Post-Keynesian Endogenous Business Cycle Models

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(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 extraneous factors, e.g.
  - technological innovation
  - monetary policy
  - wars, environmental factors, natural disasters (COVID-19?)
- the business ‘cycle’ represents the adjustment of the economy to those 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
Explanation II: Endogenous cycle mechanisms

- in this view, fluctuations are driven by factors that are endogenous to capitalist economies, e.g.
  - explosive multiplier effects contained by supply constraints (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 further source of fluctuations
- but even without shocks, the economy would fluctuate
- → this is the post-Keynesian take on business cycles
## Why does this matter?

How we conceptualise business cycles has important implications:

<table>
<thead>
<tr>
<th>Vision of capitalism</th>
<th>Exogenous shocks</th>
<th>Endogenous cycle mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>intrinsically stable system distorted by external influences</td>
<td>Unstable system that leads to crises</td>
</tr>
<tr>
<td>Explaining busts</td>
<td>identify relevant shock + friction</td>
<td>identify source of unsustainable prior boom</td>
</tr>
<tr>
<td>Policy implication</td>
<td>leave economy alone, deregulate</td>
<td>take political control over source of instability</td>
</tr>
</tbody>
</table>
### Outline

1. **Introduction**

2. **Modelling business cycles**
   - Type 1: Non-oscillatory adjustment
   - Type 2: Oscillatory adjustment
   - Type 3: Limit cycles

3. **Post-Keynesian models**
   - Kaldor
   - Minsky

4. **Evidence**

5. **Summary**
Modelling business cycles

Exogenous shocks
- Type 1: Non-oscillatory adjustment

Endogenous cycles
- Type 2: Oscillatory adjustment
- Type 3: Limit cycle

Post-Keynesian models

Evidence

Summary
A simple framework

Two macroeconomic variables \((y_t)\) and \((z_t)\) interact with each other over time:

\[
y_t = f(y_{t-1}, z_{t-1}) \tag{1}
\]
\[
z_t = g(y_{t-1}, z_{t-1}) \tag{2}
\]

Jacobian matrix =

\[
\begin{bmatrix}
\frac{dy_t}{dy_{t-1}} & \frac{dy_t}{dz_{t-1}} \\
\frac{dz_t}{dy_{t-1}} & \frac{dz_t}{dz_{t-1}}
\end{bmatrix} \tag{3}
\]
Type 1: Exogenous shocks and non-oscillatory adjustment

Suppose (1)-(2) is a linear system:

\begin{align*}
y_t &= a_1 y_{t-1} + a_2 z_{t-1} \quad (4) \\
z_t &= b_1 y_{t-1} + b_2 z_{t-1} \quad (5)
\end{align*}

\[ J = \begin{bmatrix} a_1 & a_2 \\ b_1 & b_2 \end{bmatrix} \quad (6) \]
Type 1: Shocks and non-oscillatory adjustment

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

- suppose the interaction between \( y_t \) and \( z_t \) is such that \( a_2 \cdot b_1 \geq 0 \)
  - either there is no interaction: \( a_2 \cdot b_1 = 0 \)
  - or the interaction goes in the same direction:
    \( z_{t-1} \) pushes up (down) \( y_t \) and \( y_{t-1} \) pushes up (down) \( z_t \)
    \( (a_2, b_1 > 0; a_2, b_1 < 0) \)

- what kind of dynamics emerge from this configuration?
Example: Shock to $y_0$ and non-oscillatory adjustment

\[ y(t) \quad z(t) \]

- $a_1 = 0.6$, $a_2 = 0.1$
- $b_1 = 0.2$, $b_2 = 0.7$
- $a_2 * b_1 > 0$

→ no genuine cycles, only fluctuations: ‘cycle’ driven by exogenous shocks
Type 2: Exogenous shocks and oscillatory adjustment

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

- Suppose next that the interaction between \( y_t \) and \( z_t \) is \( a_2 \cdot b_1 < 0 \)

- This interaction has opposite signs: \( y_{t-1} \) drives up \( z_t \), but \( z_{t-1} \) drags down \( y_t \) (or vice versa) \( (a_2 > 0 \land b_1 < 0; \ a_2 < 0 \land b_1 > 0) \)

- In addition, the interaction needs to be sufficiently strong \( (|a_2 b_1| > \frac{(a_1-b_2)^2}{4}) \)

- What kind of dynamics emerge from this configuration?
Example: Shock to $y_0$ and oscillatory adjustment

→ genuine cycles that converge to the equilibrium (‘damped oscillations’): (almost) endogenous cycle
Interim discussion

- the nature of fluctuations critically depends on the interaction between the two variables (same or opposite direction?)

- from the perspective of exogenous business cycle theory, oscillations are uninteresting

- exogenous business cycle theory focuses on type-1 fluctuations

- from the perspective of endogenous business cycle theory, oscillations are crucial

- these models thus exhibit *cyclical interaction mechanisms* that yield type-2 fluctuations: $a_2 b_1 < 0$

- however, both types of fluctuations ultimately depend on shocks

- even type-2 cycles are not fully endogenous
Type 3: Limit cycles

- 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 give us so-called limit cycles
Type 3: Limit cycles

Let’s go back to the generic system

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

Now suppose at least one of the functions \( f() \) and \( g() \) 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.
Type 3: Limit cycles

Consider the following example:

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

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: \( \frac{1}{e^{-yt-1}} \)
Type 3: Limit cycles

- 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

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

→ shock-independent fluctuations: fully endogenous cycle
<table>
<thead>
<tr>
<th>Introduction</th>
<th>Modelling business cycles</th>
<th>Post-Keynesian models</th>
<th>Evidence</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(3) Post-Keynesian business cycle models: Kaldor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Kaldor (1940): explosive goods market with supply constraints

- What if multiplier-accelerator effects are strong enough to make the economy unstable? Can this lead to cycles?
- an increase in aggregate income stimulates investment, which creates more income through the Keynesian multiplier effect
- if investment is very sensitive to income, this can render the goods market explosive
- 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
Kaldorian investment function
Kaldor: output-capital stock interaction

- investment translates into a growing capital stock
- a larger capital stock discourages further investment [why?]
- the two interacting variables are thus output \( Y_t \) and the capital stock \( K_t \)
- there is a cyclical interaction mechanism such that \( \frac{dK_t}{dY_{t-1}} > 0 \) and \( \frac{dY_t}{dK_{t-1}} < 0 \)
- Kaldor’s model thus gives rise to type-3 fluctuations: endogenous limit cycles
Kaldorian limit cycles

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

\[ Y(t) \quad K(t) \]
(3) Post-Keynesian business cycle models: Minsky
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 → local instability
- the economy gradually builds up more debt
- rising debt burdens eventually discourage spending
- agents begin to deleverage 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
  \( (\frac{dD_t}{dY_{t-1}}) > 0 \) and \( (\frac{dY_t}{dD_{t-1}}) < 0 \)
- together with local instability, this can produce endogenous limit cycles
Minskyan business & financial cycles

- **Boom with growing debt**
- **Overborrowing**
- **Contractionary deleveraging**
- **Return of optimism & recovery**

Diagram showing the timeline with key events:

- **Y(t)**
- **D(t)**
(4) 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 $a_2 b_1 < 0$, 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?
GDP and corporate debt exhibit regular cycles of 9 1/2 and 11 1/2 years length.

This is consistent with endogenous cycles.
(5) Summary
Summary I

- post-Keynesian theories highlight the endogenous nature of boom-bust cycles
- cycles are driven by interaction mechanisms where variables act upon each other in opposite directions
- combined with nonlinearities, this can create cycles that are independent of shocks
- Kaldorian approaches suggest cyclical interactions between output and capital
- Minskyan approaches consider interactions between output and private debt
Policy implications

- the post-Keynesian view contrasts with mainstream theories in which fluctuations are due to exogenous shocks
- in the mainstream view, fluctuations are either unavoidable or due to frictions that prevent a more efficient adjustment → policy implication: leave economy alone or deregulate
- in the post-Keynesian view, fluctuations are inherent to capitalism but inefficient → policy implication: take control over (parts) of investment and regulate finance!
Appendix
UK GDP and corporate debt, unfiltered

Data sources: BIS, FRED.