Lecture 9
The Financial Crisis, Asset Bubbles

Macroeconomics EC2B1

Benjamin Moll

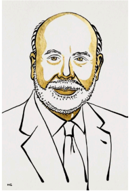
London School of Economics, Winter 2024

Plan

1. The 2008 financial crisis: some facts
2. Asset bubbles
3. Financial frictions and amplification

A Nobel Prize for Work on Financial Crises

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2022



Ill. Niklas Elmehed © Nobel Prize Outreach

Ben S. Bernanke

Prize share: 1/3

Ill. Niklas Elmehed © Nobel Prize Outreach

Douglas W. Diamond

Prize share: 1/3

Ill. Niklas Elmehed © Nobel Prize Outreach

Philip H. Dybvig

Prize share: 1/3

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2022 was awarded jointly to Ben S. Bernanke, Douglas W. Diamond and Philip H. Dybvig "for research on banks and financial crises"

Source: https://www.nobelprize.org/prizes/economic-sciences/2022/summary/

Readings

- Two supplements with derivations on moodle:
  - asset bubbles
  - financial frictions and amplification
- EC1B1 lecture notes 3 “Great Depression & Lender of Last Resort”
- Jones, chapter 10.4
- Additional readings for the interested (not examinable)
  - Brunnermeier (2008) “Bubbles”
    https://link.springer.com/referenceworkentry/10.1057/978-1-349-95121-5_44-2
  - Bernanke and Gertler (1989), “Agency Costs, Net Worth, and Business Fluctuations”
  - Kiyotaki and Moore (1997), ”Credit Cycles”
  - Mian and Sufi (2011) “House Prices, Home Equity-Based Borrowing, and the U.S. Household Leverage Crisis” (2011)
  - Mian and Sufi (2014) “What Explains the 2007–2009 Drop in Employment?”

2008 Financial Crisis: Some Facts

2008 financial crisis: some facts

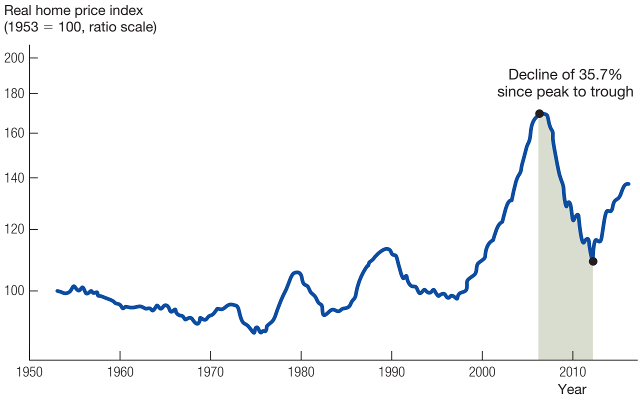
- Will show you data for U.S.
  - purely because many nice graphs are available
- UK and many other advanced economies look similar
  - though some not as extreme

Housing price boom and bust in lead up to crisis

After rising sharply in the years up to 2006, housing prices fell dramatically.

FIGURE 10.1

A Bursting Bubble in U.S. Housing Prices?

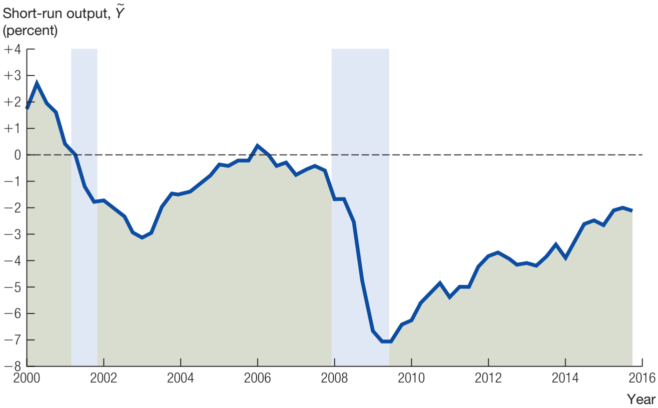


Source: Robert Shiller, www.econ.yale.edu/~shiller/data/Fig2-1.xls.

A very large drop in GDP ...

FIGURE 10.7

U.S. Short-Run Output, $\tilde{Y}$



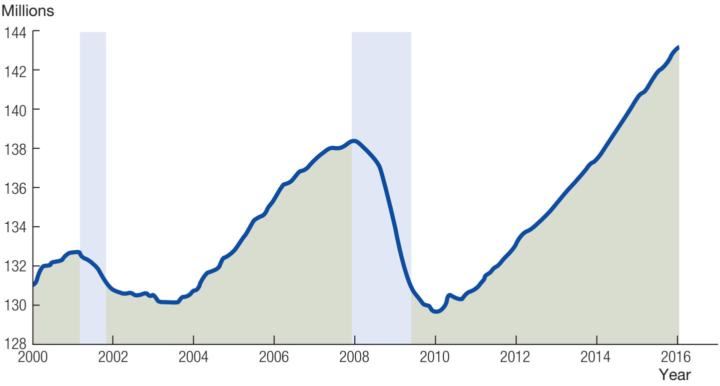
Source: The FRED database and author's calculations.

After its initial resilience to the financial crisis, the real economy declined sharply. At the bottom of the recession, real GDP was more than 7 percent below potential.

... and employment

FIGURE 10.6

Nonfarm Employment in the U.S. Economy



Source: The FRED database.

Total nonfarm employment peaked in December 2007, the date the recession is said to have started, at more than 138 million. More than 8.4 million jobs were lost by February 2010.

Asset Bubbles

What is a bubble?

- Price of an asset does not reflect its “fundamental value”
- Idea: speculators buy the asset only because they expect its price to rise in the future
- Self-fulfiling expectations: “prices rise because they are expected to rise”
- Now: a simple model of a bubble

A simple asset pricing model

- Asset pays dividends
$$\{y_t\}_{t=0}^{\infty} = y_0, y_1, \ldots$$
- Individuals discount future at $\beta = 1/(1+r)$ satisfying $0 < \beta < 1$
- How will this asset be priced?
- Main example: asset = house
    - dividend y_t = per-period benefit received from owning the house
    - either rent (investment) or benefit from living in house (owner-occupied)
    - will sometimes say “rent” instead of “dividend”

A difference equation for pricing the asset

- **Claim:** the asset price p_t must satisfy the difference equation

$$p_t = y_t + \beta p_{t+1} \tag{$*$}$$

  In words: price today = dividend + discounted price tomorrow

- **Intuition:** arbitrage – see supplement

- **Claim:** A solution to the difference equation ($*$) is

$$p_t = \sum_{j=0}^{\infty} \beta^j y_{t+j} = y_t + \beta y_{t+1} + \beta^2 y_{t+2} + \beta^3 y_{t+3} \ldots \tag{$**$}$$

  In words: Price = present discounted value (PDV) of future dividends

- **Example:** constant dividend $y_t = \bar{y}$ for all t (using $\sum_{j=0}^{\infty} \beta^j = 1/(1-\beta)$)

$$p_t = \frac{\bar{y}}{1-\beta}$$

- Is this a bubble? No
- PDV of future dividends = correct notion of fundamental value

A difference equation for pricing the asset

- Recall: the asset price p_t must satisfy the difference equation

$$p_t = y_t + \beta p_{t+1} \tag{$*$}$$

  with one solution given by

$$p_t = \sum_{j=0}^{\infty} \beta^j y_{t+j} = y_t + \beta y_{t+1} + \beta^2 y_{t+2} + \beta^3 y_{t+3} \ldots \tag{$**$}$$

- How can bubbles arise?

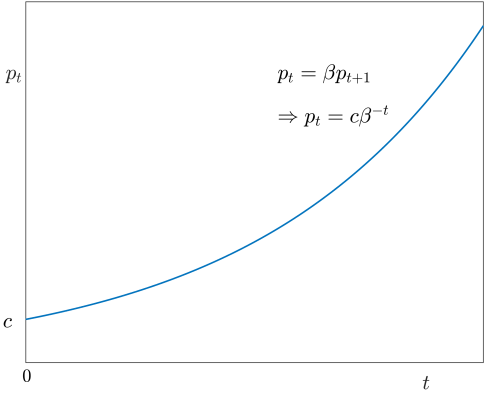
- **Key:** asset price p_t in $(**)$ is not unique solution to $(*)$
  - equation $(*)$ has many more solutions that all correspond to bubbles

A useful case: zero dividends $y_t = 0$

- Asset pricing equation is
$$p_t = \beta p_{t+1}$$
- Obvious solution
$$p_t = 0 = \text{no-bubble solution}$$
- But there is another solution
$$p_t = c\left(\frac{1}{\beta}\right)^t = c\beta^{-t} \quad \text{for a constant } c$$
- Verify:
$$p_t = c\beta^{-t} = \beta \underbrace{\left[c\beta^{-(t+1)}\right]}_{p_{t+1}} = \beta p_{t+1}$$
- In fact this works for any constant c so there are infinitely many such solutions
- All these solutions are bubble solutions: $p_t \neq$ fundamental value = 0

A pure bubble when the asset pays no dividend $y_t = 0$

When $c > 0$ asset price $p_t = c\beta^{-t}$ grows exponentially (recall $\beta < 1$)



- Buy worthless asset because expect to sell it at higher price tomorrow
- "Prices rise because they are expected to rise"

Putting everything together: positive dividends y_t

- Recall: the asset price p_t must satisfy the difference equation

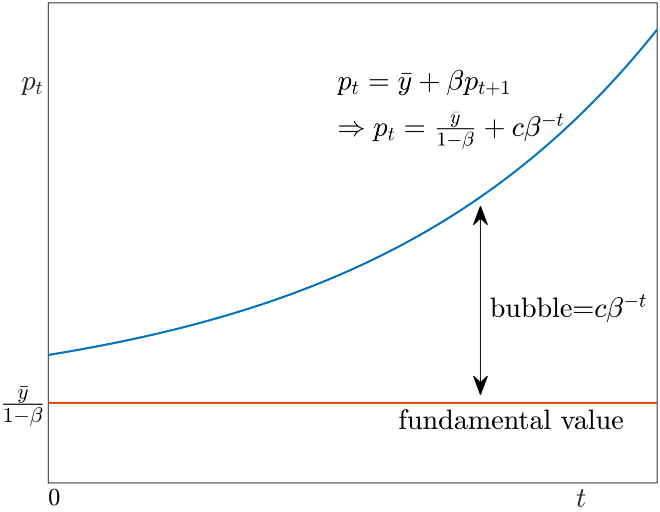
$$p_t = y_t + \beta p_{t+1} \tag{$*$}$$

- **Claim:** general solution to $(*)$ is

$$p_t = \underbrace{\sum_{j=0}^{\infty} \beta^j y_{t+j}}_{\text{fundamental value}} + \underbrace{c\beta^{-t}}_{\text{bubble component}} \qquad \text{for any constant } c$$

- Next slide: graph with constant dividend and hence constant fundamental value

Asset price = fundamental value + bubble component



Asset bubbles: summary

- It's not necessarily true that

$$\text{asset price} = \text{fundamental value} = \text{PDV of dividends}$$

- Instead there can be self-fulfilling bubbles in which

$$\text{asset price} = \text{fundamental value} + \text{bubble component}$$

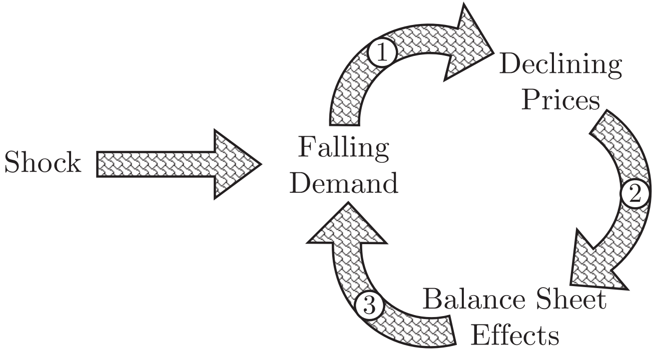
- These bubbles are self-fulfiling in sense that prices rise because they are expected to rise

- For more on bubbles, see survey by Brunnermeier (2008) "Bubbles" in the The New Palgrave Dictionary of Economics

  https://link.springer.com/referenceworkentry/10.1057/978-1-349-95121-5_44-2

Financial Frictions and Amplification

The idea in a nutshell: “financial doom loop”



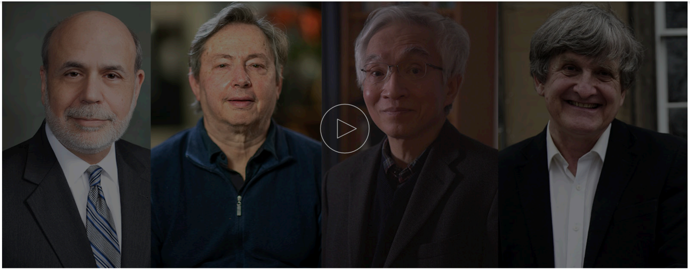
- Sometimes people call this “financial doom loop” or “diabolic loop”
- An “LSE idea”: Key work by Nobu Kiyotaki and John Moore written while both were at LSE (John Moore still is)

Watch the interviews here, particularly John Moore’s

BBVA Foundation

FRONTIERS OF KNOWLEDGE AWARDS

Nominate Eng



Ben Bernanke, Mark Gertler, Nobuhiro Kiyotaki and John Moore

In Economics, Finance and Management

The Frontiers of Knowledge Award goes to Bernanke, Gertler, Kiyotaki and Moore for establishing the nature of the linkage between the financial sector and the real economy and how it operates to amplify crises

https://www.frontiersofknowledgeawards-fbbva.es/noticias/

the-frontiers-of-knowledge-award-goes-to-bernanke-gertler-kiyotaki-and-moore-for-establishing-the-nature-of-the-linkag

Plan for this part of lecture notes

1. Preliminaries: Borrowing and Saving in a Small Open Economy

2. Preliminaries: Consumption Based Asset Pricing

3. Borrowing and Saving with a "Collateral Asset": Financial Amplification

Here:

- due to time constraints only provide overview

- see supplement for more detailed version (examinable)

Borrowing and Saving in a Small Open Economy

- "Small open economy": household can borrow and lend at a fixed world interest rate r^*
- Consumers solve

$$\max_{c_1, c_2, d_1} u(c_1) + \beta u(c_2) \quad \text{s.t.}$$

$$c_1 = y_1 + d_1$$

$$c_2 + d_1(1 + r^*) = y_2$$

$$d_1 \leq \kappa y_1, \qquad \kappa \geq 0$$

- Note: d_1 is debt, i.e. how much household borrows in period 1
- Note presence of borrowing constraint $d_1 \leq \kappa y_1$
  - borrow up to fraction (or multiple) κ of first-period income y_1
  - κ parameterizes quality of credit markets
  - $\kappa = \infty$: can borrow as much as you'd like (no constraint)
  - $\kappa = 0$: cannot borrow at all

Unconstrained solution $\kappa = \infty$

- Can write present-value budget constraint

$$c_1 + \frac{c_2}{1+r^*} = y_1 + \frac{y_2}{1+r^*} \equiv y^{PDV}$$

- Optimality condition = standard Euler equation

$$u'(c_1) = \beta(1+r^*)u'(c_2)$$

- Assumption: $\beta(1+r^*) = 1$

- Then unconstrained solution is

$$c_1^u = c_2^u = \frac{1+r^*}{2+r^*} y^{PDV}, \qquad d_1^u = c_1^u - y_1 = \frac{y_2 - y_1}{2+r^*}$$

  where u-subscript stands for "unconstrained"

Solution with borrowing constraint $d_1 \leq \kappa y_1$ with $\kappa < \infty$

Case 1: $d_1^u \leq \kappa y_1$ (loose constraint)

- can obtain unconstrained allocation (c_1^u, c_2^u, d_1^u)
- = optimal choice and constraint will never bind

Case 2: $d_1^u > \kappa y_1$ (binding constraint)

- cannot obtain unconstrained allocation (c_1^u, c_2^u, d_1^u)
- household will borrow as much as it can $d_1 = \kappa y_1$ and consumption is

$$c_1 = (1 + \kappa) y_1, \quad c_2 = y_2 - \kappa y_1 (1 + r^*)$$

- $c_1 < c_1^u = c_2^u < c_2$, i.e. can no longer smooth consumption perfectly
- borrowing constraint makes them strictly worse off

A credit crunch $\kappa \downarrow$

- Recall

$$c_1 = (1+\kappa)y_1, \quad c_2 = y_2 - \kappa y_1(1+r^*)$$

- Therefore $\kappa \downarrow \Rightarrow c_1 \downarrow$ and $c_2 \uparrow$

- Even worse consumption smoothing $\Rightarrow$ welfare falls more

Consumption-based asset pricing

- Now: no borrowing and lending but households can invest in an asset a_t
  - buy asset at price p_1 in period 1
  - asset pays a dividend D in period 2
  - asset is in fixed supply $a_0^s = a_1^s = 1$, i.e. there is one unit of the asset
- Households solve

$$\max_{c_1, c_2, a_1} u(c_1) + \beta u(c_2) \quad \text{s.t.}$$

$$c_1 + p_1 a_1 = y_1 + p_1 a_0$$

$$c_2 = y_2 + D a_1$$

- In equilibrium $a_0 = a_1 = 1$ and hence already know (^{e} for "equilibrium")

$$c_1^e = y_1, \quad c_2^e = y_2 + D$$

- Only question: **what is the equilibrium asset price p_1?**
  - note similarity to finding equilibrium r in last part of lecture 4

Equilibrium asset price

- Optimality condition

$$p_1 u'(c_1) = \beta D u'(c_2)$$

- But we already know that in equilibrium

$$c_1^e = y_1, \qquad c_2^e = y_2 + D$$

- Therefore equilibrium asset price is

$$p_1 = \frac{\beta u'(c_2^e)}{u'(c_1^e)} D = \frac{\beta u'(y_2 + D)}{u'(y_1)} D$$

- Example: log utility $u(c) = \log c$

$$p_1 = \frac{\beta c_1^e}{c_2^e} D$$

- Note: rather than asking "given prices, what is consumption?" we asked "given consumption, what is the price?"

Equilibrium asset price p_1 is depressed when c_1 is low

- Equilibrium asset price

$$p_1 = \frac{\beta u'(c_2^e)}{u'(c_1^e)} D = \frac{\beta u'(y_2 + D)}{u'(y_1)} D$$

- Example: log utility $u(c) = \log c$

$$p_1 = \frac{\beta c_1^e}{c_2^e} D = \frac{\beta y_1}{y_2 + D} D$$

- Interesting feature: p_1 is low when $c_1^e = y_1$ is low and marginal utility $u'(c_1^e)$ is high

- Intuition: don't want to buy asset if you're starving $\Rightarrow$ low asset price

- This will be key feature of model we want to get to

Borrowing and saving with collateral asset: financial amplification

- Now combine elements from two preliminaries
  - borrowing and saving in small open economy
  - consumption-based asset pricing

- Key new ingredient = collateral constraint: borrowing constraint in which amount of debt d_1 is constrained by value of its assets

- Here: assume

$$d_1 \leq \kappa p_1 a_0$$

- Idea: can borrow against value of existing assets (in case of housing: "houses as ATMs", i.e. HELOC = home equity line of credit)

- Alternative formulation: $d_1 \leq \kappa p_1 a_1$ – see supplement

Borrowing and saving with collateral asset: financial amplification

- Households solve:

$$\max_{c_1, c_2, a_1, d_1} \; u(c_1) + \beta u(c_2) \quad \text{s.t.}$$

$$c_1 + p_1 a_1 = y_1 + p_1 a_0 + d_1$$

$$c_2 + d_1(1 + r^*) = y_2 + D a_1$$

$$d_1 \leq \kappa p_1 a_0$$

- Asset is still in fixed supply: $a_0^s = a_1^s = 1$
- Unconstrained solution: see supplement
- As before, two cases: loose constraint and binding constraint
- Here: focus on binding constraint

Equilibrium with binding constraint

- Borrow as much as possible, imperfect consumption smoothing

$$d_1 = \kappa p_1 a_0 = \kappa p_1, \quad c_1 = y_1 + \kappa p_1, \quad c_2 = y_2 + D - \kappa p_1(1 + r^*)$$

- Equilibrium asset price determined by

$$p_1 = \frac{\beta u'(c_2)}{u'(c_1)} D = \frac{\beta u'(y_2 + D - \kappa p_1(1 + r^*))}{u'(y_1 + \kappa p_1)} D$$

- Key feature again: equilibrium asset price p_1 is depressed when c_1 is low

- To solve this neatly change utility slightly: log-linear utility

$$u_1(c_1) + \beta u_2(c_2), \quad u_1(c_1) = \log c_1, \quad u_2(c_2) = c_2$$

- Also assume $\kappa\beta D < 1$

Equilibrium with binding constraint and log-linear utility

- With log-linear utility equilibrium price satisfies

$$p_1 = \beta D c_1$$
$$c_1 = y_1 + \kappa p_1$$

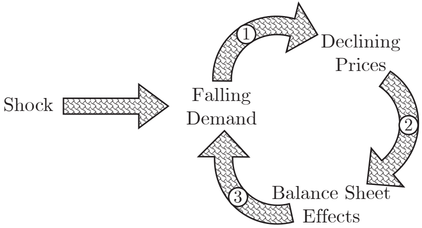
- Solving for p_1 and c_1

$$p_1 = \frac{\beta D y_1}{1 - \beta D \kappa}, \qquad c_1 = \frac{y_1}{1 - \beta D \kappa}$$

- Equilibrium features financial amplification
- Suppose $y_1 \downarrow$. Unsurprisingly $c_1 \downarrow$
- But key: c_1 may fall by a lot more than y_1!

$$\frac{\partial c_1}{\partial y_1} = \frac{1}{1 - \beta D \kappa} > 1 \quad \Rightarrow \quad \text{multiplier effect}$$

Intuition: “financial doom loop”



- Key equations

$$p_1 = \beta D c_1 \tag{1}$$

$$c_1 = y_1 + \kappa p_1 \tag{2}$$

- Mechanism: $y_1 \downarrow \Rightarrow$ consumption $c_1 \downarrow$ from (2) $\Rightarrow$ asset demand $\downarrow$ (“don’t want to buy asset when starving”) $\Rightarrow$ asset price $p_1 \downarrow$ from (1) $\Rightarrow$ tighter collateral constraint $\Rightarrow c_1 \downarrow$ from (2) $\Rightarrow p_1 \downarrow$ from (1) and so on...

Importance of house prices during the financial crisis

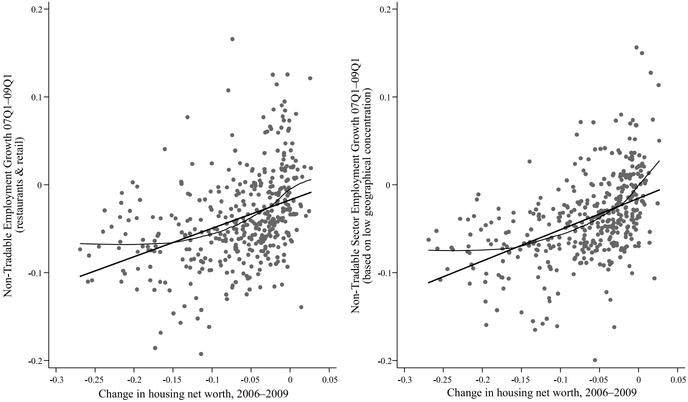


FIGURE 1.—Non-tradable employment and the housing net worth shock. This figure presents scatter-plots of county-level non-tradable employment growth from 2007Q1 to 2009Q1 against the change in housing net worth from 2006 to 2009. The left panel defines industries in restaurant and retail sector as non-tradable, and the right panel defines industries as non-tradable if they are geographically dispersed throughout the United States. The sample includes counties with more than 50,000 households. The thin black line in the left panel is the non-parametric plot of non–tradable employment growth against change in housing net worth.

Source: Mian and Sufi (2014) "What Explains the 2007-2009 Drop in Employment?"