Post-Keynesian Endogenous Business Cycle Models

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Outline

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2. Mainstream business cycle theory
   - Real business cycles
   - New Keynesian

3. Post-Keynesian business cycle theory
   - Kaldor
   - Minsky

4. Conclusion

5. Appendix
(1) Introduction
Why booms and busts?

- capitalist economies are characterised by regular booms and busts
- during busts, many people become unemployed, while machines are idle
- shouldn’t an efficient economy always fully employ its productive capacity?
- why is it that capitalist economies undergo these (inefficient) fluctuations?
Example: Ups and downs in UK unemployment

Data source: FRED.
Explanation I: Exogenous shocks

- In this view, fluctuations are driven by exogenous factors, e.g.
  - temporary changes in productivity (weather, oil prices, ...)
  - monetary policy, government spending
- The business ‘cycle’ represents the adjustment of the economy to shocks
- Imperfections in the economy may amplify shocks, but they do not create cycles by themselves
- Without shocks, the economy would not fluctuate
  → This is the mainstream take on business cycles
Explaination II: Endogenous cycle mechanisms

- in this view, fluctuations are driven by factors that are endogenous to capitalist economies, e.g.
  - over-investment (Kaldor)
  - financial fragility (Minsky)
  - distributive conflict (Goodwin)
- the business cycle is a genuine cycle: a regular sequence of booms and busts
- shocks can be a major source of fluctuations
- but: internal economic mechanisms turn those shocks into cycles
  → this is the post-Keynesian take on business cycles
(2) Mainstream business cycle theory
Building blocks of DSGE models

- economy consists of representative agents that intertemporally optimise in a world of scarce resources (‘dynamic’)
- e.g. household chooses a consumption path that maximises their lifetime utility
- economy is subject to random shocks, e.g. productivity shocks (‘stochastic’)
- the model has an equilibrium solution in which all agents maximise their objectives (‘general equilibrium’)

Real business cycle theory

- 1st generation of DSGE (1980s)
- perfectly competitive markets; no frictions; no state; no money (‘real business cycles’)
- economic activity is determined by the supply side (capital stock, labour input, technology)
- a temporary productivity shock alters household’s current and future consumption decisions → creates economic fluctuations
- business ‘cycles’ are the efficient adjustment to shocks; there’s no need for policy
Modelling real business cycles I

- consider a benchmark RBC model with two state variables (Romer 2011, chap.5)
- the capital stock ($K_t$) grows over time due to the saving decisions of households
- productivity ($A_t$) is subject to serially correlated exogenous shocks

\[
K_t = f(K_{t-1}, A_{t-1}) \tag{1}
\]
\[
A_t = g(A_{t-1}, \epsilon_t) \tag{2}
\]

Jacobian matrix =

\[
\begin{bmatrix}
\frac{dK_t}{dK_{t-1}} & \frac{dK_t}{dA_{t-1}} \\
0 & \frac{dA_t}{dA_{t-1}}
\end{bmatrix} \tag{3}
\]
Modelling real business cycles II

Linearised (deterministic) version:

\[ K_t = a_1 K_{t-1} + a_2 A_{t-1} \]  \hspace{1cm} (4)

\[ A_t = b_1 K_{t-1} + b_2 A_{t-1}, \quad b_1 = 0 \]  \hspace{1cm} (5)

\[ J = \begin{bmatrix} a_1 & a_2 \\ 0 & b_2 \end{bmatrix} \]  \hspace{1cm} (6)
Shocks and fluctuations

\[ K_t = a_1 K_{t-1} + a_2 A_{t-1} \]
\[ A_t = b_1 K_{t-1} + b_2 A_{t-1}, \quad b_1 = 0 \]

\[ J = \begin{bmatrix} a_1 & a_2 \\ 0 & b_2 \end{bmatrix} \]

- suppose there is a temporary increase in productivity (↑ \( A_{t-1} \))
- this allows for more saving, hence the capital stock increases (since \( a_2 > 0 \))
- this effect will die out slowly (because \( a_1 > 0, b_2 > 0 \))
Example: Shock to $A_0$ and non-cyclical adjustment

→ no genuine cycles, only fluctuations: ‘cycle’ driven by exogenous shocks; smooth return to equilibrium
New Keynesian business cycle theory

- 2nd generation of DSGEs (late 1990s, 2000s)
- built on RBC, but more complex and with frictions (e.g. price/wage rigidity and imperfect competition)
- sticky prices and a flexible rate of capacity utilisation render the economy demand-determined in the short-run (‘New Keynesian’)
- frictions amplify exogenous shocks and can render the adjustment path inefficient
- but: fluctuations are still driven by shocks
(3) Post-Keynesian business cycle theory: Kaldor and Minsky
Building blocks of PK business cycle models

- radical uncertainty about the future – agents have to rely on social norms and rules of thumb (bounded rationality)
- economic activity is demand-driven, not only in the short-run
- capitalism creates fluctuations and crises by itself: endogenous cycles
- cycles are driven by interaction mechanisms, whereby key macroeconomic variables act upon each other in opposite directions
Kaldor (1940): firms tend to over-invest

- firms form expectations based on past economic performance (uncertainty)
- in good times, this creates a tendency to over-invest
  - investment creates income through the Keynesian multiplier effect
  - if investment is very sensitive to income, this puts investment on an explosive path
- but for high levels of income, supply constraints will make investment inelastic with respect to income
- similarly, in a depressed economy, investment may become inelastic to income as there is always some investment to do
- thus, investment will only be temporarily be explosive
Kaldor: output-capital stock interaction

- over time, higher output translates into a growing capital stock \( \frac{dK_t}{dY_{t-1}} > 0 \)
- but a larger capital stock discourages further investment \( \frac{dY_t}{dK_{t-1}} < 0 \)
- there is thus an interaction mechanism between output \( Y_t \) and capital \( K_t \), whereby both variables act upon each other in opposite ways
Kaldorian cycles

- **Boom with growing capital stock**
- **Inefficient investment/supply constraints**
- **Disinvestment & bust**
- **Return of profitability & recovery**

![Diagram showing the stages of Kaldorian cycles](image)

- **Time (t)**
- **Y(t)** - solid line
- **K(t)** - dashed line
Minsky: stability breeds instability

- During good times, private agents take on debt to finance expenditures.
- This might be accompanied by rising asset prices (shares, real estate) that improve collateral values.
- The economy gradually builds up more debt.
- Rising debt burdens eventually discourage spending.
- Agents cut back expenditures to reduce debt.
- This creates a downward trajectory as income and asset prices fall.
Minsky: output-debt interactions

- the two interacting variables are output ($Y_t$) and private debt ($D_t$)
- there is a cyclical interaction mechanism such that
  - higher output stimulates more debt ($\frac{dD_t}{dY_{t-1}} > 0$)
  - higher debt reduces output ($\frac{dY_t}{dD_{t-1}} < 0$)
Minskyan business & financial cycles

<table>
<thead>
<tr>
<th>Time</th>
<th>Y(t)</th>
<th>D(t)</th>
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<tbody>
<tr>
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- **Overborrowing**
- **Boom w/ growing debt**
- **Contractionary deleveraging**
- **Return of optimism & recovery**
Modelling endogenous business cycles

- endogenous cycle models critically depend on cyclical interaction mechanisms
- consider a simple Minsky model in output ($Y_t$) and debt ($D_t$)

\[
Y_t = a_1 Y_{t-1} + a_2 D_{t-1}
\]
\[
D_t = b_1 Y_{t-1} + b_2 D_{t-1}
\]

\[
J = \begin{bmatrix}
a_1 & a_2 \\
b_1 & b_2
\end{bmatrix}
\]

- suppose that the interaction between $Y_t$ and $D_t$ is $a_2 \cdot b_1 < 0$
- this interaction has opposite signs: $Y_{t-1}$ drives up $D_t$ ($b_1 > 0$), but $D_{t-1}$ drags down $Y_t$ ($a_2 < 0$)
- this interaction needs to be sufficiently strong:

\[
|a_2 b_1| > \frac{(a_1 - b_2)^2}{4}
\]
Example: Shock to $Y_0$ and cyclical adjustment

$\rightarrow$ genuine cycles and equilibrium over-shooting
Comparison with RBC model

\[ a_1 = 0.2, \quad a_2 = 0.6 \]
\[ b_1 = 0, \quad b_2 = 0.9 \]
\[ a_2 b_1 = 0 \]

→ no genuine cycles, only fluctuations: ‘cycle’ driven by exogenous shocks; smooth return to equilibrium
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(4) Summary & conclusion
post-Keynesian theories highlight the **endogenous** nature of business cycles

- cycles are driven by **interaction mechanisms** where variables act upon each other in opposite directions

- Kaldorian models: cyclical interactions between output and capital

- Minskyan models: cyclical interactions between output and private debt

- these interaction mechanisms are an outcome of decentralised decision-making by boundedly rational agents: no anticipation of boom-bust dynamics and resulting inefficiencies
### Why does it matter? Policy implications

How we conceptualise business cycles has important implications:

<table>
<thead>
<tr>
<th>Vision of capitalism</th>
<th>Exogenous shocks (mainstream)</th>
<th>Endogenous cycles (PK)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>intrinsically stable system; distorted only by external influences</td>
<td>unstable &amp; inefficient system that leads to crises</td>
</tr>
<tr>
<td>Explaining busts</td>
<td>identify relevant shock + friction</td>
<td>identify source of prior boom</td>
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<tr>
<td>Policy implication</td>
<td>→ leave economy alone, deregulate</td>
<td>→ take political control over sources of instability (e.g. investment and finance)</td>
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Appendix I: Limit cycles
Limit cycles I

- to get fully endogenous cycles, we need one more ingredient: *local instability*
  - suppose the system is explosive near its equilibrium point
  - but as it gets pushed away from the unstable equilibrium, it becomes stable again
- local instability can stem from specific types of nonlinearities
- together with a cyclical interaction mechanism, this can produce so-called *limit cycles*
Let’s start from a more general system:

\[ y_t = f(y_{t-1}, z_{t-1}) \]
\[ z_t = g(y_{t-1}, z_{t-1}). \]

Suppose at least one of the functions \( f(\cdot) \) and \( g(\cdot) \) is nonlinear and

\[ \left( \frac{dy_t}{dz_{t-1}} \right) \left( \frac{dz_t}{dy_{t-1}} \right) < 0. \]

For certain kind of nonlinearities, this yields fully endogenous cycles.
Consider the following example:

\[ y_t = f(y_{t-1}) + a_2 z_{t-1} \]  \hspace{1cm} (7)  
\[ z_t = b_1 y_{t-1} + b_2 z_{t-1}, \]  \hspace{1cm} (8)  

where \( f'(y^*) \in (0, 1), \) \( f''(y^*) > 0, \) \( f'''(y^*) << 0. \)

A function that meets these criteria is the logistic function:

\[ f(y_{t-1}) = a_1 \frac{1}{e^{-y_{t-1}}}. \]
Logistic function: $\frac{1}{e^{-y_{t-1}}}$

- S-shaped
- bounded
Limit cycles IV

- the S-shaped function will generate very strong feedback from $y_{t-1}$ on $y_t$ for average values of $y_{t-1}$
- this makes the system unstable close to the equilibrium (which is the average)
- but for very large or very low values of $y_{t-1}$, the feedback becomes weak
- therefore, the system becomes stable far away from the equilibrium
- together with an interaction mechanism, this can set the system in permanent motion:
  - close to the equilibrium, it gets pushed away
  - then the destabilising forces gradually become weaker
  - the second variable will eventually pull it back
Example: Limit cycle

\[ a_1 = 4, \quad a_2 = -0.8 \]
\[ b_1 = 0.5, \quad b_2 = 0.8 \]
\[ a_2 \cdot b_1 < 0 \]

→ shock-independent fluctuations: fully endogenous cycle
Appendix II: Empirical evidence for endogenous cycles
Can the existence of endogenous cycles be proven?

- the short answer is no
- but we can check whether it’s consistent with the data
- a common argument against endogenous cycles is that many macroeconomic time series are very irregular
- but if we combine an endogenous cycle model with (autocorrelated) shocks, we also get fairly random series
- let’s compare this with some de-trended series for the UK
Stochastic limit cycle

This is the same system as above, but with AR(1) error terms $u_t$ added to each equation: $u_t = 0.8u_{t-1} + \epsilon_t$, where $\epsilon_t \sim N(0, 1)$. 

$a_1 = 4, a_2 = -0.8$

$b_1 = 0.5, b_2 = 0.8$
UK GDP and corporate debt, cyclical components

Note: Cyclical components are the residual from the regression

\[ x_{t+8} = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \beta_3 x_{t-2} + \beta_4 x_{t-3} + \nu_{t+8} \] (see Hamilton 2018, Rev Ec & Stat).
Finding periodic cycles in the data

- if GDP and corporate debt were driven by a Minskyan endogenous cycle mechanism + shocks, we would expect to find *some* regularity in the data
- a time series tool that allows to detect periodic cycles are *spectral density functions* (SDFs)
- an SDF shows how much of the variance in a time series is due to periodic frequencies
- peaks in a SDF suggest there is a dominant periodic cycle
- by contrast, if the SDF has no peak, fluctuations are irregular
Stochastic limit cycle vs stochastic fluctuations

- First simulated series has cycle mechanism $a_2b_1 < 0$, second doesn't.
- Can the SDF detect the difference?
Limit cycle vs stochastic fluctuations: SDFs

Note: Parametrically estimated spectral density functions from ARMA model.

- It can!
- How does it look with real data for GDP and corporate debt?
SDFs of UK GDP and corporate debt

- GDP and corporate debt exhibit regular cycles of 9 1/2 and 11 1/2 years length
- this is consistent with endogenous cycles