Bubbles and Crises

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Bubbles: Definition and Examples

Definition:
Asset price that deviates from fundamental values

Examples:

- Share price that exceeds the present value of future expected dividends
- House price that exceeds the expected present value of future rents

Bubbles may burst even if no new information has arrived

Assets may show bubble-like movements without actually being out-of-touch with fundamentals

Rational Bubbles: Definition

- Investors know the fundamental value and are fully conscious that they buy into a bubble
- Expected returns are calculated using rational expectations: expectations taking full account of all available information and the correct model
- Sole reason to invest in the bubble is the belief that it will continue and get bigger
- Multiple equilibria

A Generic Example

Assuming everyone is risk neutral, the asset price today (after today's dividend has been paid) is:

$$V_t = R^{-1}[d_{t+1} + E_t V_{t+1}] \tag{1}$$

where R is the risk-free interest rate and d_t is dividend.

Fundamental solution is:

$$V_t = V_t^* \equiv \sum_{i=1}^{\infty} R^{-i} E_t d_{t+i}$$

More solutions:

$$V_t = V_t^* + b_t,$$

with bubble obeying

$$b_{t+1} = R b_t$$

Bursting bubble

Let:
$p \equiv$ probability of bursting
$b_t^c \equiv$ value if continuing

Solves (1), if:

$$b_t^c = R^{-1}(1-p)b_{t+1}^c \Leftrightarrow b_{t+1}^c = Rb_t^c/(1-p)$$

If bubble does not burst, it grows faster than the risk-free interest rate.

Note that both p and the starting value for b are arbitrary

Rational bubbles: when can they occur

Consider only objects with intrinsic value, paper money another story

- There has to be infinitely many investors that the bubble can be passed on to
- Expected return must be equal to or exceed the risk-free interest rate
- Invested funds cannot grow faster than economy forever
- Rational bubbles can only exist if the risk-free interest rate is below the growth rate of the economy
- Bubbles cannot be negative (assuming free disposal)
- The asset must not be easily reproducible

Keynes on asset prices

A conventional valuation which is established as the outcome of the mass psychology of a large number of ignorant individuals is liable to change violently as the result of a sudden fluctuation of opinion due to factors which do not really make much difference ...the market will be subject to waves of optimistic and pessimistic sentiment, which are unreasoning and yet in a sense legitimate where no solid basis exists for a reasonable calculation.

It might have been supposed that competition between expert professionals,..., would correct the vagaries of the ignorant individual left to himself. ...however..most of these persons are,in fact, largely concerned not with making superior long-term forecasts of the probable yield of an investment over its whole life, but in foreseeing changes in the conventional basis of valuation a short time ahead of the general public."

Keynes: *The General Theory of Employment, Interest and Money*, p. 154

Irrational exuberance

Behavioral theories:

- Extrapolation bias
- Herding
- This time is different

Replicating actions that have been successful for others is often a good strategy outside of financial markets
Experience from stock markets

- Momentum trading can be profitable
- Buying value stocks can also be profitable

Rational bubbles and financial frictions

Ventura and Martin, sections 1 and 2

- They construct an OLG model with 2 key ingredients: Financial frictions + rational bubbles
- Fin. frictions = entrepreneurs face borrowing constraints. The amount they can borrow depends on the value of their collateral. The market value of a firm's net worth affects the firm's ability to borrow and expand
- They put these 2 ingredients together because bubbles affect asset prices, and due to fin. frictions, bubbles indirectly affect the possibility to borrow
- The authors' goal is to explain the recent crisis as a sequence of a large shock to investors' sentiment that has reduced the firm's net worth, reduced borrowing, and resulted in a bust

Individuals

- A new individual is born every period and lives for two periods
- Each individual supplies one unit of labor in her first period
- She saves all wage income and consumes only in the second period
- Individuals are risk neutral
- Share ε of individuals are Entrepreneurs

New and old firms

- Entrepreneurs invest in new firms and borrow
- Non-Entrepreneurs buy old firms, invest in old firms and lend to Entrepreneurs
- Investment in new firms is more efficient than in old firms
- Only old firms produce final goods.

A real investment in firm j, $z_{j,t}$, yields

- for an old firm $z_{j,t}$ units of capital
- for a new firm $\pi z_{j,t}$ units of capital where $\pi > 1$

Capital accumulates according to

$$k_{j,t+1} = z_{j,t} + (1-\delta)k_{j,t}, \quad \text{for old firms}$$

The fundamental value of a firm

- The fundamental value of a firm is the value of the capital stock that belongs to the firm

$$V_{j,t} = (1 - \delta)k_{j,t}$$

- $V_{j,t}$ is the price of an old firm in period t after production has been carried out and depreciation has taken place, but before the new owner has added his real investments to the capital stock

Some macro relations

Per-worker production function:

$$y_t = \ell_t^{1-\alpha} k_t^{\alpha} = k_t^{\alpha}$$

y_t, k_t and ℓ_t are per worker, $\ell_t = 1$
Non-Entrepreneurs demand a return from lending to entrepreneurs (denoted R_{t+1}) equal to the return from investing in old firms:

$$R_{t+1} = 1 - \delta + \alpha k_{t+1}^{\alpha-1}$$

($(1-\delta)$ is the return on capital resale, $\alpha k_{t+1}^{\alpha-1}$ is the increase in productivity due to an extra unit of capital - think of it as the dividend)
Labor is paid its marginal productivity, so the wage w_t is equal to:

$$w_t = (1-\alpha)\ell_t^{-\alpha} k_t^{\alpha} = (1-\alpha)k_t^{\alpha}$$

Entrepreneurs: The Credit Constraints

Entrepreneur j is allowed to borrow at most:

$$f_{j,t} = \frac{\Phi\pi}{1 - \Phi\pi} w_t > 0 \quad for \quad \Phi\pi < 1$$

Since $\pi > 1$, entrepreneurs have access to higher-return investment opportunities than non-entrepreneurs do $\Longrightarrow$ Entrepreneurs always borrow as much as possible.

Financial friction:

- Borrowing limit is proportional to wage income
- Wage income depends on capital (see last slide)

More investment yields access to more loans!

Dynamics of the economy's capital stock

$$k_{t+1} = w_t - (1-\delta)k_t + (\pi - 1)\varepsilon(1 + \frac{\Phi\pi}{1-\Phi\pi})w_t + (1-\delta)k_t$$

$$k_{t+1} = w_t + (\pi - 1)\varepsilon(1 + \frac{\Phi\pi}{1-\Phi\pi})w_t$$

k_{t+1} =wages (savings) + gain because entrepreneurs do part of the investment

$$k_{t+1} = \left[1 + \frac{\varepsilon(\pi - 1)}{1-\Phi\pi}\right](1-\alpha)k_t^{\alpha}$$

Bubbles

Value of firm with bubble:

$$V_{j,t} = (1-\delta)k_{j,t} + b_{j,t}$$

$(1-\delta)k_{j,t}$ = fundamental, $b_{j,t}$ = bubble

1. Non-Entrepreneurs have to pay more for firms and as a result some savings are diverted from real investment to consumption of the old
2. Entrepreneurs will get more when they will sell the new firms, as a result they get more credit and more real investment is undertaken by the most efficient investors

(1) and (2) go in opposite directions, as a result the total effect on real investment is ambiguous

Requirements for a rational bubble

- Bubble must have expected return equal to interest rate

$$\frac{E_t b_{j,t+1}}{b_{j,t}} = E_t R_{t+1}$$

- Bubble should never become too large for the young to purchase

Bubbles relax the credit constraint

New firm at t, value at $t+1$:

$$V_{j,t+1} = (1-\delta)k_{j,t+1} + E_t b^N_{j,t+1}$$

The basis for getting loans is augmented by the present value of the bubble:

$$f_{j,t} = \frac{\Phi}{1-\Phi\pi}\left[\pi w_t + \frac{E_t b^N_{j,t+1}}{R_{t+1}}\right]$$

Two opposing effects on capital accumulation

$$k_{t+1} = w_t - b_t - b_t^N + \varepsilon(\pi - 1)(1 + \frac{\Phi\pi}{1 - \Phi\pi})w_t + (\pi - 1)\frac{\Phi}{1 - \Phi\pi} \cdot \frac{E_t b_{t+1}^N}{R_{t+1}}$$

$$k_{t+1} = w_t \underbrace{-b_t - b_t^N}_{a} + \frac{\varepsilon(\pi - 1)}{1 - \Phi\pi} w_t + \underbrace{\frac{(\pi - 1)\Phi}{1 - \Phi\pi} \cdot \frac{E_t b_{t+1}^N}{R_{t+1}}}_{b}$$

b_t is the sum of the bubbles on all the old firms
b_t^N is the sum of the bubbles on all the new firms
a: savings go to buy bubbles instead of real investment
b: entrepreneurs get to do more of the investment

$$k_{t+1} = \left[1 + \frac{\varepsilon(\pi - 1)}{1 - \Phi\pi}\right](1 - \alpha)k_t^\alpha + \frac{\varepsilon(\pi - 1)}{1 - \Phi\pi_t} \cdot \frac{E_t b_{j,t+1}^N}{\alpha k_{t+1}^{\alpha-1} + 1 - \delta} - b_t - b_t^N$$

Bubbly episodes - an example

- Probability of bubble ending in period t constant equal to p
- Bubble starts with $b_t^N = b^N > 0$
- While bubble goes on $b_t^N = nb_t, \quad n > 0$
- Probability of a second bubble starting is negligible
- Auxiliary assumption: $\delta = 1$

The dynamics of the aggregate bubble

Expected growth in aggregate bubble comes both from old and new firms:

$$E_t b_{t+1} = R_{t+1}(1+n)b_t$$

Since bubble breaks with probability p:

$$E_t b_{t+1} = p \cdot 0 + (1-p)b^c_{t+1}$$

where $b^c_{t+1} + b^{Nc}_{t+1}$ is value of bubble if it continues.
Combining the two equations gives:

$$b^c_{t+1} = \left[R_{t+1}(1+n)/(1-p)\right] b_t$$

A bubble that continues grows faster than the interest rate

Contractionary and expansionary bubbles

Define share of bubble in savings

$$x_t = b_t / w_t$$

Ventura and Martin show that x_t evolves independently of k_t.
Capital stock evolves according to

$$k_{t+1} = \left[1 + \frac{\varepsilon(\pi - 1)}{1 - \Phi\pi} - (1 - \frac{\Phi(\pi - 1)n}{1 - \Phi\pi})(1 + n)x_t\right](1 - \alpha)k_t^{\alpha}$$

- Contractionary bubbles

$$\frac{\Phi(\pi - 1)n}{1 - \Phi\pi} < 1$$

Contractionary bubbles reduce capital stock and raise interest rates

Expansionary bubble

Expansionary bubbles

$$\frac{\Phi(\pi - 1)n}{1 - \Phi\pi} > 1$$

- Expansionary bubbles raise capital stock, and lower interest rates
- Expansionary bubbles lead to credit expansion
- They are made possible by financial frictions
- Bubbles may start low and grow for a long time
- As the bubbles grow, interest rate goes down
- They are more relevant than contractionary bubbles for current crisis