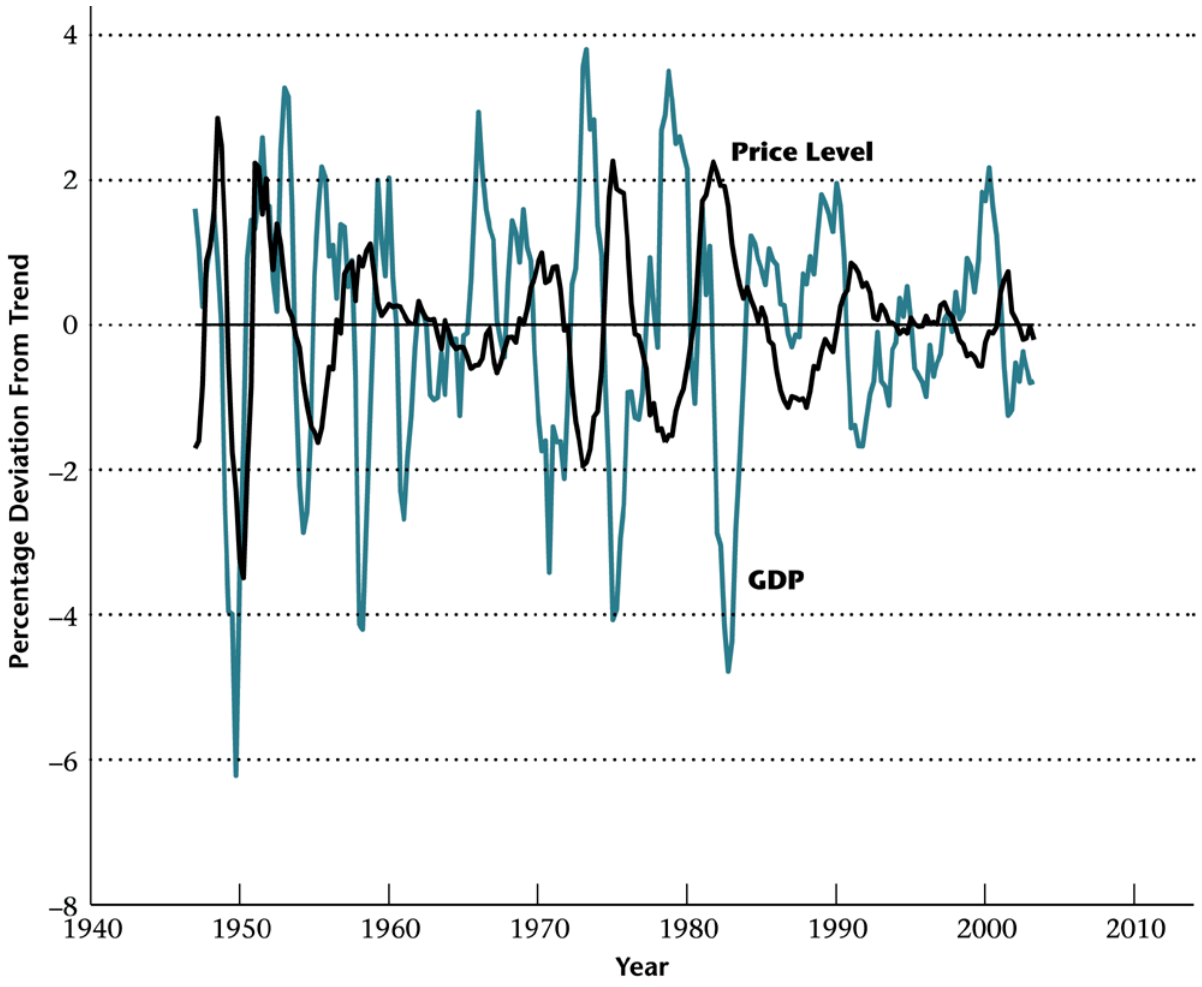
Figure 3.11 Scatter Plot for the Percentage Deviations from Trend in the Price Level (the Implicit GDP Price Deflator) and Real GDP



Muhammad Rahman
Indiana University
Bloomington

- The **Price** level is Countercyclical, coincident and less variable than GDP

Figure 3.12 Price Level and GDP

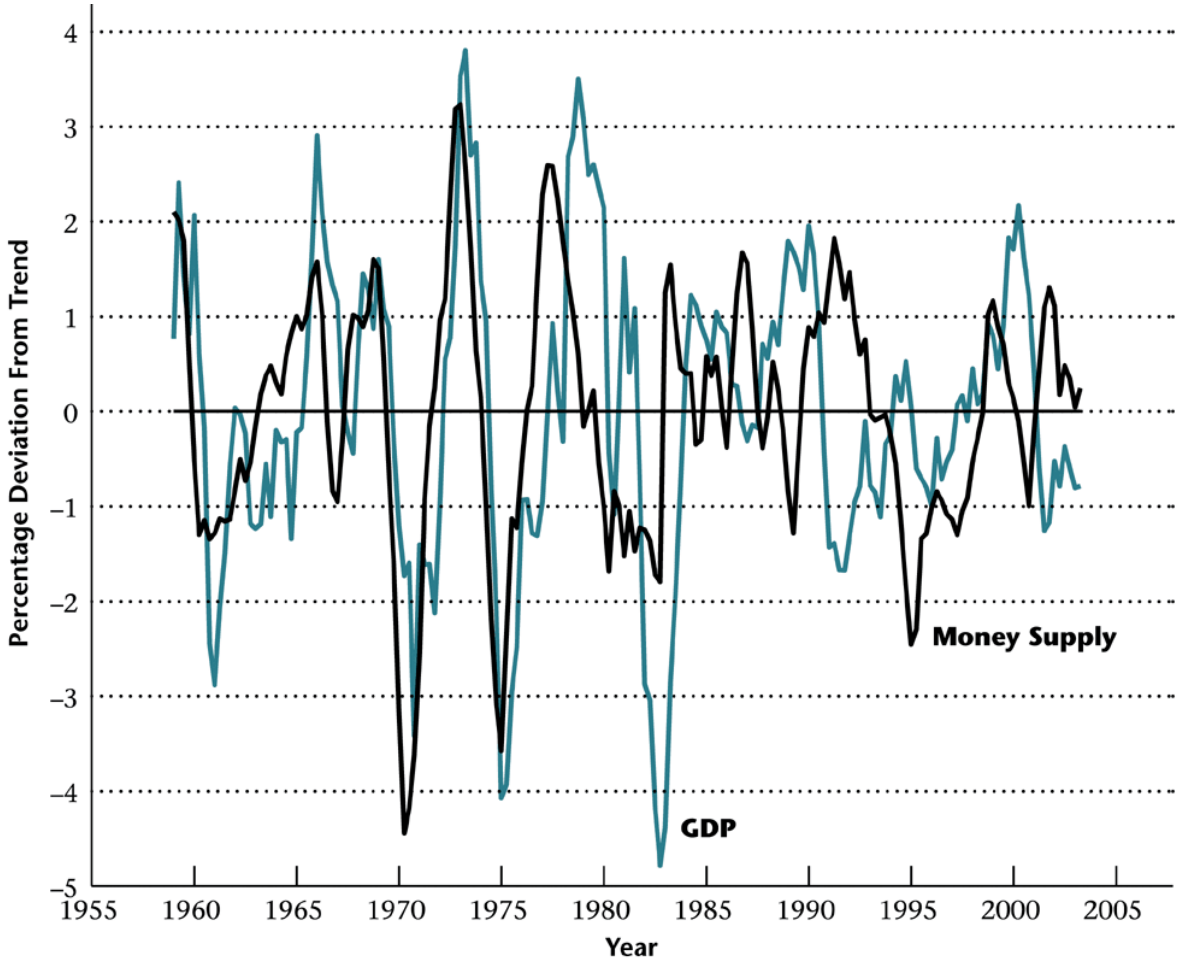


Muhammad Rahman
Indiana University
Bloomington

2) Nominal Money Supply

Nominal Money is procyclical, leading variable and less variables than GDP

Figure 3.13 Percentage Deviations from Trend in the Money Supply (black line) and Real GDP (colored line) for the Period 1959–2003



Muhammad Rahman
Indiana University
Bloomington

H. TIME SERIES BEHAVIOUR OF LABOUR MARKET VARIABLE

We will analyze three variables from the labor market:

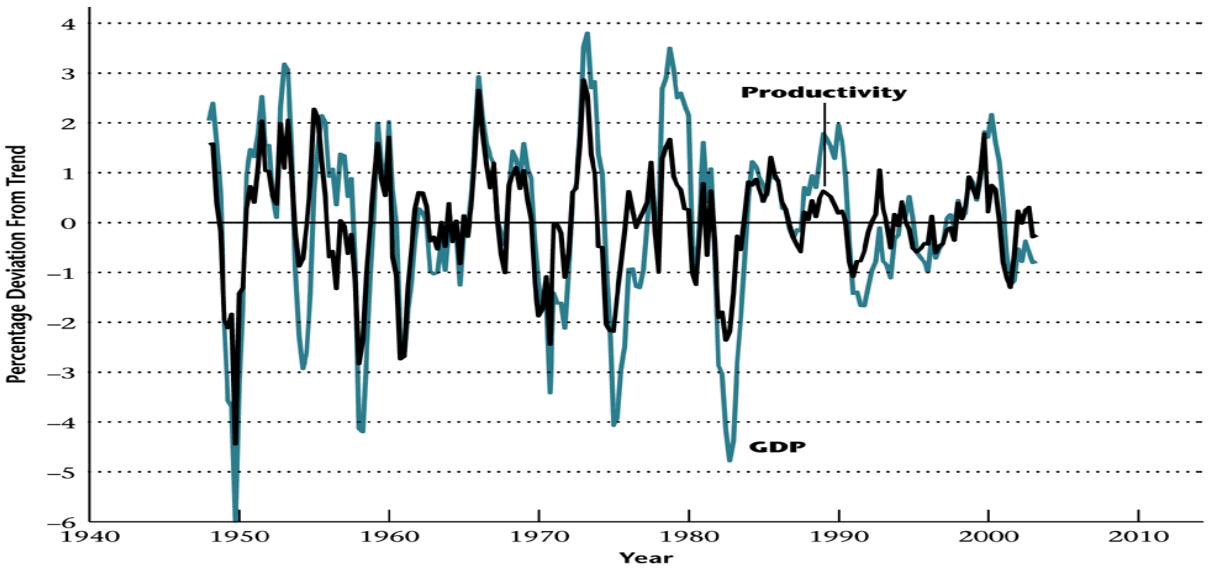
1) **Real Wage**

- Real Wage = Average of all money wage/Price Level
- Although looks simple, real wage is very difficult to calculate because we do not know all the wages.
- Real wage measures the actual purchasing power of the workers.
- Real wage is assumed to be procyclical. Empirical evidence supports that.

2) **Labor Productivity**

- Average labor productivity = aggregate output/total labor input = Y/N
- Average Productivity is coincident variable, Procyclical (correlation is about.83) and less volatile than real GDP.

Figure 3.15 Percentage Deviations from Trend in Average Labor Productivity (black line) and Real GDP (colored line) for 1948–2003

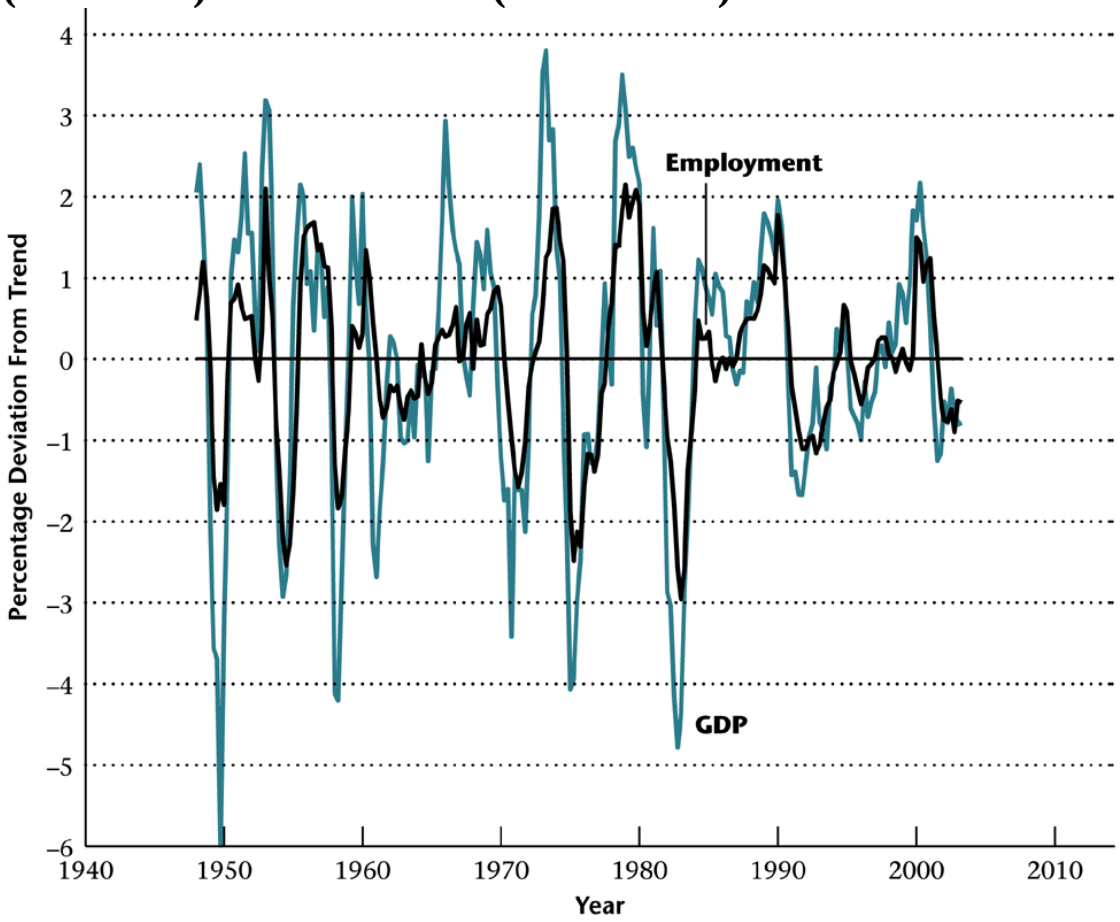


Muhammad Rahman
Indiana University
Bloomington

3) **Employment**

Employment is Procyclical, lagging variable and less volatile than real GDP.

Figure 3.14 Percentage Deviations from Trend in Employment (black line) and Real GDP (colored line)



Muhammad Rahman
Indiana University
Bloomington

Table 3.1 Correlation Coefficients and Variability of Percentage Deviations from Trend

	Correlation Coefficient	*Standard Deviation (% of S.D. of GDP)*
Consumption	0.76	75.6%
Investment	0.83	469.2
Price Level	−0.26	57.6
Money Supply	0.38	77.9
Employment	0.81	59.3
Average Labor Productivity	0.83	62.8

Table 3.2 Summary of Business Cycle Facts

	Cyclicality	*Lead/Lag*	*Variability Relative to GDP*
Consumption	Procyclical	Coincident	Smaller
Investment	Procyclical	Coincident	Larger
Price Level	Countercyclical	Coincident	Smaller
Money Supply	Procyclical	Leading	Smaller
Employment	Procyclical	Lagging	Smaller
Real Wage	Procyclical	?	?
Average Labor Productivity	Procyclical	Coincident	Smaller

I. WHY ARE WE INTERESTED IN TIMESERIES BEHAVIOR OF MACROECONOMIC VARIABLES

1) Consistency

- Macro models that we will develop have to be consistent with the above business cycle facts.
- The business cycle facts will also help us to build models.
- The business cycle facts will help us establish the "**Causal relationship**" (which variable is a lead and which variable is a lag) between different variables. It will be crucial for policy experiments.

2) Forecasting

- Based on our time series observations, we would like to make predictions the economy.
- Forecasting is also a fundamental purpose of our model building process.

J. SUCCESS AND FALIURES OF TIMESERIES MACRO ANALYSIS

- There has been noticeable success of time series macro to explain various comovements of critical macroeconomic variables(Investment, average productivity, real wage)
- In some cases, the success was moderate (consumption, Philips curve).
- In some cases, time series macroeconomics has been completely a failure (some people claim that revered Philips curve is such an example).
- Forecasting models has been quite successful. But it is because some economists claim that they are too complicated.
- The issue of "**Causality**" has not been entirely resolved. Theory sometimes predict wrong causal relationships (Sims,1980,Econometrica)