Bubbly Firm Dynamics and Aggregate Fluctuations

Haozhou Tang [1] Donghai Zhang[2]

[1]Bank of Mexico

[2]University of Bonn

XXV Meeting of the Central Bank Researchers Network
Oct 30. 2020

The views expressed in this paper are the sole responsibility of the authors and do not necessarily reflect the views of the Bank of Mexico.

Motivation

- Boom-bust episodes of asset prices/credit
  - pro-cyclical
  - magnitude difficult to be rationalized by fundamentals
- Renewed interest in bubbles
  - focus on the aggregate implications of bubbles
  - bubbles and financial frictions: bubbly collateral, bubbly liquidity, etc.

This Paper

- Introduce bubbles to a model with firm dynamics and firm heterogeneity
  - firm heterogeneity, entry and exit, idiosyncratic productivity shocks
  - the value of a firms exceeds its net present value of expected dividends: a bubble component in addition to the fundamental component
  - the heterogeneity of bubbly/bubbleless firms
- Effects of bubbles
  - selection effect (hitherto unexplored)

Main Findings

- Empirical findings: after a positive bubble shock
  - output and aggregate productivity increases
  - firm exit rate declines
  - overshooting of firm entry rate: it increases in the short run followed by a drop below its steady state level
- Model's quantitative results:
  - bubbly firms are on average smaller and less productive
  - bubbly firms are less likely to exit
  - business cycle dynamics after a bubble shock is consistent with empirical findings

Literature

- Bubbles and their real effects
    - Tirole (1985), Weil (1987)
    - Olivier (2000), Farhi and Tirole (2012), Martin and Ventura (2012, 2016), Gali (2014), Miao and Wang (2018), Domeij and Ellingson (2018), Queiros (2019), Vuillemey and Wasmer (2019), Ikeda and Phan (2019)
    - Gali and Gambetti (2015), Martin, Moral-Benito, and Schmitz (2018)
- Firm dynamics/heterogeneous agents model
    - Lucas (1978), Hopenhayn (1992)
    - Floetotto and Jaimovich (2008), Lee and Mukoyama (2013), Khan and Thomas (2013), Clementi and Palazzo (2016), Sedlacek and Sterk (2017)
    - Bachmann and Bayer (2014), Schaal (2017), Arellano, Bai, and Kehoe (2018), Bloom et al. (2018), Senga (2018), Ottonello and Winberry (2018), Winberry (2020)
- Empiricall literature
    - asset bubbles: Campbell and Shiller (1988) (see also Queiros 2017), Jorda et al. (2015), Schularick and Taylor (2012), Gilchrist et al. (2005);
    - SVAR using medium run restriction (Max FEVD): Uhlig (2003, 2004), Barsky and Sims (2011), Zeev and Pappa (2017), Ben Zeev et al. (2017), and Levchenko and Pandalai-Nayar (2020).

Empirical Analysis

The Decomposition of Asset Price

Let P_t denote the value of a representative infinite-lived asset that yields a stream of dividend $\{D_t\}$.

The value (price) of such an asset is the sum of a fundamental component (F_t) and a bubble (B_t) component:

$$P_t = F_t + B_t,$$

The fundamental component is the net present value of future dividends:

$$F_t \equiv E_t \left\{ \sum_{h=1}^{\infty} \left(\prod_{j=0}^{h-1} (1/R_{t+j}) \right) D_{t+j} \right\}.$$

Log-linearize this equation leads to:

$$f_t = c + \sum_{h=0}^{\infty} \Lambda^h \left[(1-\Lambda) E_t\{d_{t+h+1}\} - E_t\{r_{t+h}\} \right], \tag{1}$$

Log-linearized price-fundamental differential $\equiv p_t - f_t$

The Vector AutoRegressive Model

we consider a VAR that consists the following variables:

1. TFP
2. real GDP (y_t)
3. real dividend (d_t)
4. real stock price S&P 500 (p_t)
5. real interest rate (r_t)
6. the firm entry (en_t) or exit rate (ex_t), separately to keep the VAR small

Let $Y_t \equiv [TFP_t, y_t, d_t, p_t, r_t, en_t]'$, the reduced form representation of our VAR model is:

$$Y_t = B(L)Y_t + U_t \tag{2}$$

f_t can be constructed within the VAR $\forall t$.

The SVAR: Structural Assumption

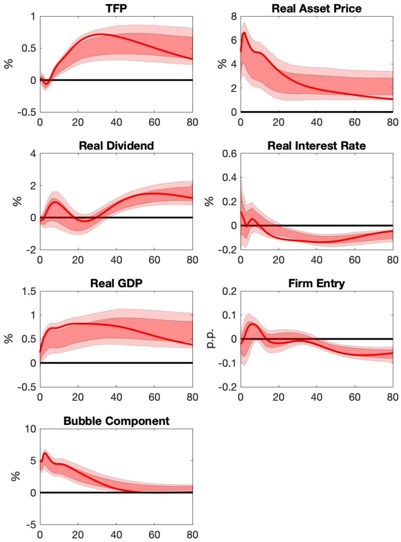
Objective: identify exogenous shocks to asset bubble

Identification Assumption:

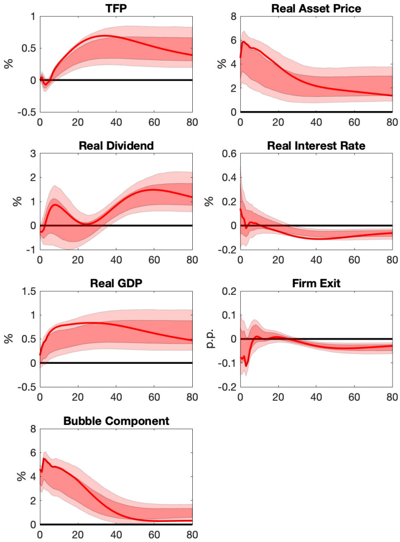
- the shock that maximizes the forecast error variance decomposition of the price-fundamental differential $(p_t - f_t)$ in the subsequent periods is a bubble shock...
- ...once controlled for productivity shocks, both the unexpected ones and anticipated ones (news shocks), and selected structural shocks such as credit supply and monetary policy shocks

Empirical Findings: IRFs to a Bubble Shock

Details



Empirical Findings: IRFs to a Bubble Shock



Robustness checks

Our baseline SVAR controls for both current and anticipated TFP shocks.

Results are robust to controlling for additional shocks:

1. credit supply shocks
2. monetary policy shocks
3. fiscal policy shocks

The Model

The Model: Firms

- Production function:

$$y_t = \varphi_t k_t^{\alpha}$$

  - φ_t: the idiosyncratic productivity component

$$\log \varphi_{t+1} = \rho \log \varphi_t + \varepsilon_{t+1}$$

  - Decreasing returns to scale: $\alpha < 1$
  - k_t: predetermined at t
  - c^f: fixed operation cost

The Model: Households

- Infinite-horizon, risk-neutral

$$U_t = E_t \sum_{\tau=0}^{\infty} \beta^{\tau} C_{t+\tau}$$

  - β: subjective discount factor; C: consumption
- a new cohort joins the economy in every period
  - g: the relative size of the cohort to the incumbents
  - create new firms, draw φ_t according to log-normal distribution function

$$\varphi_t \sim \log N\left(\mu_0, \sigma_0^2\right)$$

The Model: Value Function

- The start-of-period value of a firm equals

$$V(\lambda,\mu,k) = y(\lambda,k) - c^f + p\max\{V^c(\lambda,\mu,k), V^x(k)\} + (1-p)V^x(k),$$

  - λ: aggregate states; μ: idiosyncratic states besides k; $1-p$: probability of i.i.d. death shocks
  - Continuation value:

$$V^c(\lambda,\mu,k) = \max_{k'}\left\{(1-\delta)k - k' - g(k,k') + \beta\int V(\lambda',\mu',k')\,dJ(\lambda',\mu'|\lambda,\mu)\right\}.$$

  - Adjustment cost

$$g(k,k') = c_0 1\{k \neq k'\}k + c_1\left(\frac{k'-(1-\delta)k}{k}\right)^2 k.$$

  - Exit value

$$V^x(\mu) = (1-\delta)k - g(k,0).$$

  - Firms exit if
    - draw death shocks
    - continuation value lower than exit value

The Model: Bubbles

- Decompose continuation value into

$$V^c(\lambda,\mu,k) = F^c(\lambda,\mu,k) + B,$$

  - $F^c(\lambda,\mu,k)$: the fundamental component, i.e., the net present value of expected flows to shareholders
  - B: the bubble component, a pyramid scheme

$$B = \beta \int B' dJ\left((\lambda',\mu'|\lambda,\mu)\right),$$

$$B' = \begin{cases} 0, & \text{with } 1-p^b \\ \left(\beta \cdot p^b \cdot p^s(\lambda,\mu,k')\right)^{-1} B, & \text{with } p^b \end{cases}$$

  - $p^s(\lambda,\mu,k')$: the probability of continuation
  - New firms receive B_0 with p_b

The Model: BGP

- Along a BGP

$$b' = [\beta(1+g)]^{-1} b + b_0,$$

  - b: the ratio of aggregate bubbles to aggregate output
  - b_0: a constant

Quantitative Analysis: Calibration (skip)

Panel A: Fixed Parameters

Parameter	Description	Value
α	Decreasing returns to scale	0.65
ρ	Idiosy. shock persistence	0.7
σ	Idiosy. shock volatility	0.3764
$1-p$	Prob. of a death shock	0.04
δ	Depreciation rate	0.1
β	Discount factor	0.98
g	Growth rate	2.42%

Panel B: Estimated Parameters

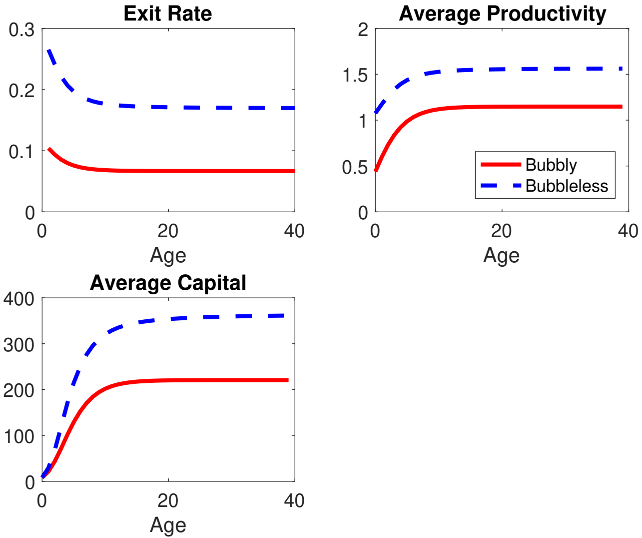
Parameter	Description	Value
μ_0	Average productivity of new entrants	2.278
σ_0	Std of productivity of new entrants	0.01
b_0	Initial bubble component	84.48
c_f	Fixed cost of production	9.25
c_0	Fixed adjustment cost	10^{-5}
c_1	Variable adjustment cost	0.021
c_e	Entry cost	67.26
p_b	Surviving probability of a bubble	0.919

Quantitative Analysis: Calibration (skip)

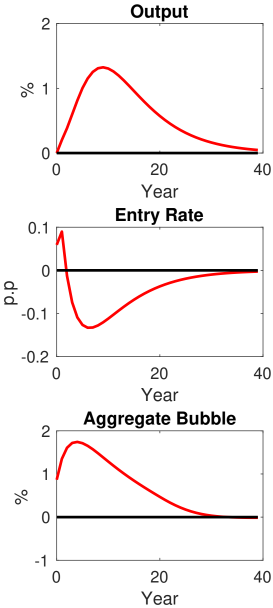
Moment	Data	Model
Average entry rate	0.104	0.117
Share of two-year-old establishments	0.07	0.09
Exit rate of one-year-old firms	0.243	0.105
Exit rate of three-year-old firms	0.158	0.091
Shiller's CAPE	20.6	20.6
Investment inaction rate	0.081	0.085
Average investment rate	0.122	0.170
Standard deviation of investment rate	0.337	0.180

Table: Calibration Targets and Model Fit

Quantitative Results: Firms' life cycles



Quantitative Results: Impulse Responses to a Bubble Shock



Concluding Remarks

- Empirical findings: after a positive bubble shock
  - output and aggregate productivity increases
  - firm exit rate declines
  - overshooting of firm entry rate: it increases in the short run followed by a drop below its steady state level
- Model's quantitative results:
  - bubbly firms are on average smaller and less productive
  - bubbly firms are less likely to exit
  - business cycle dynamics after a bubble shock is consistent with empirical findings

VAR: details

Back Data:

- Quarterly data from 1977 to 2016
- annual firms' entry and exit rates from BDS, interpolated to obtain quarterly data
- the stock price, dividend and earning of the SP500 are taken from Shiller (2015)
- utilization adjusted TFP from Fernald (2014)
- other macro aggregate variables from FRED
- excess bond premium from Gilchrist and Zakrajsek (2012) updated by Favara et al. (2016)
- monetary shocks constructed following Gertler and Karadi (2015)
- fiscal expenditure shocks constructed following Blanchard and Perotti (2002)

Confident bands: Following Kilian (1998), we construct standard errors from 2000 bias-corrected bootstraps. Both the 90% and the 68% confidence bands are included.