Post-Keynesian Endogenous Business Cycle Models

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Outline

(1) Introduction

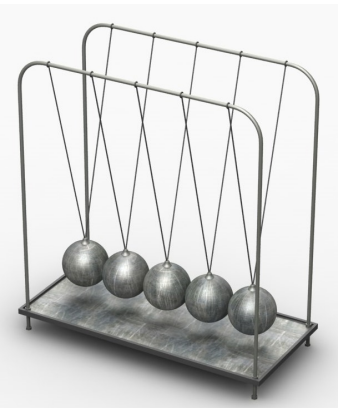
Why booms and busts?

- 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.

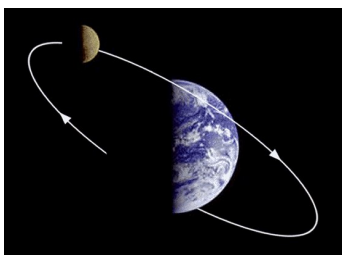
Explanation I: Exogenous shocks



- 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

$\rightarrow$ 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.
  - 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

$\rightarrow$ 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 $\rightarrow$ 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

$$K_t = f(K_{t-1}, A_{t-1}) \tag{1}$$

$$A_t = g(A_{t-1}, \epsilon_t) \tag{2}$$

$$\text{Jacobian matrix} = \begin{bmatrix} \frac{dK_t}{dK_{t-1}} & \frac{dKt}{dA_{t-1}} \\ 0 & \frac{dA_t}{dA_{t-1}} \end{bmatrix} \tag{3}$$

Modelling real business cycles II

Linearised (deterministic) version:

$$K_t = a_1 K_{t-1} + a_2 A_{t-1} \tag{4}$$

$$A_t = b_1 K_{t-1} + b_2 A_{t-1}, \qquad b_1 = 0 \tag{5}$$

$$J = \begin{bmatrix} a_1 & a_2 \\ 0 & b_2 \end{bmatrix} \tag{6}$$

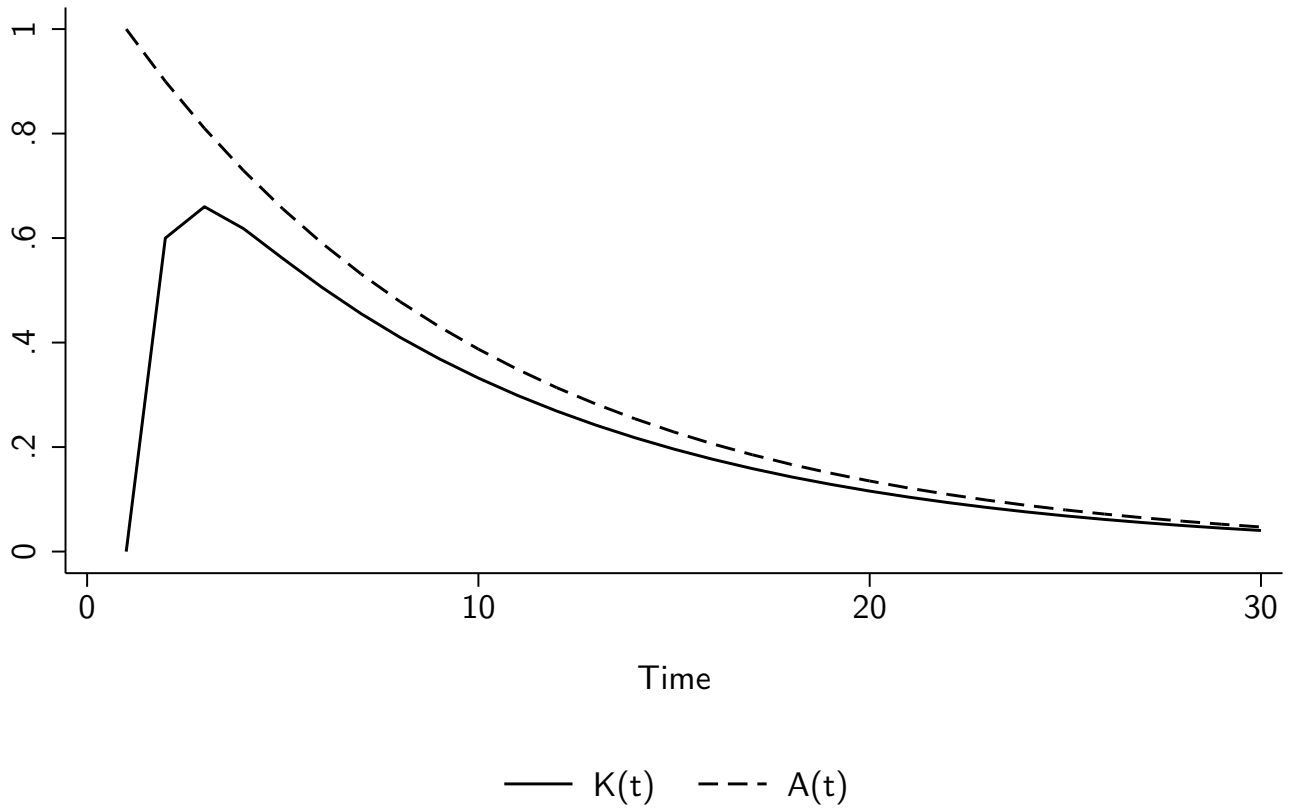
Shocks and fluctuations

$$K_t = a_1 K_{t-1} + a_2 A_{t-1}$$
$$A_t = b_1 K_{t-1} + b_2 A_{t-1}, \qquad b_1 = 0$$

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

- suppose there is a temporary increase in productivity ($\uparrow A_{t-1}$)
- 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



$a_1 = .2$, $a_2 = .6$
$b_1 = 0$, $b_2 = .9$
$a_2 * b_1 = 0$

$\rightarrow$ 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

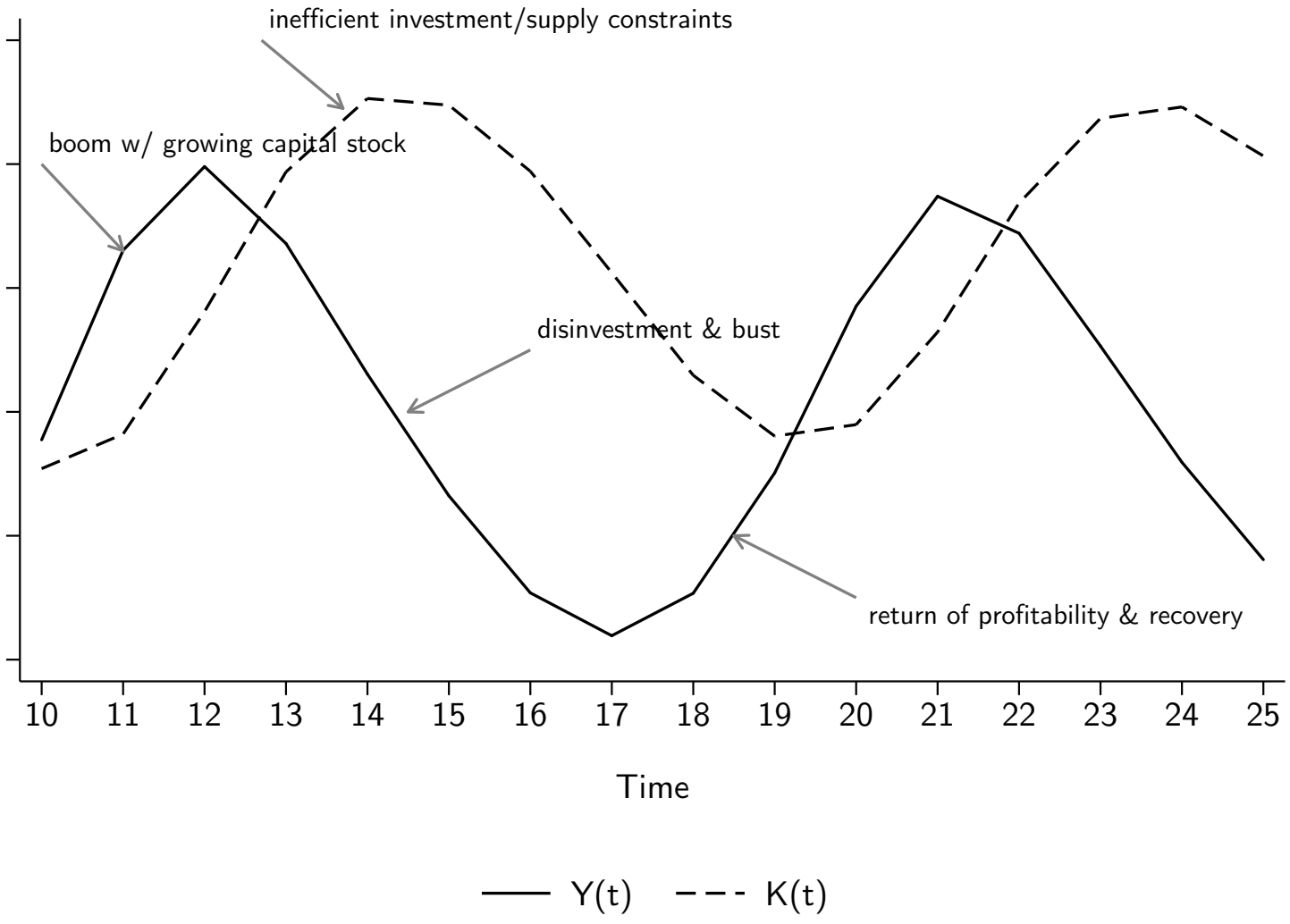
Kaldor (1940): firms tend to over-invest

- 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



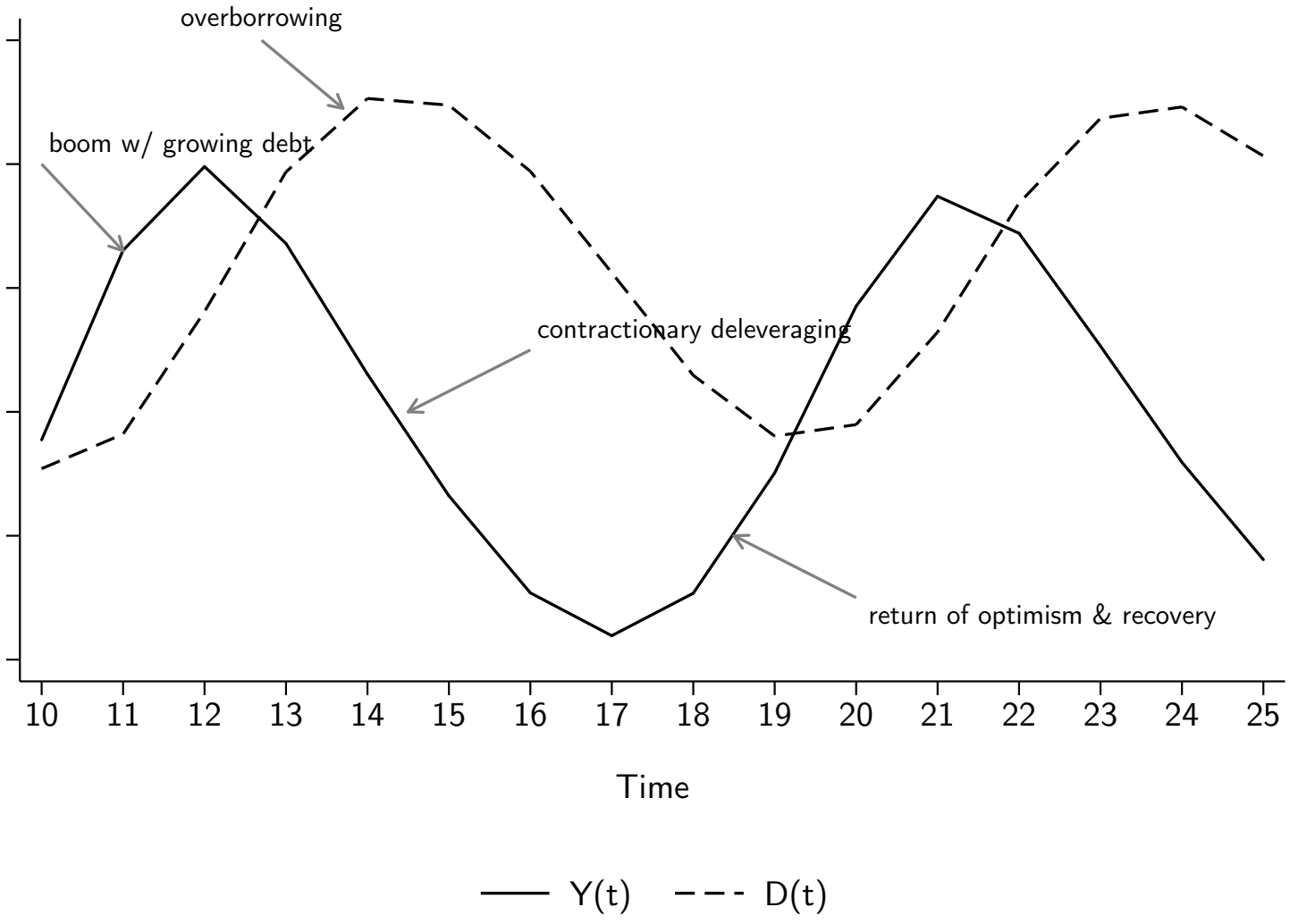
Minsky: stability breeds instability

- 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



Modelling endogenous business cycles

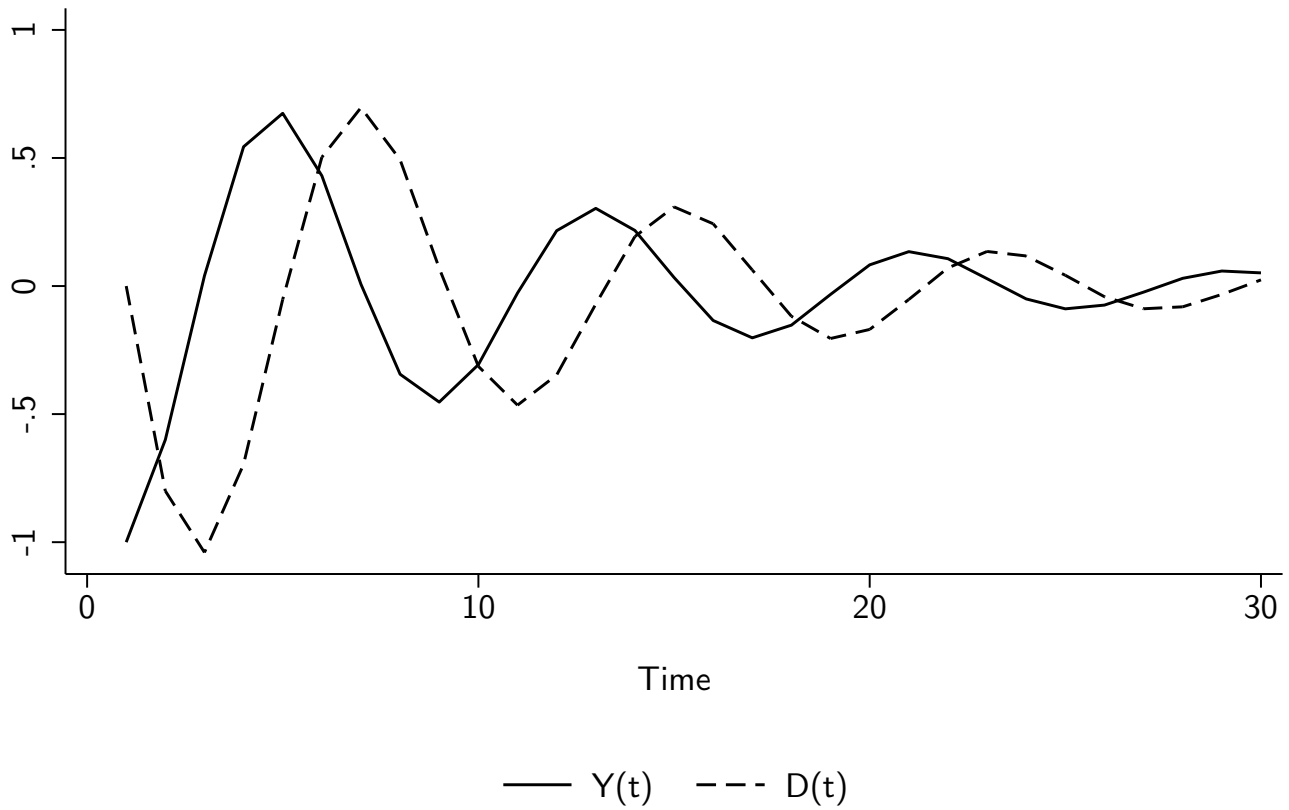
- endogenous cycle models critically depend on cyclical interaction mechanisms
- consider a simple Minsky model in output (Y_t) and debt (D_t)

$$Y_t = a_1 Y_{t-1} + a_2 D_{t-1}$$
$$D_t = b_1 Y_{t-1} + b_2 D_{t-1}$$

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

- 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: $|a_2 b_1| > \frac{(a_1 - b_2)^2}{4}$

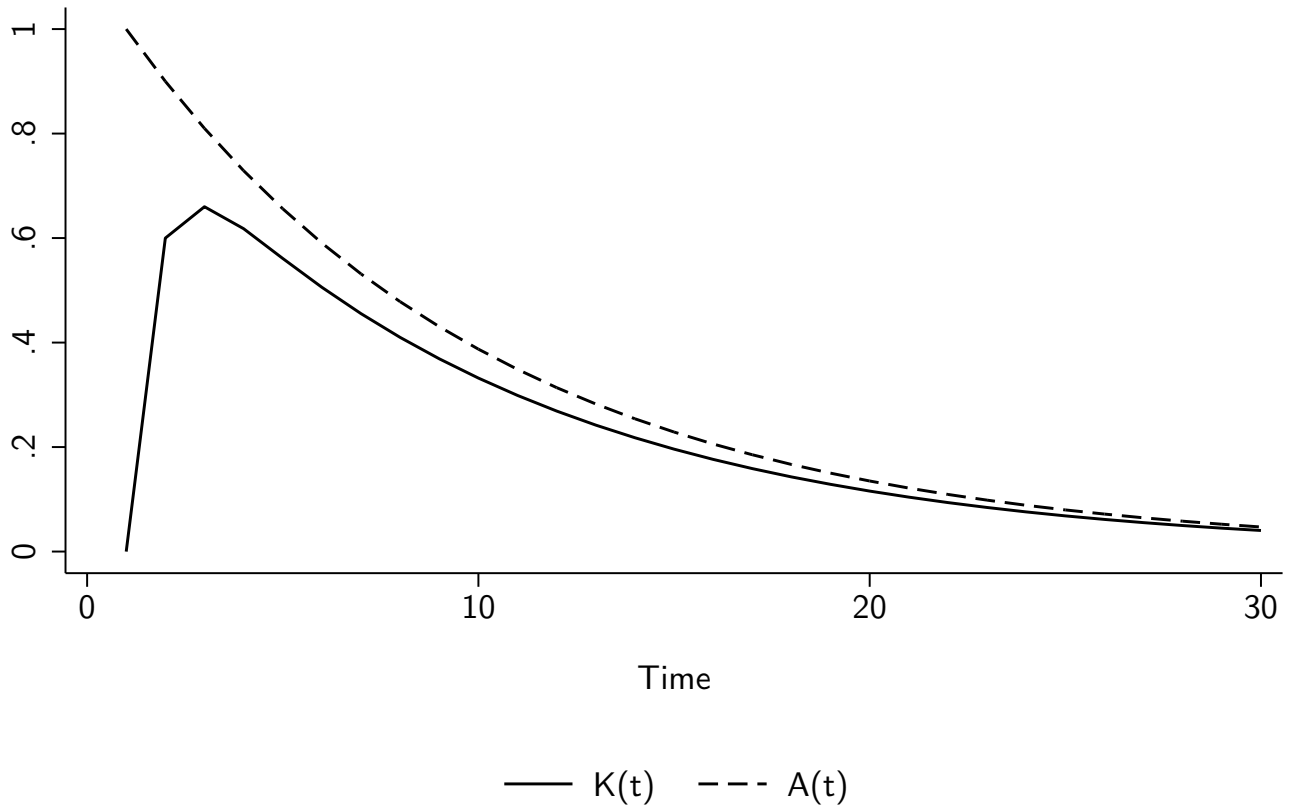
Example: Shock to Y_0 and cyclical adjustment



$a_1 = .6$, $a_2 = -.5$
$b_1 = .8$, $b_2 = .7$
$a_2 * b_1 < 0$

$\rightarrow$ genuine cycles and equilibrium over-shooting

Comparison with RBC model



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(4) Summary & conclusion

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:

	Exogenous shocks (mainstream)	**Endogenous cycles (PK)**
Vision of capitalism	intrinsically stable system; distorted only by external influences	unstable & inefficient system that leads to crises
Explaining busts	identify relevant shock + friction	identify source of prior boom
Policy implication	$\rightarrow$ leave economy alone, deregulate	$\rightarrow$ take political control over sources of instability (e.g. investment and finance)

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*

Limit cycles II

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 $(\frac{dy_t}{dz_{t-1}})(\frac{dz_t}{dy_{t-1}}) < 0$.

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

Limit cycles III

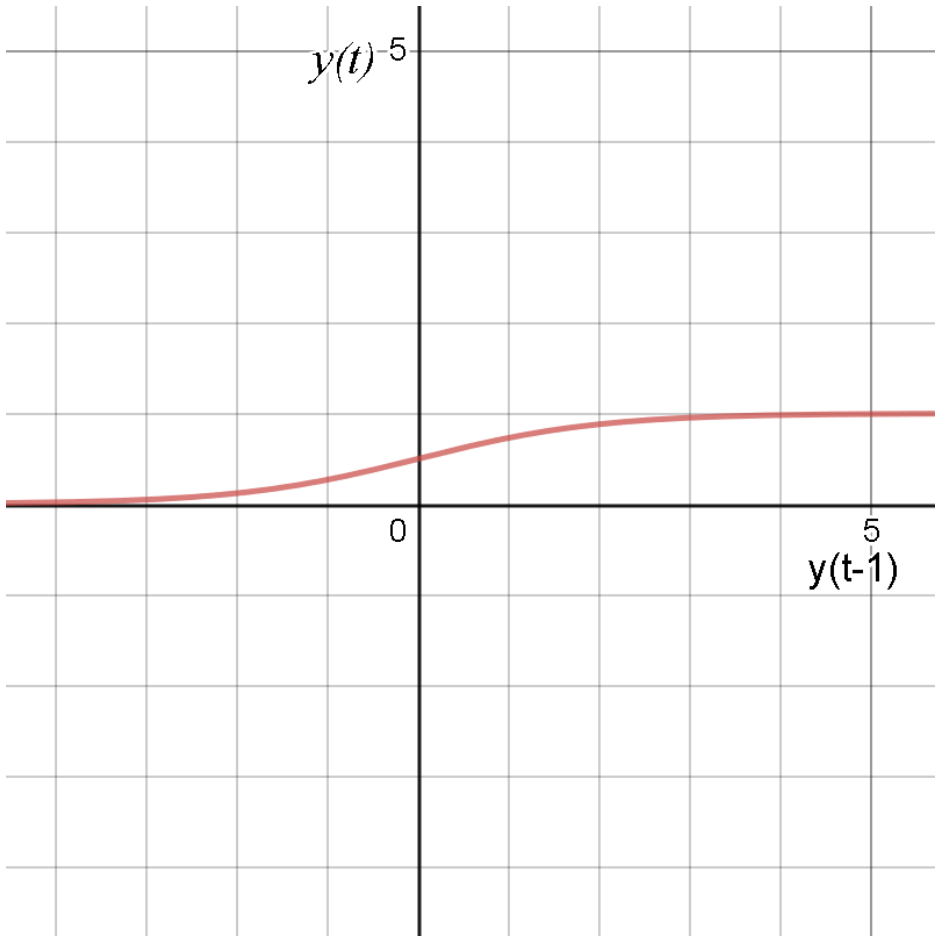
Consider the following example:

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

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

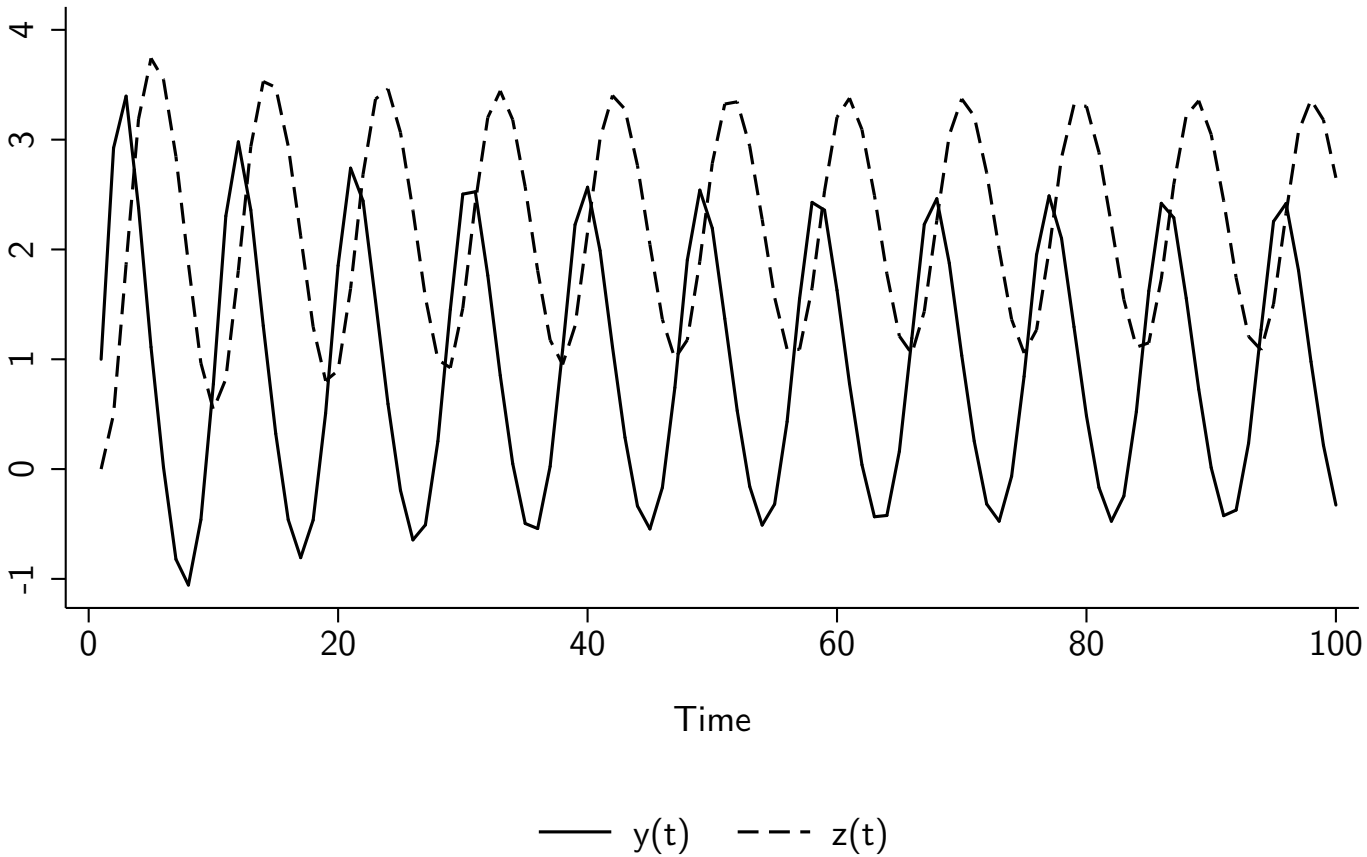


- S-shaped
- bounded

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



a1= 4, a2= -.8
b1= .5, b2= .8
a2*b1 < 0

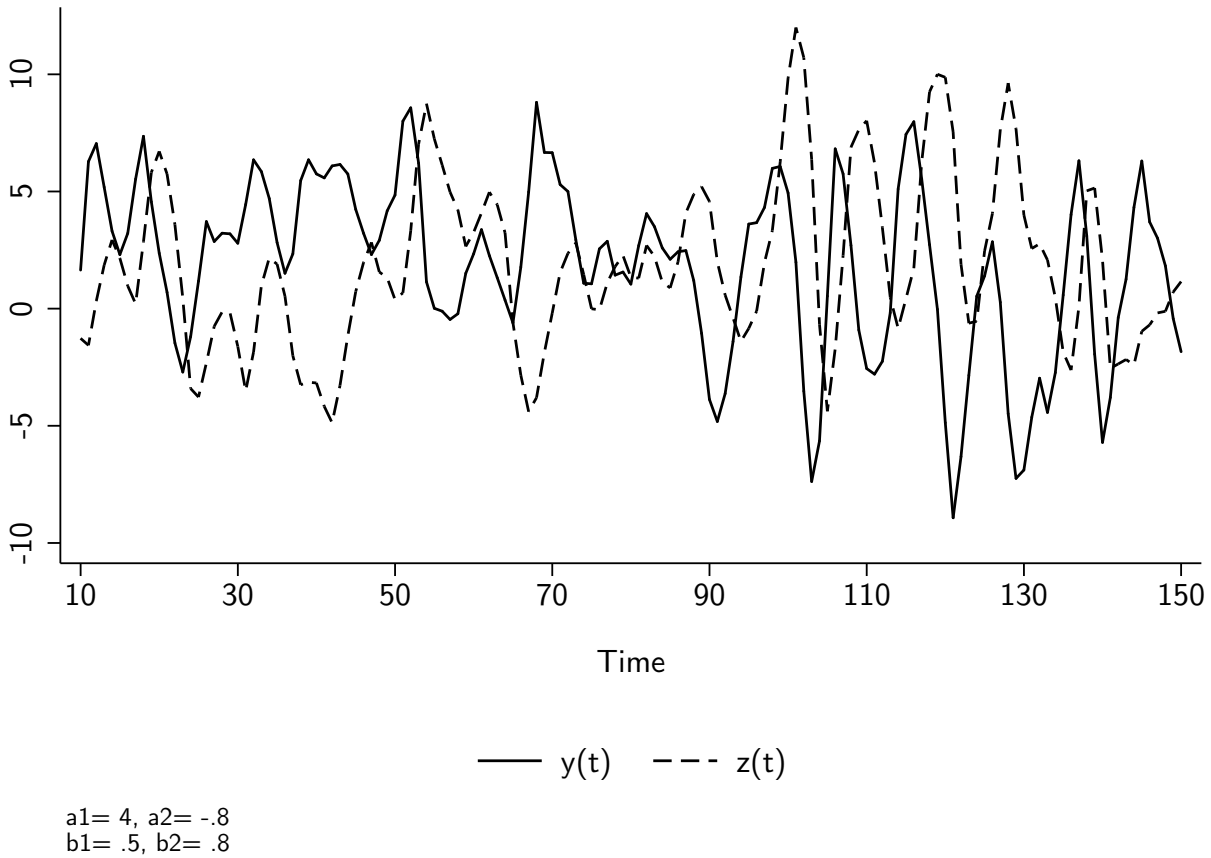
$\rightarrow$ shock-independent fluctuations: fully endogenous cycle

Appendix II: Empirical evidence for endogenous cycles

Can the existence of endogenous cycles be proven?

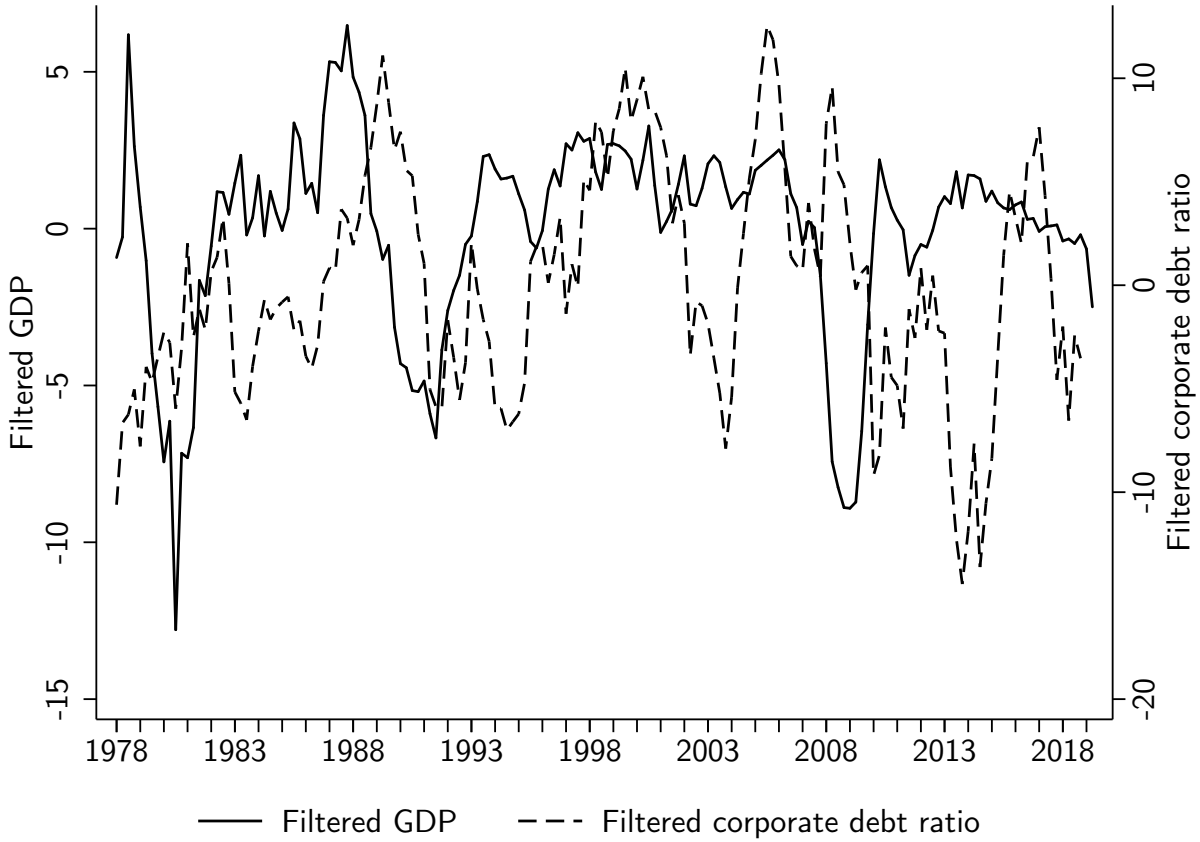
- the short answer is no
- but we can check whether it's consistent with the data
- a common argument against endogenous cycles is that many macroeconomic time series are very irregular
- but if we combine an endogenous cycle model with (autocorrelated) shocks, we also get fairly random series
- let's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

UK GDP and corporate debt, cyclical components



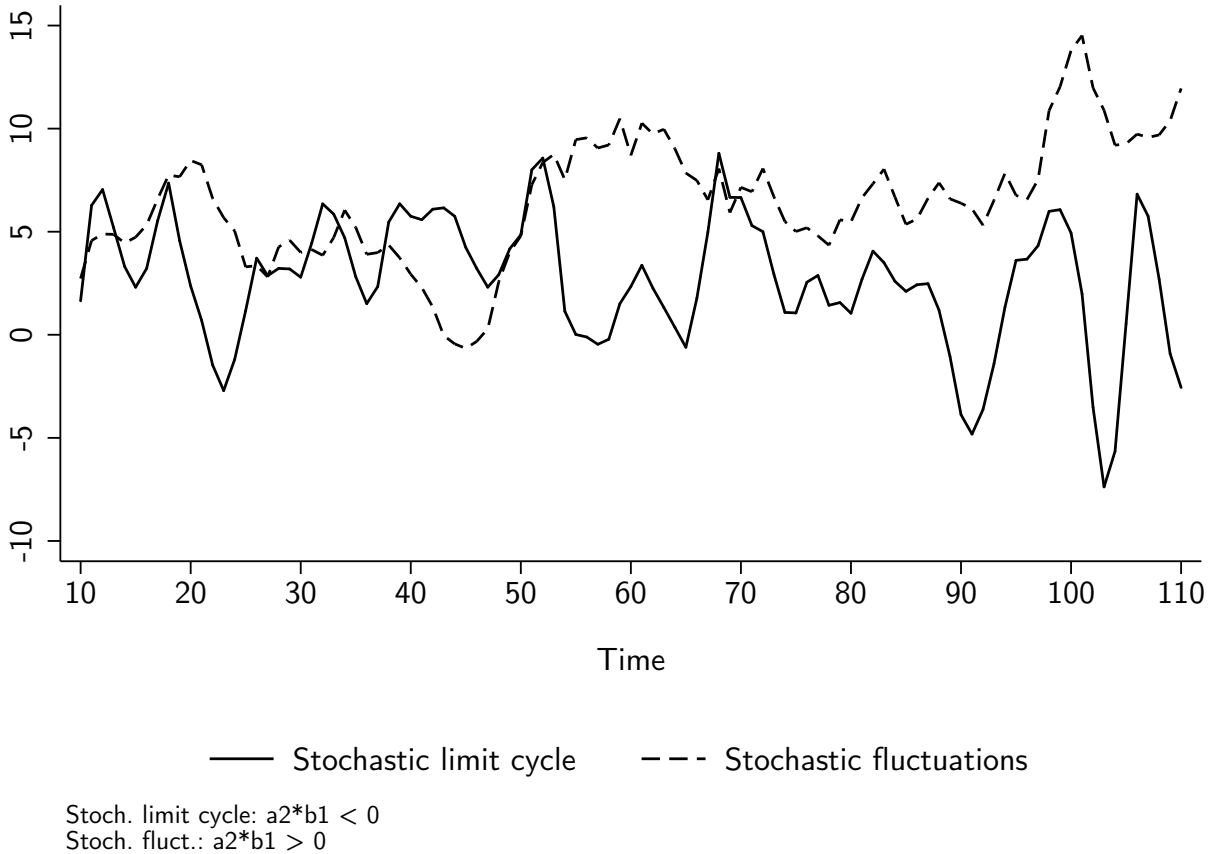
Note: Cyclical components are the residual from the regression

$x_{t+8} = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \beta_3 x_{t-2} + \beta_4 x_{t-3} + \nu_{t+8}$ (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

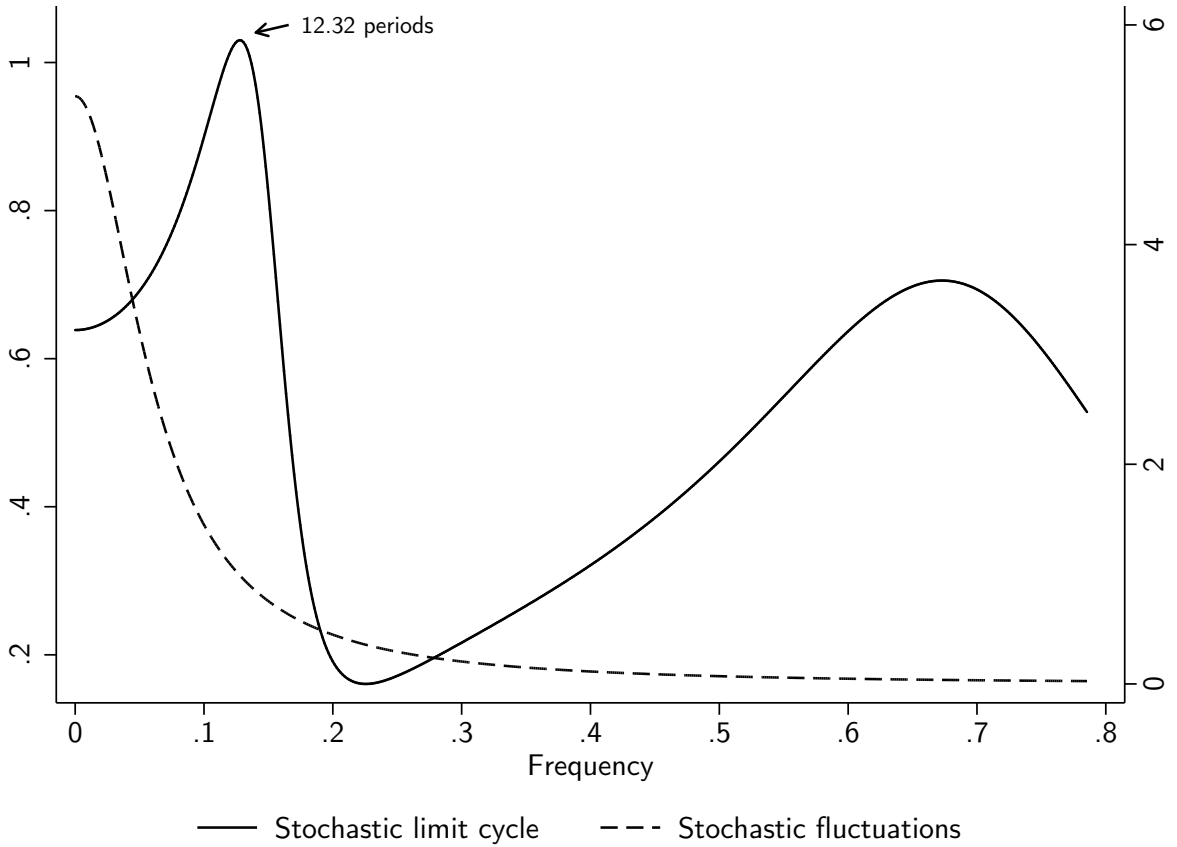
Stochastic limit cycle vs stochastic fluctuations



Stoch. limit cycle: a2*b1 < 0
Stoch. fluct.: a2*b1 > 0

- first simulated series has cycle mechanism $a_2 b_1 < 0$, second doesn't
- Can the SDF detect the difference?

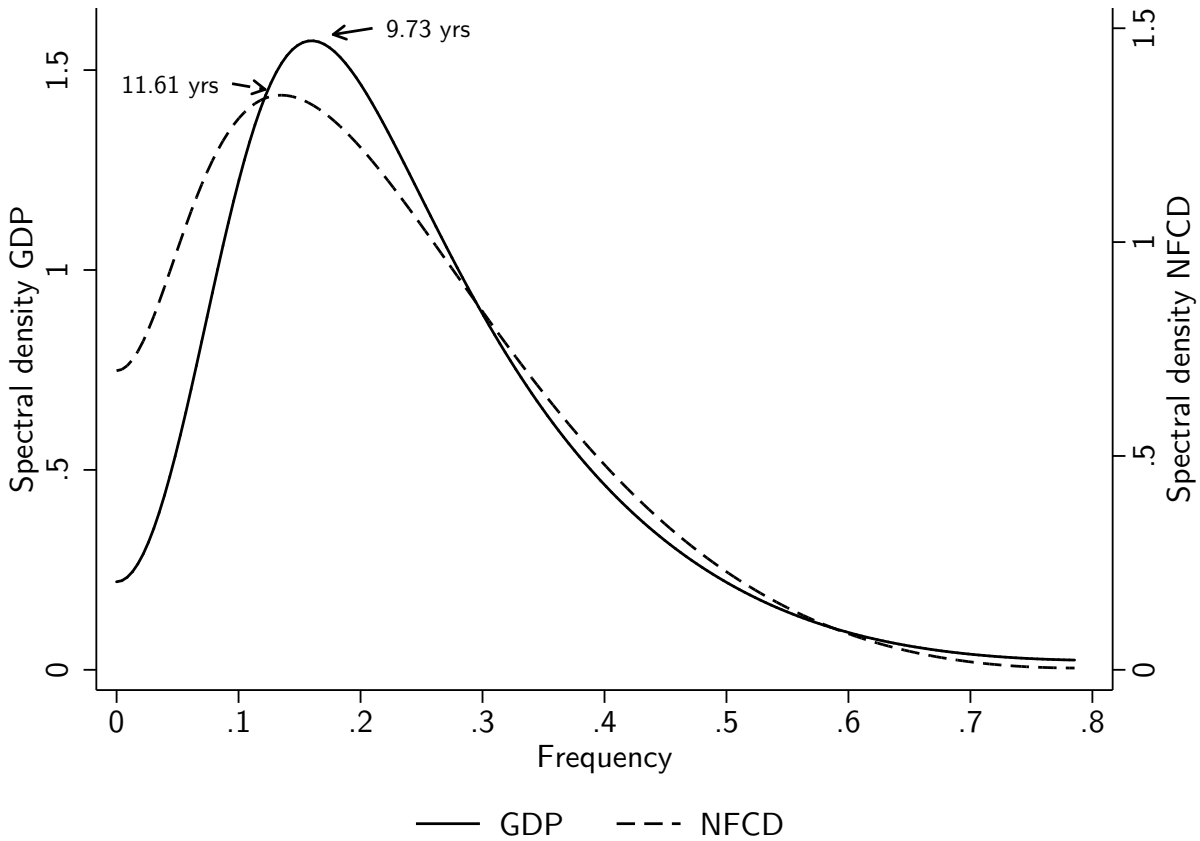
Limit cycle vs stochastic fluctuations: SDFs



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