Key empirical features of recessions and some thoughts on ABM approaches

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Overview

- Brief summary of mainstream theory
- Evidence on the key empirical features
- Some thoughts on ABM approaches

Dynamic stochastic general equilibrium (DSGE)

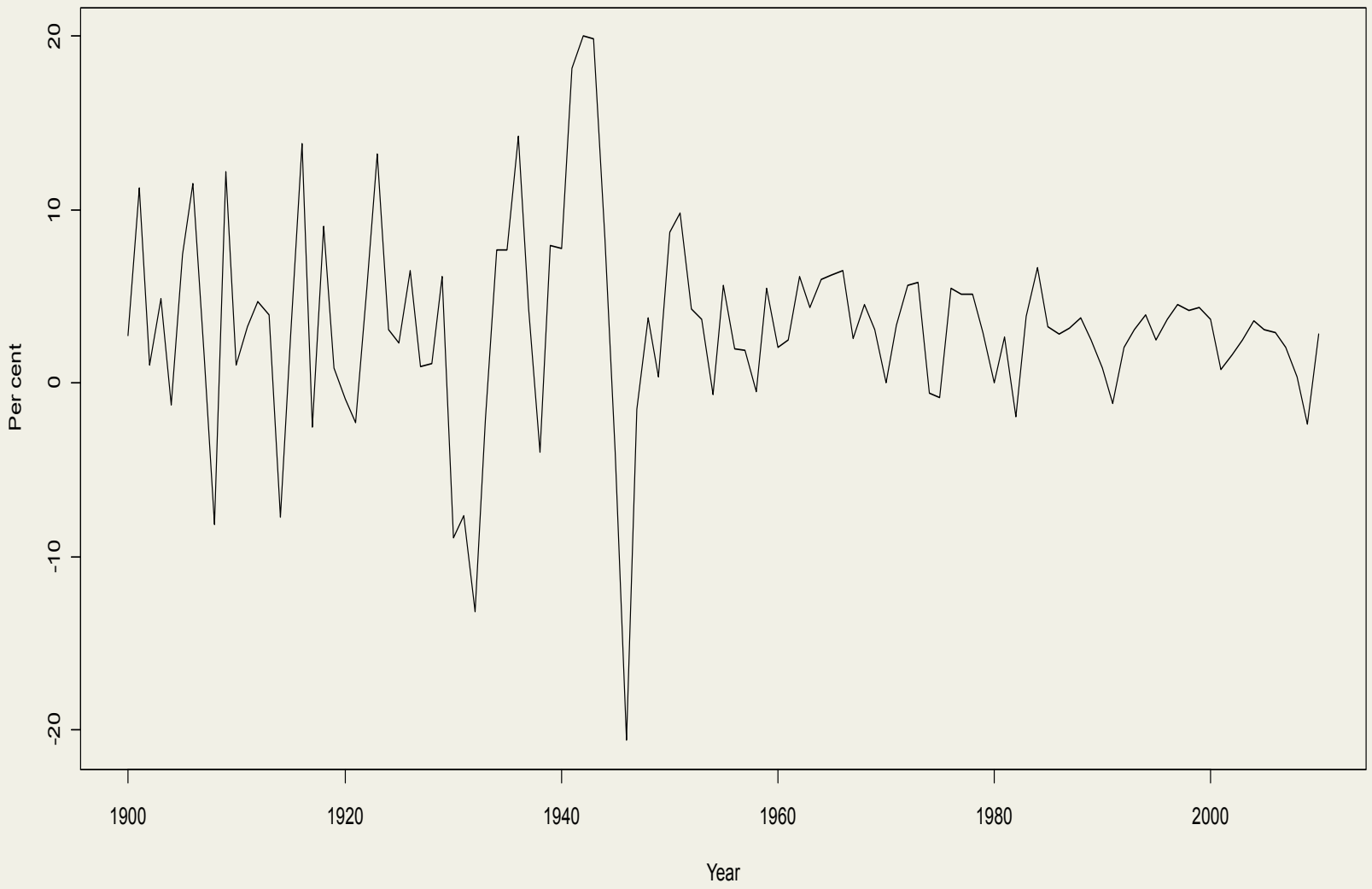
- Woodford, *Macroeconomics*, 2009; Tovar, *Bank for International Settlements*, 2008
- Oliver Blanchard, chief economist IMF, MIT Discussion Paper, **August 2008**, 'The State of Macro':
- **'**For a long while after the explosion of macroeconomics in the 1970s, the field looked like a battlefield. Over time however, largely because facts do not go away, a largely shared vision both of fluctuations and of methodology has emerged…… *The state of macro is good*'
- 'DSGE models have become ubiquitous. Dozens of teams of researchers are involved in their construction. Nearly every central bank has one, or wants to have one. '

DSGE (1)

- A single agent (the representative agent) represents the behaviour of the entire economy
- The agent maximises utility over time, choosing between consumption and leisure
- The agent has two decisions to make in every period
- how much of time to spend at work producing output (income) and how much to take in leisure
- how much of this output to allocate to investment, which will increase future levels of output, and how much to consume now

DSGE (2)

- A temporary reduction in productivity today encourages the agent to work less now than in the future, because it will earn relatively more per hour in the future than it does today
- It may work sufficiently less for it to seem as if is unemployed
- But according to DSGE, it is actually a rational agent maximising its expected lifetime utility by choosing to minimise its working hours
- The Great Depression of the 1930s as an 'extended voluntary holiday' Krugman
- DSGE models introduce some market imperfections, but the above is the core of the theory


Annual percentage change in real US GDP,1900-2010
Per cent
20
10
0
-10
-20
1900
1920
1940
1960
1980
2000
Year

Why is this a ‘cycle’?

- Positive cross-correlations in output growth of the different sectors over time (Lucas 1977)
- Also, low but positive first order autocorrelation, and zero at all other lags
- In the frequency domain, weak concentration of the power spectrum at 5-12 years

The data

- Annual data on GDP growth, 17 countries, 1871-2010
- Angus Maddison, *Monitoring the World Economy 1820-1992,* OECD, Paris, 1995
- Quarterly data only exist after World War Two, and in many countries not until the 1960s or 1970s
- Recession is defined as periods when GDP growth is < 0
- There are alternatives e.g. the period before GDP regains its previous peak level, but qualitatively the results are robust w.r.t. this
- P Ormerod, 'Risk, recessions and the resilience of the capitalist economies', *Risk Management*, 2010

How general is the experience?

- 17 countries. Is the distribution of the cumulative sizes of recessions in each country the same?
- 136 pair-wise Anderson-Darling tests of null hypothesis. Rejected at p = 0.05 only 11 times
- Implies pooled data is homogeneously distributed
- It suggests that there are features which are common to recessions across countries, so in principle a general theoretical model can explain recessions
- certain aspects of the statistical analysis of the data would become more problematic if the pooled data contained heterogeneity across countries

Empirical results overview

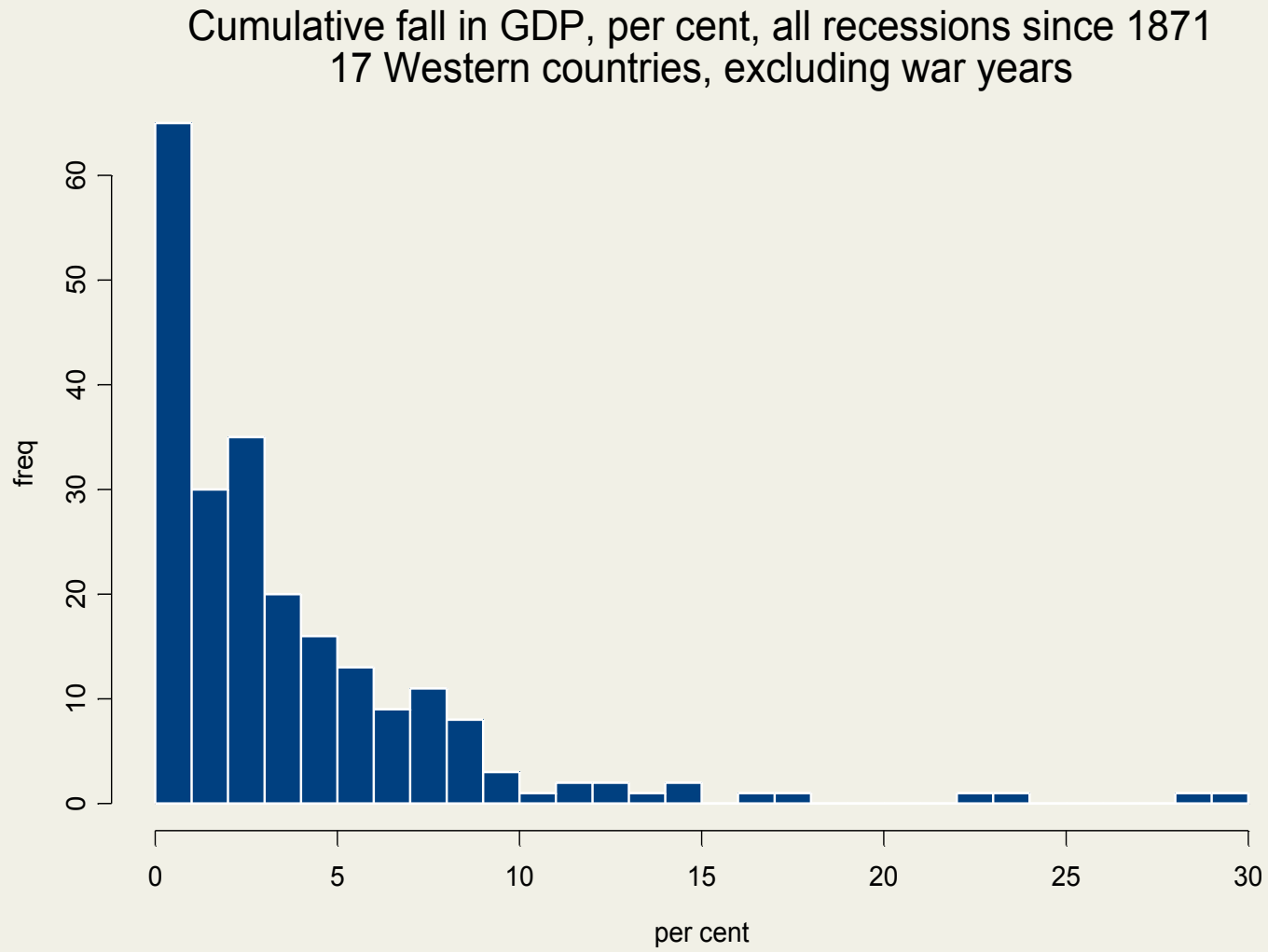
- Most recessions are very short – 70 per cent only last 1 year, 90 per cent no more than 2 years
- Capitalism is resilient – the recovery period is in general not dependent on the size of the recession
- The cumulative size of recessions has a very right-skew distribution
- The wait-time between recessions is also right-skewed
- Global recessions, when most countries are in recession, are comparatively rare
- Most recessions are *not* financial in origin
- Suggestions that financial recessions are rare and the Great Depression of the 1930s was unique

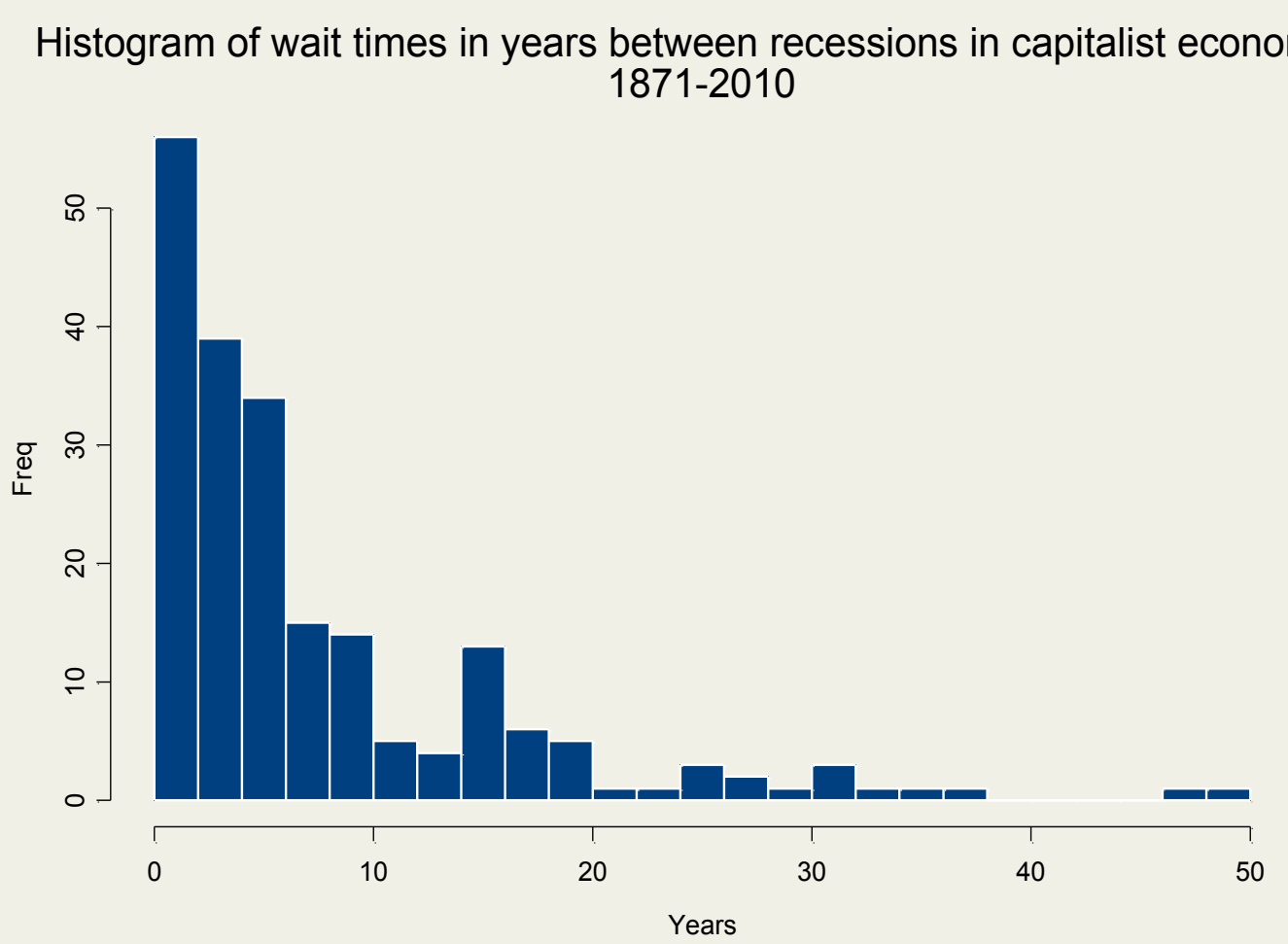
Duration of recessions i.e. number of consecutive years in which real GDP growth is less than zero

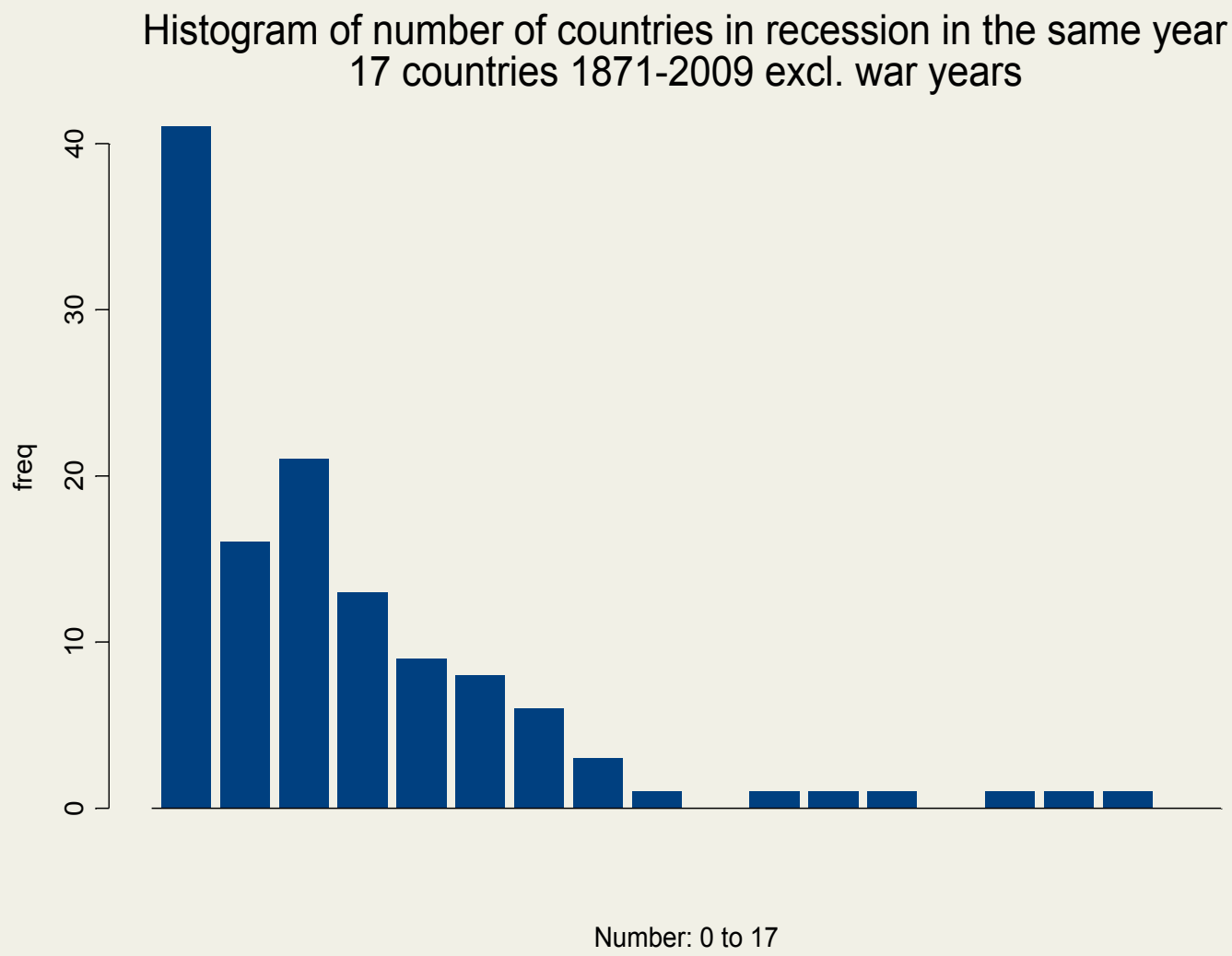
- Number which last 1 year 175
- 2 years 63
- 3 years 20
- 4 years 6
- 5 years 5
- 6 years 1
- 7 years 1
- These experiences span a wide range of policy attitudes and institutional frameworks

Duration and size of initial shock

- Percentage lasting 1 year is the same if we split the sample into initial shock < and > 1 per cent
- This is true for all shocks up to and including 6 per cent
- This accounts for more than 90 per cent of recessions


Cumulative fall in GDP, per cent, all recessions since 1871
17 Western countries, excluding war years
freq
0
10
20
30
40
50
60
0
5
10
15
20
25
30
per cent


Histogram of wait times in years between recessions in capitalist economies
1871-2010
Freq
0
10
20
30
40
50
0
10
20
30
40
50
Years


Histogram of number of countries in recession in the same year
17 countries 1871-2009 excl. war years
freq
0
10
20
30
40
Number: 0 to 17

Relations of production (1)

- The input-output matrix describes how much industry *i* supplies to all industries, including itself, and how much it buys from other industries
- It is an asymmetric square matrix, and in general its eigenvalues will have non-zero imaginary parts (Goodwin, 1949). This is a potential reason why the business cycle exists

Relations of production (2)

- The distribution of the connections between industries is highly non-Gaussian
- This another reason why it does not really make sense to model the economy with a 'representative' agent
- If an adverse event takes place in any given industry, the consequences will generally be quite different depending on the extent to which that industry is connected by the structure of production to the others
- The distributions are non-Gaussian but also non-scaling (Caiado and Ormerod, *Int. J. Complexity in Leadership and Management*, 2012 forthcoming)

A simple ‘animal spirits’ model of the cycle

- Ormerod, *Physica A*, 2002
- **This replicates key stylised facts about the cycle** e.g.

➢ Structure of autocorrelation function of GDP growth

➢ Power spectrum of growth

➢ Non-Gaussian distribution of both size and duration of recessions

➢ Positive cross-correlations in output growth across sectors

The model (1)

- Populated by firms, whose size is drawn from a power law distribution
- Firms decide their rate of growth of output, which is a function of simple extrapolation of their own recent growth, and their view of overall sentiment across firms
- This is compatible with Keynes' *General Theory*. One rule when capital stock is fixed, one when it can vary
- Similarly, sentiment ('animal spirits') depends on a the firm's sentiment in the previous period, and negatively on the overall rate of growth of output in the previous period (*General Theory*, chapter 22)

The model (2)

- $x_i(t) = \alpha x_i(t - 1) + (1 - \alpha)[Y(t - 1) + \varepsilon_i(t)]$
- $y_i(t) = \beta y_i(t - 1) - \beta[X(t - 1) + \eta_i(t)]$
- Output growth is ‘x’, sentiment ‘y’
- Lower case is a firm, upper case the weighted average
- The ‘error’ terms represent uncertainty and heterogeneity of expectations

The model (3)

- Agents operate under uncertainty and are heterogeneous
- The implications of any given level of overall sentiment for the growth rate of output of a firm differs both across the N agents and over time.
- Firms are uncertain about the precise implications of a given level of sentiment for the exact amount of output which they should produce.
- The variable Y is based upon an interpretation of a range of information which is in the public domain. Agents again differ at a point in time and over time in how they interpret this information and in consequence the value which they attach to Y.

The model (4)

- As the non-Gaussian distribution of firm size is reduced, oscillations, for any given set of parameters, become lower in amplitude
- They can always be increased by increasing the standard deviations of ε and η, but then the cross-correlations of output growth across agents approaches zero
- So the cycle arise from:

➢ uncertainty

➢ Heterogeneous expectations of firms

➢ The fact that firms operate at very different sizes

Conclusion

- Models of the business cycle should be compatible with the empirical evidence on recessions
- The structure of production is important i.e. the technological connections between firms, and the fact that firms operate on very different scales of output