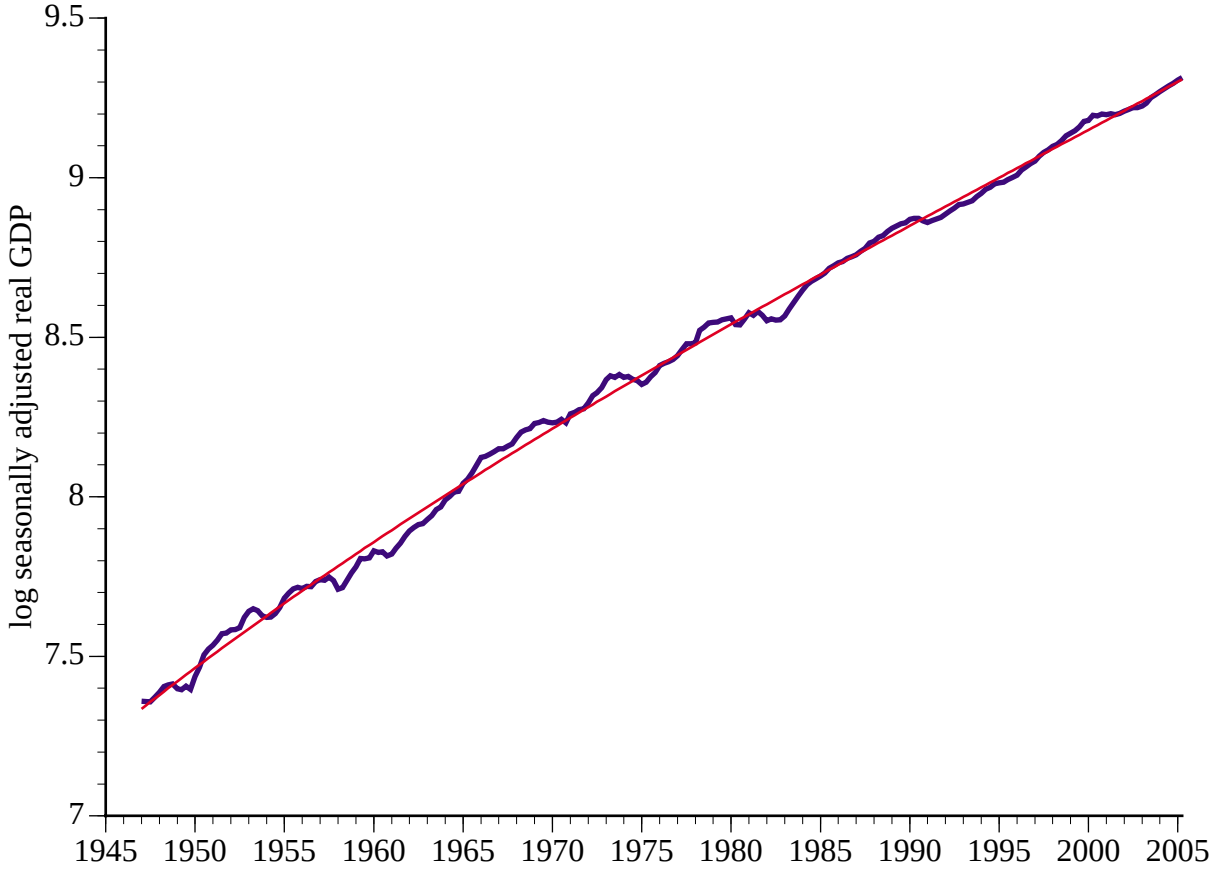
1. What is a Business Cycle?

- As we saw previously, if we plot log (real output) against time and fit a (cubic) time trend we get a fairly good fit but there are significant fluctuations about the trend line as in the following graph for US GNP



It is interesting to note that both the quadratic and cubic terms are significantly different from zero at conventional significance levels- that is, there is evidence consistent with the hypothesis that economic growth trended down in the 1970s and 1980s relative to the 1960s and 1990s. An alternative way of allowing for lower trend growth rates in the 1970's and 1980's is to fit a piece wise linear time trend with a break in the slope in the early 1970's and another in the early 1990s.

- On the other hand, if we regress the annual growth rate of real income against time and time

squared, neither coefficient is significantly different from zero at conventional significance levels (t-statistic is -1.06577 for t and 0.61908 for t^2). This reflects a more general issue in time series statistics. If the underlying process is non-stationary, that is, the trend rate of growth of the economy is a random process instead of the deterministic trend estimated above, deterministic trend lines may appear statistically significant when there really is no such trend in the data.

- The simplest random growth rate model makes the trend level of output a random walk with drift:

$$\ln y_t = a + \ln y_{t-1} + \varepsilon_t \qquad (1)$$

so that the *growth rate* from t-1 to t, which equals $(a + \varepsilon_t)$, is stochastic. This can be justified on the grounds that growth in aggregate employment and the aggregate capital stock are both likely to have random components, while technological change is also likely to be random. However, we then should fit the output growth to the growth in factor supplies and technological change rather than simply specify a simple trend process such as that given above. Many authors essentially take a weighted moving average of observations from the recent past to define the current trend level of output.

- However we identify the trend, we might hope to explain the general trend with growth theory models. What explanation is there for the fluctuations about trend?

- We would have little hope of getting a *theory* to explain these fluctuations *unless* they displayed some *regularity*. This was the idea behind the work of Mitchell and his co-workers at the NBER in the 1930's and 1940's. They studied many economic time series and documented their deviations about trend in an attempt to identify regularities which might form the basis for a theory of "business cycle fluctuations". Such a theory could then in turn be used to make further testable predictions.

- Why use a large number of individual time series rather than aggregate data?

(i) Any one time series is subject to measurement error.

(ii) Use of aggregate data already presupposes the components behave in the same cyclical manner.

(iii) Disaggregated data may be more comparable to data from other countries.

(iv) Deviations of individual series from the cyclical pattern may be suggestive of possible hypotheses about the source of business cycles.

- It was believed that business cycles represented an inefficient allocation of resources and should be avoided if possible. A theory of fluctuations might enable the introduction of reforms which would mitigate their severity if not remove them altogether.

- Koopmans criticized the NBER approach as "measurement without theory" and effectively ended that line of research for decades. More recently, time series analysts have again become interested in defining and measuring "business cycles." However, their approach has been somewhat different. They have focused on *stochastic difference equations* as a modeling tool.

2. Some Regularities in the Behavior of Post-WWII US Data

- We can also look at the cyclical behavior of US time series in the post-WWII era using the graphs in the appendix to this chapter. You could examine the related graphs and discussion of them in, for example, Barro's text. The particular graphs presented in the appendix are based on data available from the Federal Reserve Bank of St. Louis web site (http://www.stls.frb.org/fred/index.html).

- Implicitly, the graphs are based on the "stochastic growth" model (1). Business cycles are part of the deviations from the average growth rates.

- In Chart 1, the growth rate of real personal consumption and real private investment are graphed along with deviations of annual GDP growth from its average. We see that consumption has about the same variability as real GDP, while investment varies substantially more. The peaks

and troughs in both consumption and investment correspond to those in real GDP.

- Chart 2 shows how the different components of consumption vary over the cycle. Consumer durables is the most volatile component of consumption, and services consumption the least volatile. The components tend to cycle together.

- Chart 3 plots the growth in the residential and non-residential components of investment and deviations from trend of real GDP. In the early part of the sample, residential investment was more volatile, but the fluctuations in growth rates appear more similar over the last decade. There is also some evidence in Chart 3 that peaks and troughs in residential investment tend to *lead* fluctuations in the other two series.

- Chart 4 shows that business inventories as a proportion of GNP (right hand scale) also tend to correspond with the cycle in GDP growth rates, although there is some hit that they could lag a small amount. Inventories are the least volatile component of investment.

- Charts 5, 6 and 7 look at variability in real income variables. Chart 5 shows that real disposable income growth more or less tracks GDP growth and is of a similar volatility. Chart 6 shows that real non-farm corporate profits growth is much more volatile than GDP, but again with fluctuations that generally coincide with GDP. Comparing Charts 1, 3 and 6, real profits are more variable than investment (note the scale change).

- Chart 7 suggests that wage and salary growth also is pro-cyclical with a similar volatility to GDP. This variable combines movements in employment, average hours and real wages. It could also reflect changes in the *composition* of the labor force.

- Chart 8-15 focus on other labor market variables. Chart 8 shows that the ratio of employed people to the civilian population over the age of 16 varies quite closely with GDP, with perhaps a slight tendency to lag, and has fluctuations of a similar magnitude to GDP.

- Chart 9 shows that the growth of average hours in non-agricultural employment is broadly pro-

cyclical but much less variable than GDP. On the other hand, the growth in help wanted advertisements (Chart 10) is pro-cyclical and much more variable than GDP.

- The growth in manufacturing employment also is pro-cyclical (Chart 11), and of a similar magnitude to GDP fluctuations. The growth rate has trended down over time, reflecting the fact that manufacturing employment has been declining relative to employment elsewhere in the economy. A shift from manufacturing to services could explain this, but so could a faster rate of labor productivity growth in manufacturing than in other sectors of the economy.

- Charts 12-15 focus on unemployment as opposed to employment. Chart 12 suggests that the unemployment rate is a *lagged counter-cyclical* variable, although it tends to be somewhat smoother than GNP growth. The median unemployment duration (Chart 13), also appears to be a lagged counter-cyclical variable, although it fluctuates more than the unemployment rate.

- The counter-cyclical movements are perhaps clearer in Charts 14 and 15, which graph the growth rates of people who have been unemployed for more than 15 or less than 5 weeks. Perhaps not surprisingly the growth of longer term unemployed (Chart 14) appears to be somewhat more “smoothed” than the growth in shorter term unemployed people (Chart 15).

- Charts 16 and 17 show the relationship between fiscal variables and fluctuations in GNP. Chart 16 graphs growth in real government consumption and investment expenditure against deviations in GDP growth about trend. If anything, growth in government expenditure appears to be counter-cyclical. However, it appears to be pro-cyclical for some cycles. Chart 17 suggests that the consolidated government surplus as a percentage of GDP tend to be more pro-cyclical, although perhaps lagging GDP growth somewhat.

- Chart 18 shows that imports and exports fluctuate more than GDP. If you look closely, imports tend to be pro-cyclical. Exports were neither pro- nor counter-cyclical early in the sample, but also tend to track imports more closely after the move to floating exchange rates.

- Charts 19 and 20 focus on interest rates. Chart 19 shows that the 10 year bond rate is smoother than the 3-month and 1-year T-Bill rates (the latter two rates tend to move in a very similar fashion). Chart 19 suggests that interest rates became more volatile after the early 1970s. This may reflect a change in Federal Reserve Policy away from targeting interest rates toward other objectives. Subsequently, interest rates tended to move counter-cyclically in the 1970s, but the correlation (either positive or negative) with GDP fluctuations appears to have diminished in more recent decades. Chart 20, which graphs the spread between the 10 year and 1 year bond rates with GDP growth suggests that this spread tends to *lead* GDP fluctuations.

- Another feature of Chart 19 is the gap between interest rates and GDP growth that opens up in the 1970s and 1980s and then closes again in the 1990s. This broad pattern corresponds somewhat with the inflation rate graphed in Chart 21. Evidently, increases in inflation tend to raise nominal interest rates. Borrowers and lenders are both concerned about *real* interest rates, not the *nominal* interest rate. If inflation is expected over the life of a loan, lenders will demand, and borrowers will be willing to pay, compensation for the expected erosion in the value of the loan. The after-inflation return on a loan, or cost of borrowing, is the nominal interest rate less the anticipated rate of inflation.

- Chart 19 also shows that the inflation rate tends to move counter-cyclically with GDP growth deviations – although in some cycles (early 1950s, early 1980s) it is pro-cyclical. Different macroeconomic theories make different predictions about the correlation between inflation and output: real business cycle theories predict a negative correlation between inflation and output; new classical theories predict a contemporaneous or short lagged positive correlation between GNP growth and *unanticipated* inflation and no relation between GNP growth and *anticipated* inflation; Keynesian models predict a longer lagged positive correlation. In sorting the evidence vis-a-vis the last two theories we need to be able to measure anticipated inflation and this is difficult because we don't have good direct data on expectations.

- Charts 21 and 22 also examine money growth rates. In the 1960s and 1970s, M2 growth tended

to be pro-cyclical, perhaps with a slight *lead* over GDP fluctuations. However, the relationship appears to have disappeared entirely in the last decade. Chart 22 suggests that M1 and base money growth have remained more pro-cyclical. The increasing volatility of M1 and money base growth rates is also very noticeable. The large swings in M1 growth from the mid-1980s at least partially reflected substitutions into M1 from other components of M2 since they were not matched by similarly sharp changes in overall M2 growth rates. The sharp increase in the money base in 2001 reflects the response of the Federal Reserve to the attack on the World Trade Center in New York.

- Chart 23 suggests a stronger relationship between growth in loans and GDP than between the conventional monetary aggregates and GDP. However, the graph also suggests that the loans variable *lags* GDP.

- Finally, Chart 24 looks at real energy prices and GDP. It suggests that there has been a pro-cyclical movement in real energy prices over the last decade or so, but the relationship is weak prior to that.