ECOS3021 Business Cycles and Asset Markets – Reading Notes

Topic One: Introduction to Business Cycles – Concepts and Measurements, Time Series Properties, and Stylised Facts

The Hodrick-Prescott Filter

- The business cycle is a time-series of fluctuations or recurrent deviations of aggregate real output.
- The Hodrick-Prescott filter is used to remove the trend component from quarterly macroeconomic series, hence, it is a detrended measure of the GDP fluctuations.
- Consider the problem of decomposing a time series yt, t = 1, … T into a trend component gt (potential output) and a cyclical component (ct) such that:

$$y_t = g_t + c_t$$

- There are many ways of filtering yt to extract the cyclical component from the series.
- One method is to apply a deterministic filter which extracts the cyclical component as the deviation of yt from linear or quadratic time trend.
- Another common method is to apply the first difference filter which extracts ct as $y_t - y_{t-1}$.
- Following Hodrick and Prescott (1980), the business cycle regularities that have been documented for many countries use the Hodrick-Prescott (HP) filter to extract the cyclical component of a series, or to remove the rend component of a series.
- This filter computes the trend component as the solution to the following convex minimisation problem with respect to (gt):

$$\min \sum_{t=1}^{T} (y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} \left[(g_{t+1} - g_t) - (g_t - g_{t-1}) \right]^2$$

- The first term is the sum of squared deviations from trend and is a measure of the degree of fit between yt and gt.
- The second term is the sum of squares of the trend component's second difference and is a measure of the degree of smoothness of gt.
- This term is zero when the change in gt is constant for all t, when gt is linear.
- Thus, there is a trade-off between the two objectives of fit and smoothness.
- The weight placed on each objective is determined by the weighting factor h which must eb set.
- Higher values represent a higher penalty on acceleration in the trend component. For h = infinity, gt is linear, or smooth.
- The weighting factor can be interpreted as the ratio of the variance of the cyclical component to the variance of the trend component, most of the time setting it to 1600.

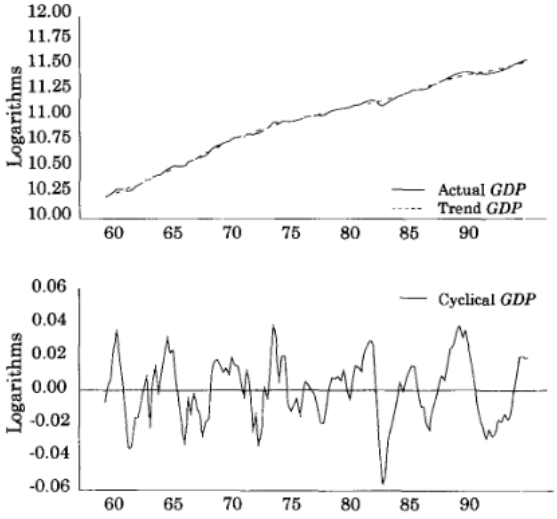


FIGURE 1
Actual, trend and cyclical *GDP*(*P*)
(1989-90 prices, seasonally adjusted)

- Let a time series yt be viewed as the sum of a growth (trend) component gt and a cyclical component ct : yt ¼ gt þ ct for t ¼ 1; ... ;T. The growth component should be smooth, so that the procedure recommended by Hodrick and Prescott (1997) is to minimize that term.
- The larger h is, the smoother is the result because it penalises variability in potential growth.

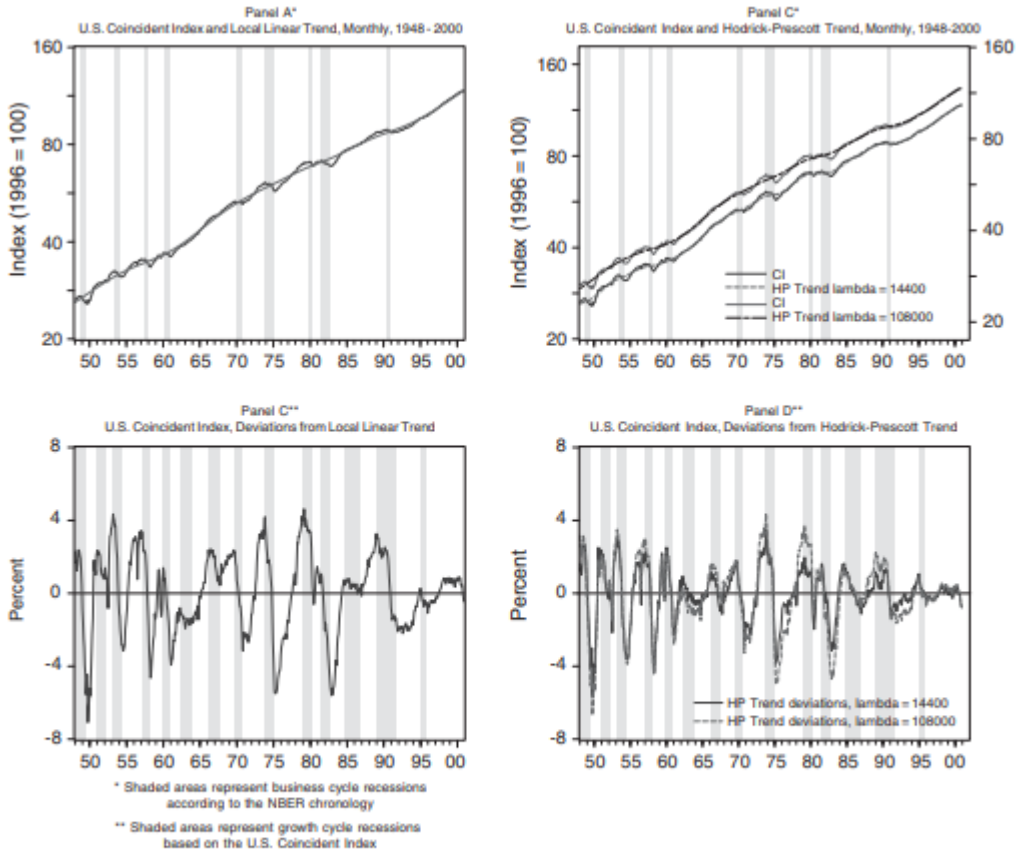


Fig. 7. Panel A: U.S. coincident index and local linear trend, monthly, 1948–2000; Panel B: U.S. coincident index, deviations from local linear trend; Panel C: U.S. coincident index and Hodrick–Prescott trend, monthly, 1948–2000; Panel D: U.S. coincident index, deviations from Hodrick–Prescot trend.

- The Hodrick–Prescott (1997) approach is flexible, and with very high l it produces growth cycles quite similar to PAT but it falls short on smoothness.

Business Cycle Properties

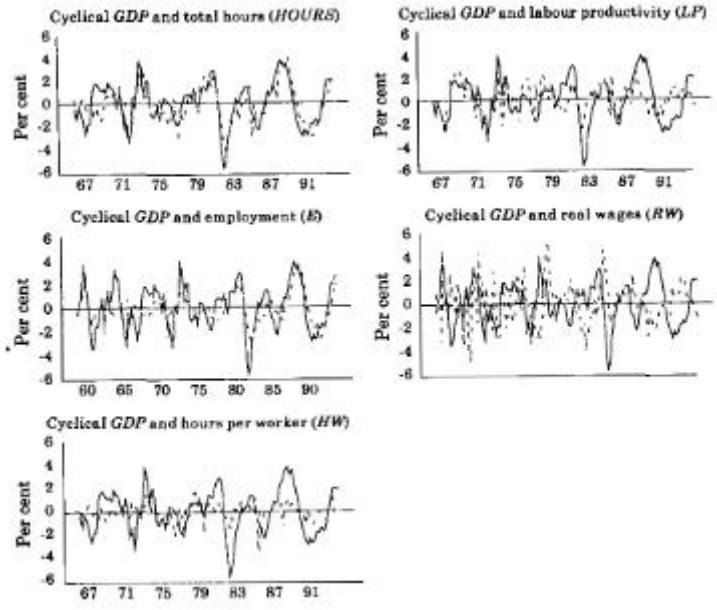
- For the cyclical component of each series, the statistics are reported as follows: the amplitude of fluctuations measured as a percentage standard deviation, the degree of persistence measured by the serial correlation coefficient and the degree of comovement at various leads and lags of the series with cyclical real GDP.
- When the cross correlations are close to one, the series is highly procyclical, when they are close to negative one, highly counter-cyclical and when they are close to zero, the series is uncorrelated with the cycle.
- If the cross correlation is largest in absolute value) in column x(t - i), where i > 0, then the series tends to peak i quarters before real GDP, that is, tends to lead the cycle by i quarters.
- If the cross correlation is largest in absolute value) in column x(t - i), where i < 0, then the series tends to lag i quarters before real GDP, that is, tends to lag the cycle by i quarters.

- If the cross correlation is largest in column x(t), the series is contemporaneous with the cycle.

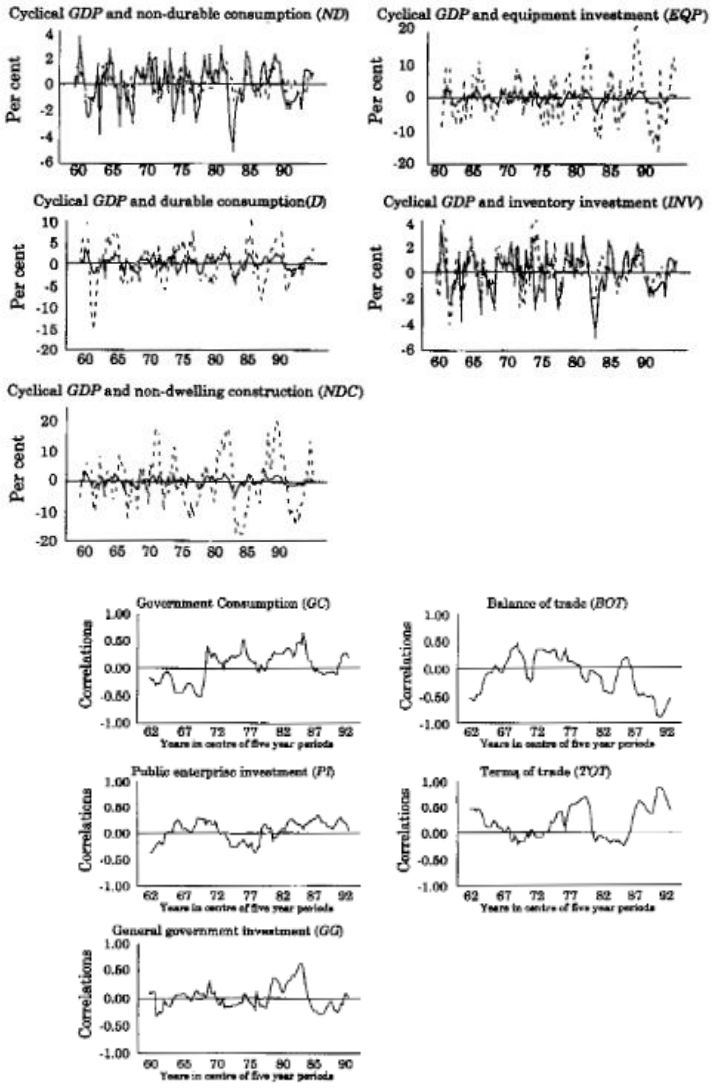
Cyclical Properties of Production Inputs

Series X	Sample Period	Volatility (% st. dev.)		First Order AR	Cross Correlation of Real GDP with $x(t-5)$	$x(t-4)$	$x(t-3)$	$x(t-2)$	$x(t-1)$	$x(t)$	$x(t+1)$	$x(t+2)$	$x(t+3)$	$x(t+4)$	$x(t+5)$
GDP(P)	59(3) – 95(2)	1.88		0.78											
	59(3) – 73(3)	1.76		0.66											
	73(4) – 95(2)	1.96		0.83											
HOURS	66(3) – 95(2)	1.63	(0.87)	0.75	−0.14	0.00	0.23	0.42	0.58	0.74	0.74	0.63	0.48	0.31	0.16
	66(3) – 73(3)	0.04	(0.02)	0.57	−0.49	−0.55	−0.35	−0.23	−0.12	0.11	0.01	0.04	0.11	0.18	0.38
	73(4) – 95(2)	1.83	(0.93)	0.76	−0.12	0.05	0.29	0.48	0.65	0.82	0.84	0.70	0.53	0.34	0.17
–EMP	59(3) – 95(2)	1.18	(0.63)	0.88	−0.27	−0.13	0.06	0.27	0.49	0.65	0.69	0.65	0.52	0.37	0.24
	59(3) – 73(3)	0.61	(0.35)	0.72	−0.47	−0.46	−0.31	−0.07	0.20	0.39	0.29	0.20	0.00	−0.06	0.02
	73(4) – 95(2)	1.44	(0.73)	0.89	−0.23	−0.06	0.15	0.36	0.58	0.76	0.83	0.80	0.67	0.51	0.34
–HW	66(3) – 95(2)	0.79	(0.42)	0.23	0.12	0.13	0.28	0.32	0.31	0.39	0.31	0.11	−0.01	−0.11	−0.18
	66(3) – 73(3)	0.52	(0.29)	0.24	−0.18	−0.44	−0.34	−0.39	−0.38	−0.08	−0.14	−0.22	−0.03	0.02	0.22
	73(4) – 95(2)	0.87	(0.44)	0.23	0.13	0.20	0.35	0.40	0.40	0.47	0.38	0.16	0.00	−0.12	−0.21
KS	59(3) – 95(2)	0.83	(0.44)	0.95	−0.52	−0.52	−0.45	−0.30	−0.11	0.11	0.30	0.44	0.53	0.55	0.53
	59(3) – 73(3)	0.52	(0.30)	0.92	−0.49	−0.65	−0.71	−0.63	−0.50	−0.25	−0.05	0.13	0.27	0.35	0.40
	73(4) – 95(2)	0.99	(0.51)	0.96	−0.58	−0.52	−0.40	−0.22	−0.00	0.23	0.41	0.55	0.63	0.64	0.61
DKS	59(3) – 92(2)	0.31	(0.16)	0.86	−0.40	−0.43	−0.38	−0.26	−0.09	0.11	0.25	0.37	0.44	0.46	0.43
	59(3) – 73(3)	0.27	(0.15)	0.94	−0.45	−0.49	−0.48	−0.42	−0.31	−0.16	−0.03	0.10	0.22	0.32	0.38
	73(4) – 92(2)	0.35	(0.18)	0.83	−0.43	−0.44	−0.36	−0.20	0.01	0.26	0.40	0.52	0.55	0.54	0.47
IS	59(3) – 95(2)	2.47	(1.31)	0.86	−0.35	−0.36	−0.30	−0.16	0.06	0.37	0.60	0.75	0.75	0.63	0.43
	59(3) – 73(3)	2.23	(1.27)	0.79	−0.35	−0.50	−0.57	−0.53	−0.35	0.02	0.35	0.57	0.64	0.55	0.36
	73(4) – 95(2)	2.62	(1.34)	0.85	−0.30	−0.22	−0.10	0.10	0.31	0.54	0.73	0.83	0.81	0.65	0.41

- The table includes total employment and hours workers by all employed persons per quarter. The inventory stock is included as an input to production.
- Total hours is procyclical, contemporaneous with the cycle and somewhat less variable than output.
- Employment is procyclical and less variable than output because employers tend to hold on to their employees, which is why is often lags behind GDP.
- Labour productivity is less variable than output, procyclical and contemporaneous with the cycle.



- The procyclical behaviour of average productivity is generally interpreted as evidence that the real wage is procyclical.
- For Australia, the real wage appears countercyclical and tends to lead the cycle.
- The expenditure components are private consumption, private investment, inventory investment, government consumption, government investment and exports and imports of goods.
- Private consumption is procyclical, contemporaneous with the cycle and less variable than output because people tend to smooth their consumption over time.



- Non-durable consumption is less variable than output whereas expenditure on durables is more variable than output because such consumption is discretionary and highly dependent on the state of the economy.
- Private investment are more variable than output. Strongly procyclical and contemporaneous with the cycle. Non-dwelling investment tends to lag the cycle by about two quarters.
- Inventory investment is highly procyclical and contemporaneous with the cycle.
- Government consumptions appears uncorrelated with the cycle.
- Exports of goods and services are procyclical and contemporaneous with the cycle.
- Imports are strongly procyclical and lag the cycle slightly in each sample period.
- Imports are more variable than exports and both are more variable than output.
- In terms of the nominal variables, monetary aggregates are procyclical and more variable than output.
- Currency is contemporaneously correlated with the cycle but leads slightly.

Describing the Business Cycle

- The classic definition of this was provided by Bums and Mitchell (1946, p. 3):
  - ***Business Cycles*** *are a type of fluctuation found in aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic.*
- The classical cycle refers to the presence of hills and valleys in a plot of the levels of the series whereas the growth cycle refers to the same things in some *detrended* series.
- This distinction is rarely appreciated in academic work on the cycle and a great deal of confusion exists because of this lack of recognition
- A recession can occur in the classical cycle only if growth is negative, since output has to decline, whereas a 'growth recession' occurs when growth is less than trend (actual output is below potential), which you can only see with the detrended series.

- These movements do not exhibit uniformity of either period or amplitude, which is to say, they do not resemble the deterministic wave motions which sometimes arise in the natural sciences.
- (i) Output movements across broadly defined sectors move together. (In Mitchell's terminology, they exhibit high conformity; in modern time series language, they have high coherence.)
- (ii) Production of producer and consumer durables exhibits much greater amplitude than does the production of nondurables.
- (iv) Business profits show high conformity and much greater amplitude than other series. (v) Prices generally are procyclical because of inflationary pressures.
- (vi) Short-term interest rates are procyclical; long-term rates slightly so.
- To theoretically inclined economists, this conclusion should be attractive and challenging, for it suggests the possibility of a unified explanation of business cycles, grounded in the general laws governing market economies,
- Insofar as business cycles can be viewed as repeated instances of essentially similar events, it will be reasonable to treat agents as reacting to cyclical changes as "risk," or to assume their expectations are rational

Time series decomposition and measurement of business cycles, trends and growth cycles

- Major cyclical slowdowns and speedups deserve to be analyzed, but the needed time series decomposition presents difficult problems, mainly because trends and cycles influence each other.
- alternative trend estimates, deterministic and stochastic, linear and nonlinear, and the corresponding series of deviations from these trends.
- First, reasonably good trend estimates are required to study economic growth empirically and test related theories. This task cannot be accomplished without sufficiently long and reliable data and without confronting the question of how trends and cycles influence each other.
- The appraisal of cyclical indicators can be substantially improved by considering their trends and the fluctuations in the deviations from trends.
- Leading indicators are much more sensitive to all types of disturbances, whether associated with business cycles or with fluctuations at shorter frequencies; hence they are generally much more volatile than coincident indicators.
- For a long time, the dominant approach to modeling growth and fluctuations was to view them as a sum of a deterministic trend and stochastic (random) deviations treated as the residual ''cyclical'' component.
- A linear deterministic trend is, of course, free of any cyclical or stochastic short-term movements.
- Indeed, it is very unlikely that any given type of linear deterministic trend would persist over long stretches of time, surviving major structural and technical changes, wars, business expansions and contractions, financial crises, rising and falling inflation, etc.
- From the point of view of cyclical analysis, the cost of using a linear trend is that too much of the overall variation is attributed to business cycles.
- Moreover, the linear trends do a poor job of differentiating between good and bad economic times.
- To prove this, consider the log-linear trend fitted to real GDP in Fig. 6 panel A and the deviations from it shown in panel B. The data run below the trend line in five periods: 1947–1951; 1954; 1956–1963; Q4 1981–Q1 1984; and Q4 1990–Q1 1999.