Post-Keynesian Endogenous Business Cycle Models

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(1) Introduction

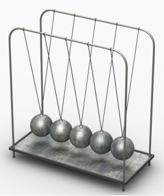
Why booms and busts?

- 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.

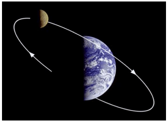
Explanation I: Exogenous shocks



- 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

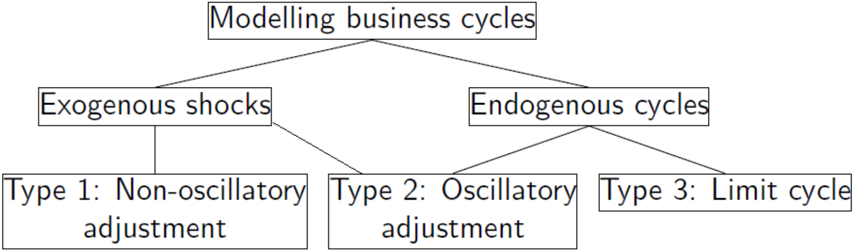
→ this is the post-Keynesian take on business cycles

Why does this matter?

How we conceptualise business cycles has important implications:

	Exogenous shocks	**Endogenous cycle mechanisms**
Vision of capitalism	intrinsically stable system distorted by external influences	Unstable system that leads to crises
Explaining busts	identify relevant shock + friction	identify source of unsustainable prior boom
Policy implication	leave economy alone, deregulate	take political control over source of instability

Outline


Modelling business cycles
Exogenous shocks
Endogenous cycles
Type 1: Non-oscillatory adjustment
Type 2: Oscillatory adjustment
Type 3: Limit cycle

A simple framework

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

$$y_t = f(y_{t-1}, z_{t-1}) \tag{1}$$

$$z_t = g(y_{t-1}, z_{t-1}) \tag{2}$$

$$\text{Jacobian matrix} = \begin{bmatrix} \frac{dy_t}{dy_{t-1}} & \frac{dy_t}{dz_{t-1}} \\ \frac{dz_t}{dy_{t-1}} & \frac{dz_t}{dz_{t-1}} \end{bmatrix} \tag{3}$$

Type 1: Exogenous shocks and non-oscillatory adjustment

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

$$y_t = a_1 y_{t-1} + a_2 z_{t-1} \tag{4}$$

$$z_t = b_1 y_{t-1} + b_2 z_{t-1} \tag{5}$$

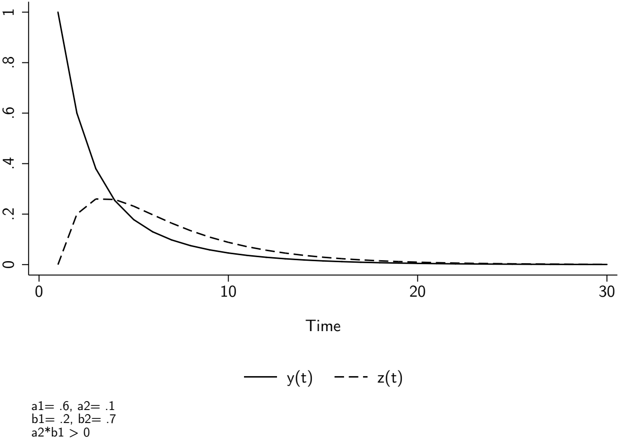
$$J = \begin{bmatrix} a_1 & a_2 \\ b_1 & b_2 \end{bmatrix} \tag{6}$$

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



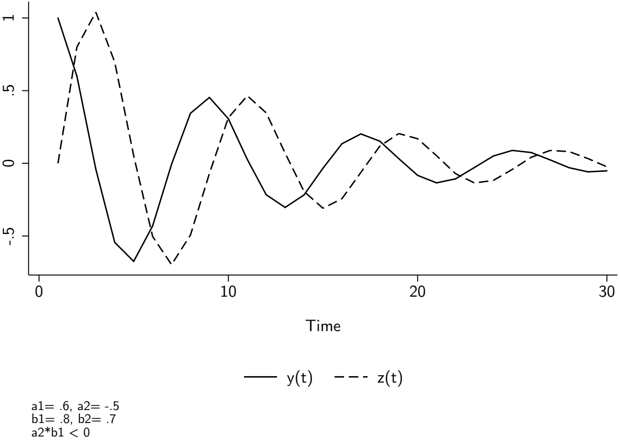
→ no genuine cycles, only fluctuations: ‘cycle’ driven by exogenous shocks

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) ($a_2 > 0$ & $b_1 < 0$; $a_2 < 0$ & $b_1 > 0$)
- 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 $(\frac{dy_t}{dz_{t-1}})(\frac{dz_t}{dy_{t-1}}) < 0$.

For certain kind of nonlinearities, this yields fully endogenous cycles.

Type 3: Limit cycles

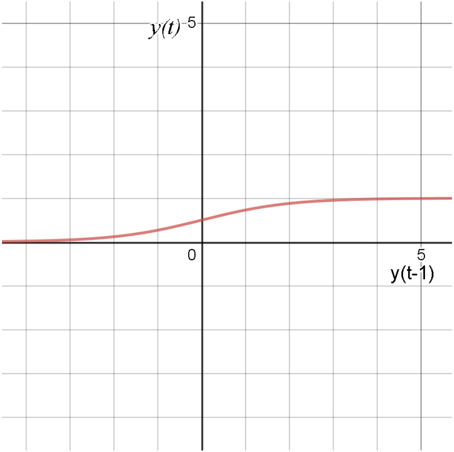
Consider the following example:

$$y_t = f(y_{t-1}) + a_2 z_{t-1} \tag{7}$$
$$z_t = b_1 y_{t-1} + b_2 z_{t-1}, \tag{8}$$

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: $\frac{1}{e^{-y_{t-1}}}$

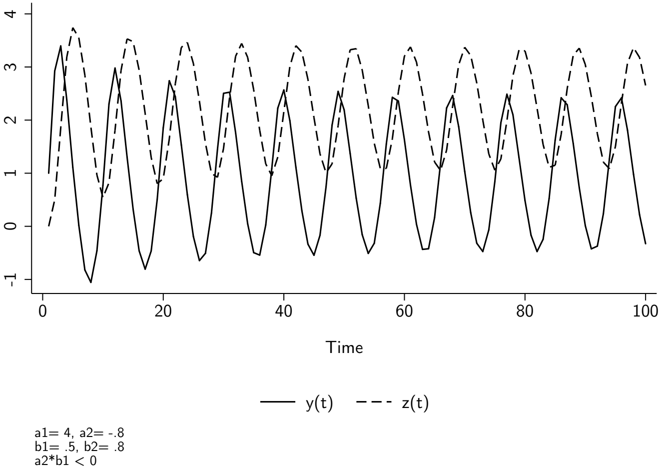


- S-shaped
- bounded

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



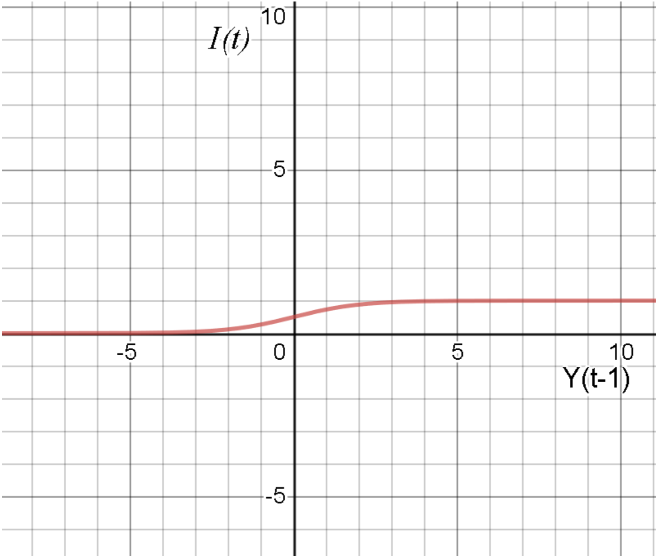
→ shock-independent fluctuations: fully endogenous cycle

(3) Post-Keynesian business cycle models: Kaldor

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

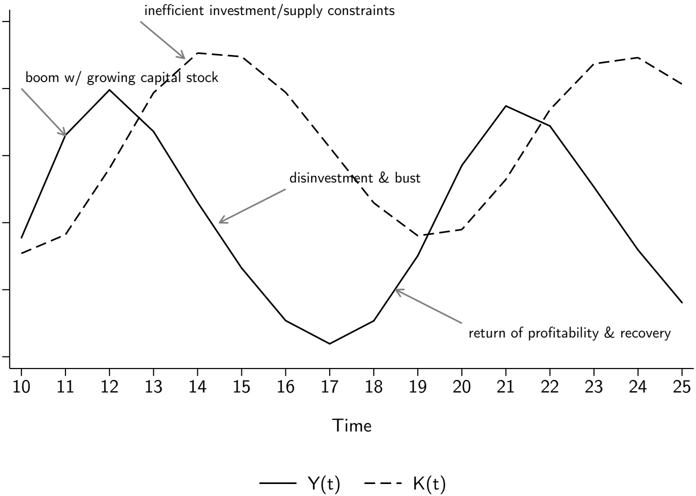
Kaldorian investment function



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



(3) Post-Keynesian business cycle models: Minsky

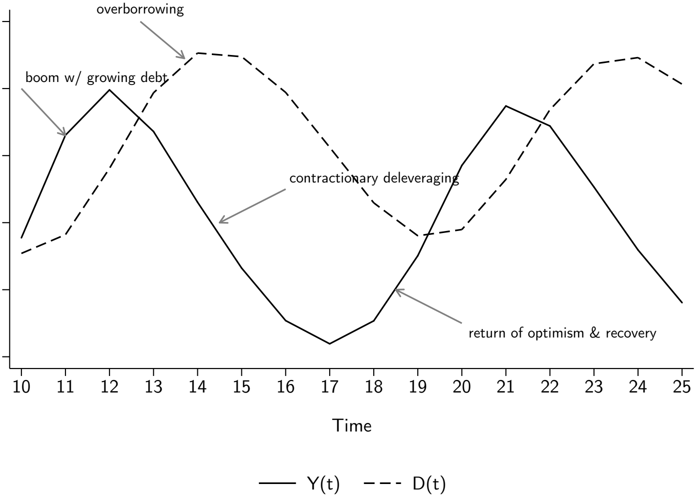
Minsky: stability breeds instability

- 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 $\rightarrow$ 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

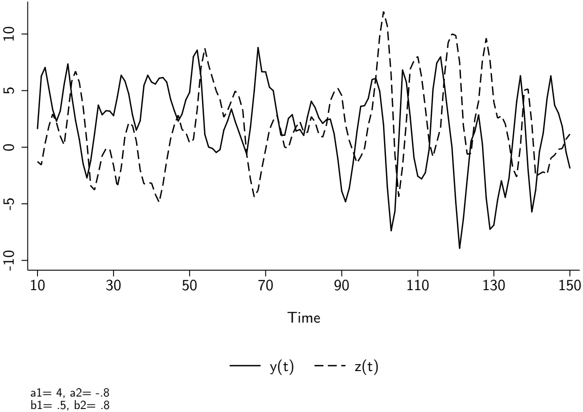


(4) Empirical evidence for endogenous cycles

Can the existence of endogenous cycles be proven?

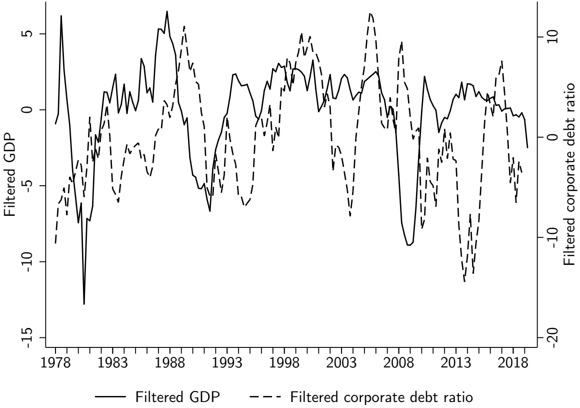
- the short answer is no
- but we can check whether it's consistent with the data
- a common argument against endogenous cycles is that many macroeconomic time series are very irregular
- but if we combine an endogenous cycle model with (autocorrelated) shocks, we also get fairly random series
- let's 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 $\epsilon_t \sim N(0, 1)$.

UK GDP and corporate debt, cyclical components



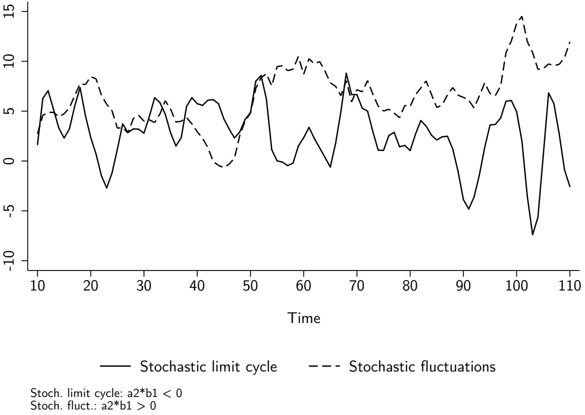
Note: Cyclical components are the residual from the regression

$x_{t+8} = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \beta_3 x_{t-2} + \beta_4 x_{t-3} + \nu_{t+8}$ (see Hamilton 2018, *Rev Ec & Stat*).

Finding periodic cycles in the data

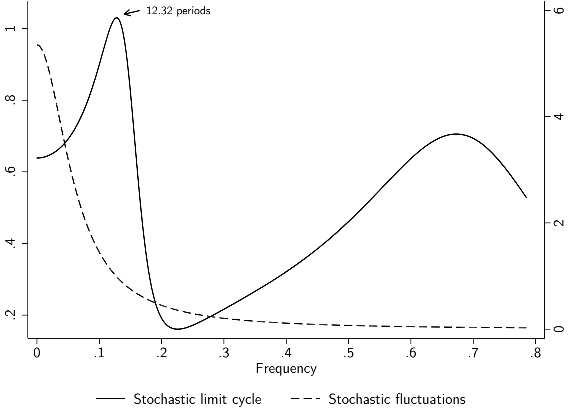
- if GDP and corporate debt were driven by a Minskyan endogenous cycle mechanism + shocks, we would expect to find *some* regularity in the data
- a time series tool that allows to detect periodic cycles are *spectral density functions* (SDFs)
- an SDF shows how much of the variance in a time series 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?

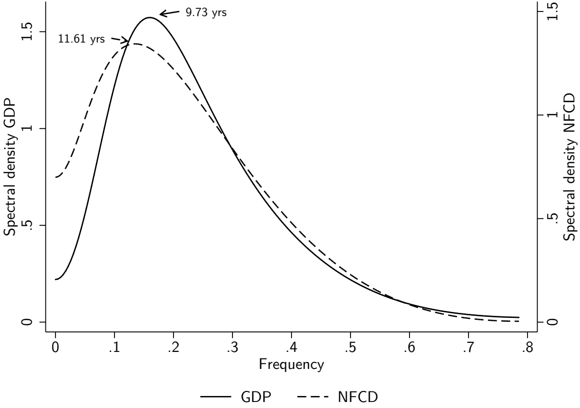
Limit cycle vs stochastic fluctuations: SDFs



Note: Parametrically estimated spectral density functions from ARMA model.

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

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

(5) Summary

Summary I

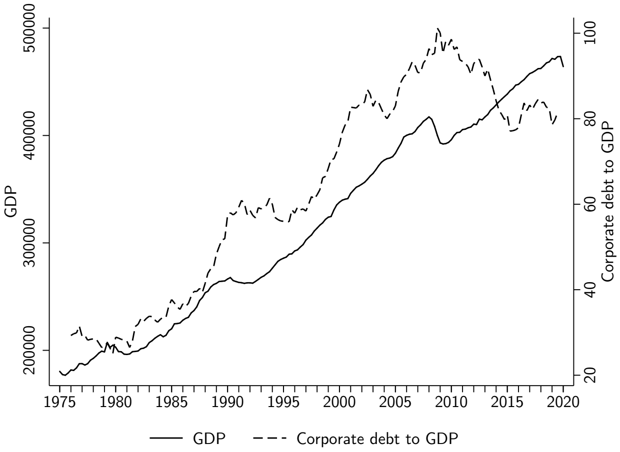
- post-Keynesian theories highlight the endogenous nature of boom-bust cycles
- cycles are driven by interaction mechanisms where variables act upon each other in opposite directions
- combined with nonlinearities, this can create cycles that are independent of shocks
- Kaldorian approaches suggest cyclical 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
  $\rightarrow$ policy implication: leave economy alone or deregulate
- in the post-Keynesian view, fluctuations are inherent to capitalism but inefficient
  $\rightarrow$ policy implication: take control over (parts) of investment and regulate finance!

Appendix

UK GDP and corporate debt, unfiltered



Data sources: BIS, FRED.