Macroeconomics (300 Level): Macroeconomic Data Lec 3

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Defining Macroeconomic Data 1: GDP

i. Gross domestic product (GDP) is the current, dollar value of all *final* goods and services that are produced within a country in a given period of time.

ii. GDP includes only final goods and not intermediate goods. It also excludes non-market activity, illegal or shadow economy etc.

iii. $GDP_t = \sum_{i=1}^{n} p_{it} y_{it}$ is nominal GDP at time t if we have n goods and price of each good is p_{it}.

Defining Macroeconomic Data 1: 3 Approaches for Measuring GDP

i. GDP can be defined either as market value of goods produced (output approach) or equivalently the total expenditure by all economic actors in the economy (expenditure approach) or as the total income earned by all factors of production (income approach).

ii. Expenditure approach: $GDP_t = C_t + I_t + G_t + (X_t - IM_t)$.

iii. Every expenditure on a final good is an income to some factor of production such as wages, rent, profits etc, which is also equal to market value of final output produced.

Defining Macroeconomic Data 1: Measurement of Expenditure Components

i. Expenditure approach: $GDP_t = C_t + I_t + G_t + (X_t - IM_t)$.

ii. I_t includes new capital purchases or capital investment, residential investments by households and inventory accumulation or subtracts inventory decumulation.

iii. Durable goods' expenditure is part of consumption in NIPA accounts of US.

iv. Why do we add X_t and subtract IM_t?

Defining Macroeconomic Data 1: Problems of GDP as Measure of Welfare

i. GDP is market value of goods and services, which means that it does not necessarily represent the social value of various goods and services.

ii. GDP excludes non-market activity such as household chores and unpaid child and elderly care.

iii. GDP measures miss the shadow economy or black markets.

iv. GDP does not measure human development and welfare in a broader sense and economic well being is defined very narrowly, which may not translate well to welfare or happiness.

v. It does not account for distribution of GDP across population and inequality.

Defining Macroeconomic Data 1: Real Versus Nominal GDP in 1 Good Case

i. Nominal GDP $= py$ units of money or monetary units, where p is price in money units of one unit of good y.

ii. Real GDP $= \frac{py}{p} = y$ units of good y (real terms).

iii. Welfare depends on real consumption, not nominal value of consumption.

Defining Macroeconomic Data 1: Real Versus Nominal GDP in Multiple Good Case

i. With $n = 2$, the value of real GDP depends on which good is chosen as numeraire: $Y = y_1 + y_2 \frac{p_2}{p_1}$ if y_1 is numeraire or $Y = y_2 + y_1 \frac{p_1}{p_2}$ if y_2 is numeraire.

ii. When $n >> 2$, denominating GDP in terms of units of any good is not helpful due to huge number of possible choices.

iii. Hence, we define Real GDP (Y_{t+s}) in period $t + s$ as constant dollar GDP by always measuring quantities in terms of prices in some fixed, base year t when there are n goods.

Defining Macroeconomic Data 1: Real Versus Nominal GDP in Multiple Good Case

i. $Y_{t+s} = \sum_{i=1}^{n} p_{i,t} y_{i,t+s}$, $\forall s > 0$, where t is base year.

ii. Define GDP Deflator or implicit price index as $P_{t+s} = \frac{\sum_{i=1}^{n} p_{i,t+s} y_{i,t+s}}{\sum_{i=1}^{n} p_{i,t} y_{i,t+s}}$, which is ratio of nominal GDP to real GDP in period $t+s$ with base year t.

iii. Notice that $P_t = 1$ by definition and real GDP changes reflect only changes in real quantities rather than prices.

iv. Even better measure is real GDP per capita since it accounts for increase in real GDP over time due to population growth.

v. $\textit{Nominal GDP}_{t+s} = P_{t+s}.Y_{t+s}$, $\textit{Real GDP}_{t+s} = Y_{t+s}$, $\textit{Real GDP Per Capita}_{t+s} = \frac{Y_{t+s}}{N_{t+s}}$ with base year t.

Defining Macroeconomic Data 1: Problems of Constant Dollar GDP with Fixed Base Year

i. Problems with constant dollar GDP may arise if relative prices change a lot over time.

ii. Suppose only bread and cars are produced in economy and in 1950, 10 units of bread and 1 unit of car is consumed with prices of \$1 and \$10 respectively. In 2020, 12 units of bread and 2 units of cars are consumed with prices of \$1 and \$5 respectively.

iii. Verify that $GDP_{2020} = 12 * 1 + 2 * 5 = 22$ and $GDP_{1950} = 10 * 1 + 1 * 5 = 15$ if base year is 2020 but $GDP_{2020} = 12 * 1 + 2 * 10 = 32$ and $GDP_{1950} = 10 * 1 + 1 * 10 = 20$ if base year is 1950.

iv. Growth rate between 1950 and 2020 is higher when base year is 1950.

Defining Macroeconomic Data 1: Chain Weighted

i. To account for changes in relative prices, chain weighted index is used in practice.

ii. Chain weighted index uses rolling base years and for every two consecutive time periods t and $t+1$, it calculates the GDP values by using time t as base year once and time $t+1$ as base year once, before taking a geometric average between the two GDP values.

iii. Chain weighted GDP values are smoother and account for relative price changes over time, leading to more accurate GDP comparisons over time.

Defining Macroeconomic Data 1: Logarithms and Growth Rates

i. $\Delta \ln(x_{t+1}) = \ln(x_{t+1}) - \ln(x_t) \approx g_{t+1} = \frac{x_{t+1}-x_t}{x_t}$.

ii. **Proof:**

$g_{t+1} = \frac{x_{t+1}-x_t}{x_t} \implies 1 + g_{t+1} = 1 + \frac{x_{t+1}-x_t}{x_t} = \frac{x_t + x_{t+1} - x_t}{x_t} = \frac{x_{t+1}}{x_t} \implies g_{t+1} = \frac{x_{t+1}}{x_t} - 1$.

$\ln(1+\epsilon) \approx \epsilon$ for $\epsilon \approx 0 \implies \ln(1+g_{t+1}) \approx g_{t+1}$ and hence

$g_{t+1} \approx \ln\left(1 + \frac{x_{t+1}}{x_t} - 1\right) = \ln\left(\frac{x_{t+1}}{x_t}\right) = \ln(x_{t+1}) - \ln(x_t)$.

iii. You should also know that $\%\,\Delta\left(\frac{XY}{Z}\right) \approx \%\,\Delta X + \%\,\Delta Y - \%\,\Delta Z$ for small percentage changes.

Defining Macroeconomic Data 1: Decomposition of Growth in Nominal GDP

i. $\textit{Nominal GDP}_{t+s} = P_{t+s}.Y_{t+s}$, $\textit{Real GDP}_{t+s} = Y_{t+s}$.

ii. $\textit{Real GDP Per Capita}_{t+s} = y_{t+s} = \frac{Y_{t+s}}{N_{t+s}}$ with base year t.

iii. $\textit{Nominal GDP}_{t+s} = P_{t+s}.Y_{t+s} = P_{t+s} \times y_{t+s} \times N_{t+s}$.

iv. By using the last percentage result on previous slide, we get that:
$\%\,\Delta \textit{ in N GDP}_{t+s} \approx \%\,\Delta \textit{ in } y_{t+s} + \%\,\Delta \textit{ in } N_{t+s} + \%\Delta \textit{ in } P_{t+s}$.

v. In words, the percentage change in nominal GDP can be decomposed into percentage change in real GDP per capita, population growth and inflation, as measured by GDP deflator.

Defining Macroeconomic Data 1: Growth Rates

i. $g_x(t, t-1) = \frac{x_t - x_{t-1}}{x_{t-1}}$

ii. $g_x(t, t-h) = \frac{x_t - x_{t-h}}{x_{t-h}}$

iii. $x_t = (1 + g_x(t, t-1)).x_{t-1}$

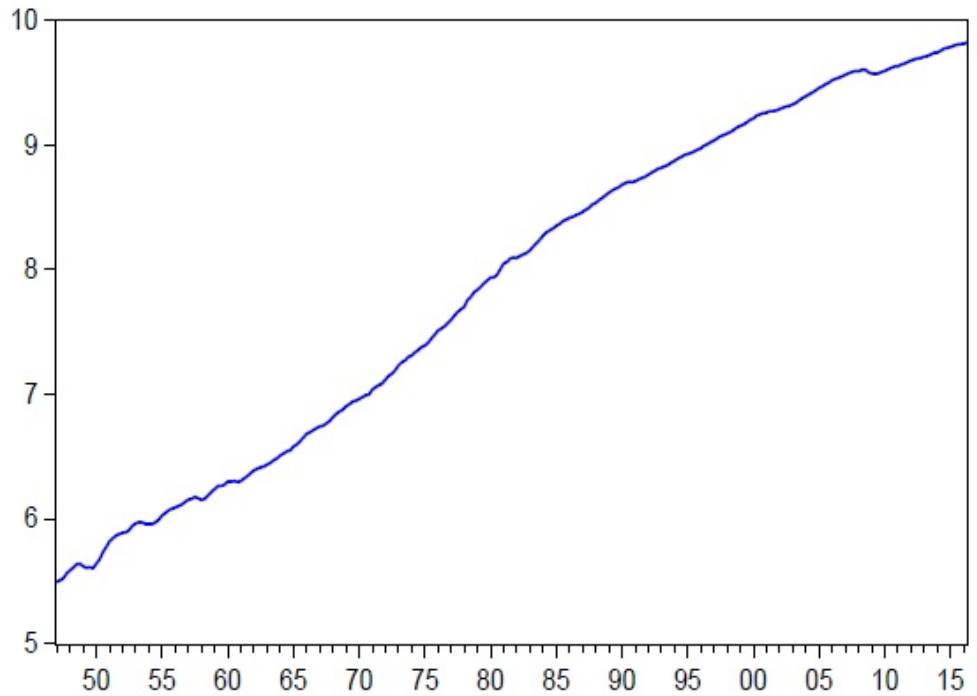
iv. $x_t = (1+g)^t.x_0$ if constant growth rate per year exists over time.

v. The last equation can be rearranged to get $g = \left(\frac{x_t}{x_0}\right)^{\frac{1}{t}} - 1$

vi. **Example:** If GDP in 1900 is \$1,000 and in 2000 it is \$15,000. Suppose that GDP has grown at constant rate g. Take 1900 as period 0, 2000 as period 100 and calculate g. Verify that your answer is that $g = 2.7\%$ per year.

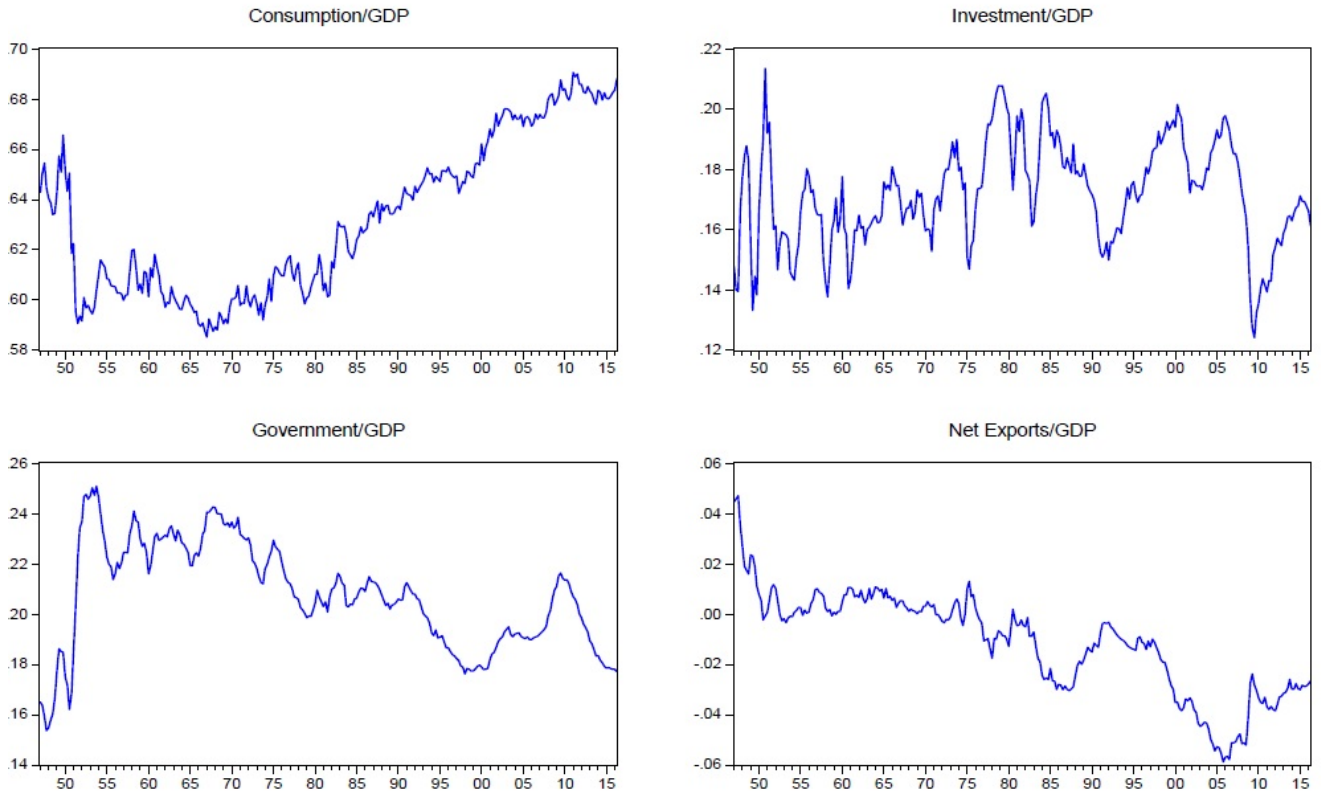
Defining Macroeconomic Data 1: Log of Nominal GDP for US

Figure 1.1: Logarithm of Nominal GDP



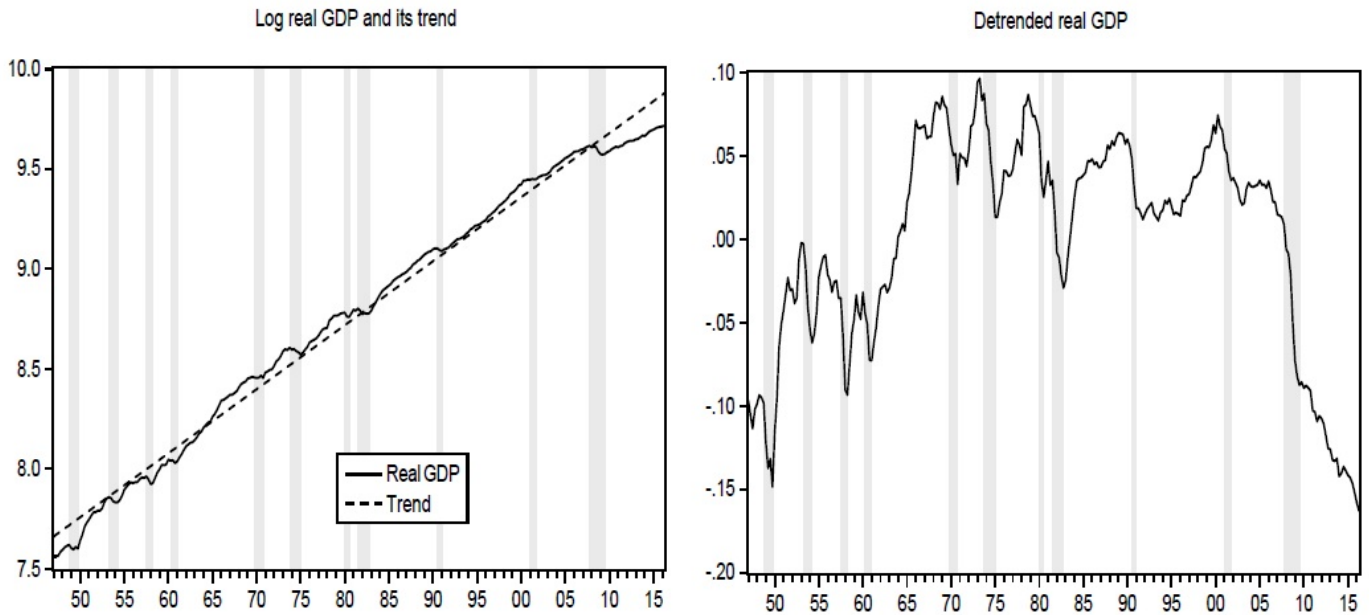
Defining Macroeconomic Data 1: Expenditure Components of Nominal GDP

Figure 1.2: GDP Components as a Share of Total GDP



Defining Macroeconomic Data 1: Log of Real GDP and Detrended Real GDP

Figure 1.3: Real GDP



Defining Macroeconomic Data 2: CPI

i. Consumer price index (CPI) is a measure of inflation which is based on a fixed basket of N goods that an average household consumes and fixed quantities for any given good across time are used.

ii. CPI in any year t is the cost of this fixed basket in year t relative to cost of basket in base year b.

iii. $Cost_t = \sum_{i=1}^{N} p_{it}\, x_i$ and $Cost_b = \sum_{i=1}^{N} p_{ib}\, x_i$ in base year.

iv. $P_t^{CPI} = \frac{Cost_t}{Cost_b} \implies P_b^{CPI} = 1$ and when P_t^{CPI} rises over time on average, then inflation is positive or on average, the cost of living or cost of consuming this basket increases.

Defining Macroeconomic Data 2: GDP Deflator Versus CPI

i. In GDP deflator, quantities produced change over time but CPI uses a fixed basket of goods over time.

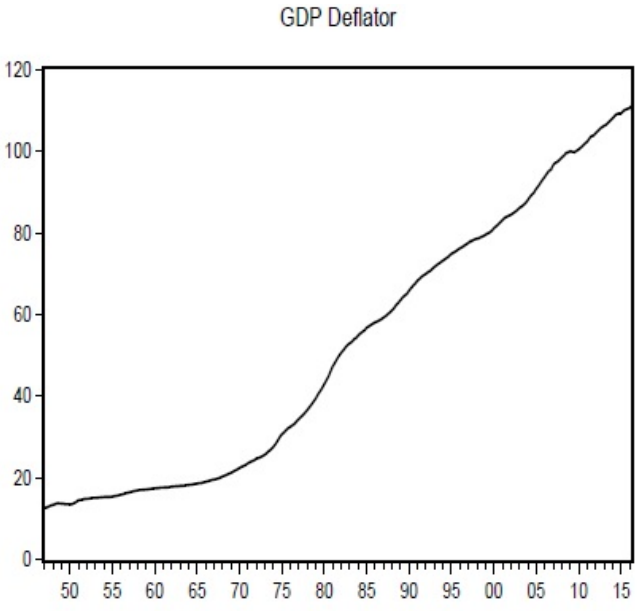
ii. GDP deflator is measure of overall prices of goods produced in economy.

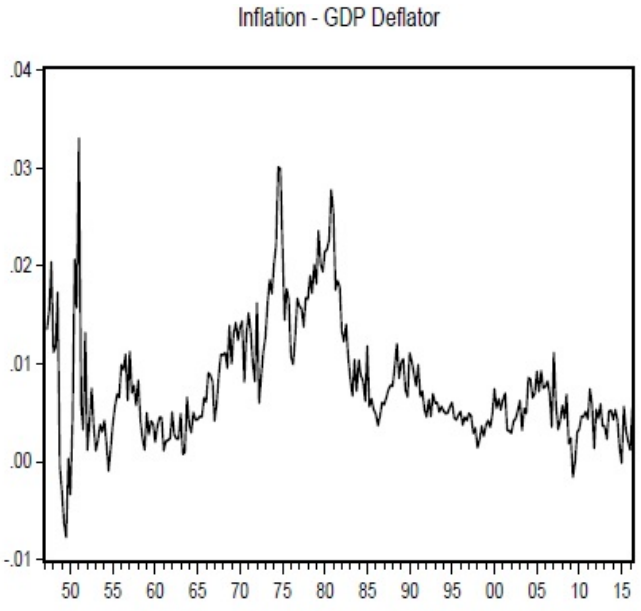
iii. CPI uses a basket consumed by typical household which excludes investment, exports and government expenditure but includes imports.

iv. Typically, CPI gives a higher and more volatile inflation measure relative to GDP deflator due to substitution bias in CPI, arising from fixed quantities in consumer basket.

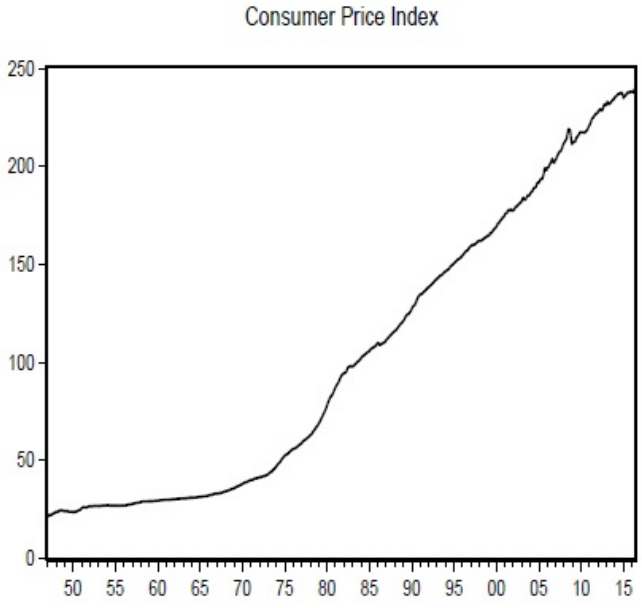
v. CPI is a more direct measure of cost of living for typical household and hence a better measure of consumer welfare.

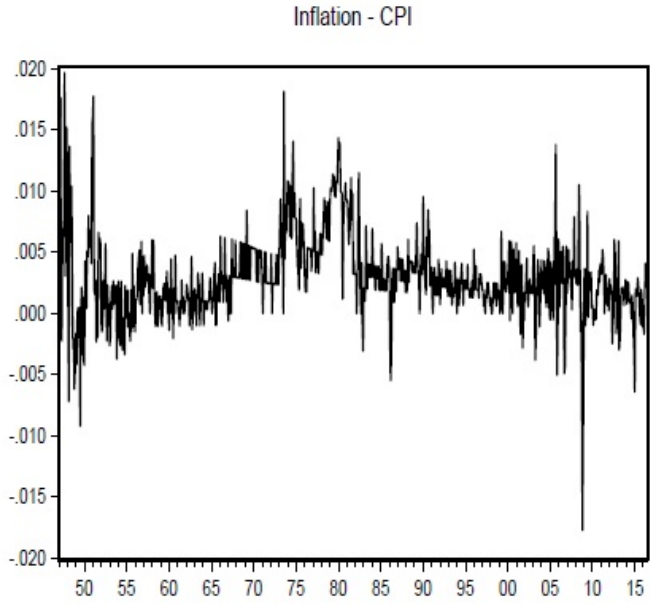
Defining Macroeconomic Data 1: GDP Deflator Based Inflation in US





Defining Macroeconomic Data 1: CPI Based Inflation in US





Defining Macroeconomic Data 3: Measuring the Labor Market

i. Let E be total number of employed people per period, lets say a year/quarter and L be total working age population. $E \leq L$.

ii. Labor force LF includes employed and unemployed U - defined as those who actively seek work but are not employed i.e $LF = E + U$, $LF \leq L$

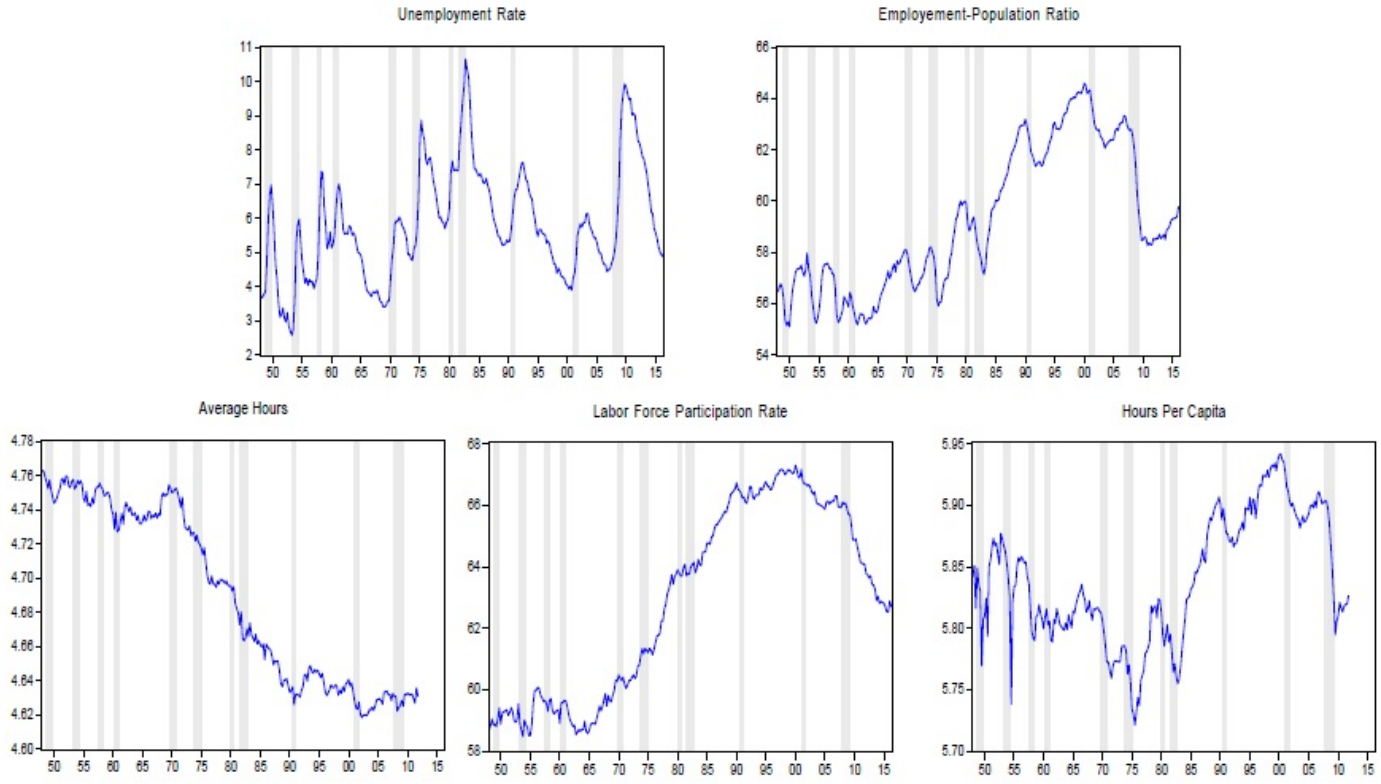
iii. Total hours worked $N = h \times E$ where h is average hours worked by employed workers. Hours worked per working age person $n = \frac{N}{L} = \frac{h \times E}{L}$, which can change due to both **intensive** and **extensive** margin changes.

iv. $lfp = \frac{LF}{L}$ is labor force participation rate.

v. Unemployment rate $u = \frac{U}{LF} = \frac{U}{U+E}$.

Defining Macroeconomic Data 3: Labor Market Data for US

Figure 1.6: Labor Market Variables



Defining Macroeconomic Data 4: Business Cycle Measurement

i. **Method 1: NBER business cycle dating committee:** loosely speaking, they define a recession as two or more quarters of a sustained slowdown in overall economic activity.

ii. The committee examines large amounts of different indicators and sectors, employment tendencies, productivity etc.

iii. **Method 2:** Trend versus cycle separation: measuring business cycles as deviations from trend.

Defining Macroeconomic Data 4: NBER Business Cycle Committee

Defining Macroeconomic Data 4: Stylized Facts About Business Cycles

i. Business cycles do not display regular, periodic, sine wave like behavior: asymmetries.

ii. Expansions tend to be long and mild and are measured in years.

iii. Recessions are short but sharp or dramatic episodes: measured in months. Decline per period is quite large during recessions.

Defining Macroeconomic Data 4: Business Cycle Statistics for US Economy

Table 1
Business Cycle Statistics for the U.S. Economy

	Standard Deviation	Relative Standard Deviation	First Order Auto-correlation	Contemporaneous Correlation with Output
Y	1.81	1.00	0.84	1.00
C	1.35	0.74	0.80	0.88
I	5.30	2.93	0.87	0.80
N	1.79	0.99	0.88	0.88
Y/N	1.02	0.56	0.74	0.55
w	0.68	0.38	0.66	0.12
r	0.30	0.16	0.60	-0.35
A	0.98	0.54	0.74	0.78

Source: King and Rebelo (1999)

Defining Macroeconomic Data 4: Stylized Facts About Business Cycles

i. Observe the relative business cycle volatility patterns for various series in table in last slide for US data.

ii. Most macroeconomic time series are pro-cyclical.

iii. Wages, government expenditures and capital stocks tend to be fairly a-cyclical.

iv. By persistence, we mean the parameter ρ in equation: $x_{t+1} = \rho x_t + \epsilon_{t+1}$.

v. Most macro time series are fairly persistent, i.e $\rho \approx 0.9$ is estimated.

Thank you