Price and Volume Dynamics in Bubbles

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Prices and volume in historical bubbles

(a) US Housing Market (2000–2012)


(c) Experimental Markets, SSW (1988)

(d) Japan Equities (1985–1995)

(DeFusco et al. 2018)
Research questions

Questions

1. *prices*: what is the underlying mechanism behind the run-up and crash?

2. *volume*: why do investors trade so much during a bubble?

This paper

1. propose a simple model of bubbles $\rightarrow$ a novel mechanism for trading volume

2. test its predictions about volume using detailed, account-level data

3. empirically establish the role of extrapolators in driving the run-up and crash
The model

- start with the concept of *extrapolation*
  - forming beliefs about future price changes based on past price changes
  - generate price run-up and crash
- but extrapolation *alone* may not be able to generate sufficiently high volume
  - extrapolators share similar beliefs (Barberis et al. 2018; DeFusco et al. 2018)
  - ownership makes them even more optimistic (Hartzmark et al. 2019)
- couple extrapolation with *the disposition effect*
  - the tendency to sell winners and hold on to losers
  - this combination generates high volume
    - “disposition extrapolators” *buy* after price initially rises, but *sell* if price rises more
  - interaction between beliefs (extrapolation) and preferences (disposition)
- make new predictions about the sources of volume
  - through the interaction of extrapolation and the disposition effect
  - on the extensive-margin (liquidations and initiations)
  - trading of assets investors have never traded before
Empirical set-up

- **data**: detailed, account-level transaction data from a large Chinese brokerage firm
  - around 2 million investors
  - complete trading history since the first day of trading
  - other data: demographics, survey responses, prior trading experience, etc.
- **setting**: the 14-15 Chinese stock market bubble
  - price rose by 100%; volume by 500% → rich dynamics of prices and volume
- **strategy**: *ex-ante* estimation of extrapolation and disposition from transaction data
Main findings

Sources of volume

- as a group, disposition extrapolators increase volume by almost 800%
  - e.g., pure extrapolators: 500% → 300% difference
- mechanism
  - extrapolation: large holdings throughout the run-up
  - disposition: quick reshuffling of portfolio composition
- additional evidence at the investor and stock levels
  - e.g., stocks traded more by disposition extrapolators → higher turnover
- decomposition of aggregate volume
  - 55% from extensive-margin; 68% from trading of new stocks

Extrapolators and prices

- predictive and IV regressions using panel data
  - address reverse causality concerns
- one s.d. variation in the degree of extrapolation → 1% in weekly returns

Overall

- document new, stylized facts about the sources of volume
- support the bubble framework we propose
Intuition
The model’s intuition
Predictions about volume

- **Prediction 1**
  During a bubble, disposition extrapolators increase their volume more than other investors do

- **Prediction 2**
  During a bubble, a greater fraction of total volume comes from extensive-margin trading (as opposed to intensive-margin trading)

- **Prediction 3**
  During a bubble, a greater fraction of total volume comes from trading stocks investors have not traded before
Background
Background of the bubble
Data
Data and sample

Data

- provided by one of the largest Chinese brokerage firms
  - branches in almost all of China’s provincial-districts
- three main datasets
  1. transactions: all transactions since the first day of trading
  2. demographics: age, gender, education, etc.
  3. surveys: wealth, income, risk tolerance, investment horizon and objective, etc.

Sample selection

- retail investors as opposed to institutions
  - retail accounts: 45% of stock ownership and 90% of total volume
- regular accounts with balance between 0.01 to 1 million RMB, excluding
  - leverage accounts
  - large accounts de facto managed by institutions and take shadow leverage
- final sample size: ~600,000 retail accounts
Measuring extrapolation and disposition

- time frame: 2005-2013; prior to the bubble

Degree of extrapolation (DOX)
- volume-weighted average past returns based on all initial buys

\[
DOX = \frac{\sum (Buy \times PastRet)}{\sum Buy}
\]

- PastRet: past one-month return → robust to alternative horizons
- no momentum in Chinese markets → not rational trading
- initial buys (not additional buys) → cleaner source of beliefs
- consistent with survey-based measures of extrapolative beliefs (Liu et al. 2019)

Degree of disposition (DOD)
- \( DOD = \frac{PGR}{PLR} \) or \( PGR - PLR \), where

- Proportion of Gains Realized (PGR) = \( \frac{\text{Realized Gains}}{\text{Realized Gains} + \text{Paper Gains}} \)
- PLR is similarly defined
Evidence on Volume
Evidence I: Group-level

- disposition extrapolators: \textit{DOX} and \textit{DOD} above the median
  - pure extrapolators: only \textit{DOX} above the median

\textbf{Figure:} Total volume
Evidence I: Group-level, cont’d

(a) Holdings

(b) Turnover

Figure: Decomposition of total volume
## Evidence II: Investor-level

<table>
<thead>
<tr>
<th></th>
<th>ΔVolume</th>
<th>ΔTurnover</th>
<th>ΔBalance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DOX</strong></td>
<td><strong>2.64</strong>*</td>
<td><strong>0.02</strong></td>
<td><strong>0.32</strong>*</td>
</tr>
<tr>
<td></td>
<td>(5.56)</td>
<td>(-0.10)</td>
<td>(17.33)</td>
</tr>
<tr>
<td><strong>DOD</strong></td>
<td><strong>3.65</strong>*</td>
<td><strong>1.96</strong>*</td>
<td><strong>-0.05</strong>*</td>
</tr>
<tr>
<td></td>
<td>(7.84)</td>
<td>(11.24)</td>
<td>(-4.04)</td>
</tr>
<tr>
<td><strong>DOX*DOD</strong></td>
<td><strong>0.76</strong>**</td>
<td><strong>0.27</strong>**</td>
<td><strong>-0.04</strong>*</td>
</tr>
<tr>
<td></td>
<td>(2.15)</td>
<td>(1.99)</td>
<td>(-4.61)</td>
</tr>
<tr>
<td><strong>BAL</strong></td>
<td>-14.96***</td>
<td>-0.60</td>
<td>-1.39***</td>
</tr>
<tr>
<td></td>
<td>(-13.61)</td>
<td>(-1.45)</td>
<td>(-32.24)</td>
</tr>
<tr>
<td><strong>EXP</strong></td>
<td><strong>3.25</strong>**</td>
<td><strong>1.33</strong>**</td>
<td><strong>0.04</strong>**</td>
</tr>
<tr>
<td></td>
<td>(30.55)</td>
<td>(34.34)</td>
<td>(9.14)</td>
</tr>
<tr>
<td><strong>HHI</strong></td>
<td><strong>2.70</strong>**</td>
<td><strong>-3.67</strong>**</td>
<td><strong>1.03</strong>**</td>
</tr>
<tr>
<td></td>
<td>(2.08)</td>
<td>(-7.74)</td>
<td>(20.71)</td>
</tr>
<tr>
<td><strong>VOL</strong></td>
<td>-80.00***</td>
<td><strong>-69.62</strong>**</td>
<td><strong>6.15</strong>**</td>
</tr>
<tr>
<td></td>
<td>(-3.91)</td>
<td>(-10.10)</td>
<td>(7.09)</td>
</tr>
<tr>
<td><strong>SKEW</strong></td>
<td><strong>1.14</strong>*</td>
<td><strong>0.63</strong>**</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(1.70)</td>
<td>(2.96)</td>
<td>(-0.56)</td>
</tr>
<tr>
<td><strong>RET</strong></td>
<td>4.75</td>
<td><strong>6.69</strong>**</td>
<td><strong>-2.18</strong>**</td>
</tr>
<tr>
<td></td>
<td>(1.11)</td>
<td>(4.45)</td>
<td>(-7.07)</td>
</tr>
<tr>
<td>Demographics</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Margin account, dummy</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Traded warrants before, dummy</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Survey-based characteristics</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Evidence III: Stock-level

- stock-level degree of extrapolation is defined by
  \[ \overline{DOX}_{j,t} = \sum_{i=1}^{N} \left( \frac{Buy_{i,j,t}}{\sum_{i=1}^{N} Buy_{i,j,t}} \right) DOX_i \]
  - \( Buy_{i,j,t} \): number of \( j \) shares bought by investor \( i \) in week \( t \)

- stock-level degree of disposition is defined by
  \[ \overline{DOD}_{j,t} = \sum_{i=1}^{N} \left( \frac{Sell_{i,j,t}}{\sum_{i=1}^{N} Sell_{i,j,t}} \right) DOD_i \]
  - \( Sell_{i,j,t} \): number of \( j \) shares sold by investor \( i \) in week \( t \)

- run the following panel regression
  \[ \text{Turnover}_{j,t} = \beta_0 + \beta_1 \overline{DOX}_{j,t} + \beta_2 \overline{DOD}_{j,t} + \text{Controls} + \varepsilon_{j,t} \]
  - stock fixed effects (robust to time fixed effects)
  - time-clustered standard errors (robust to double-clustered S.E.)
<table>
<thead>
<tr>
<th></th>
<th>Turnover (t)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>$DOX_t$</td>
<td>0.04***</td>
<td>0.04***</td>
<td>0.01***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(14.30)</td>
<td>(9.34)</td>
<td>(2.92)</td>
<td></td>
</tr>
<tr>
<td>$DOD_t$</td>
<td>0.02***</td>
<td>0.01***</td>
<td>0.01***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7.76)</td>
<td>(6.32)</td>
<td>(5.53)</td>
<td></td>
</tr>
<tr>
<td>Return ($t$)</td>
<td></td>
<td></td>
<td></td>
<td>0.28***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3.97)</td>
</tr>
<tr>
<td>Return ($t-1$) to ($t-12$)</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Turnover ($t-1$) to ($t-12$)</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Stock FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Time-clustered SE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.50</td>
<td>0.52</td>
<td>0.70</td>
<td></td>
</tr>
</tbody>
</table>

Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
### Evidence IV: Prediction 2 and 3

<table>
<thead>
<tr>
<th>Volume (in RMB)</th>
<th>Run-up</th>
<th>Crash</th>
<th>Quiet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction of extensive-margin trades</td>
<td>55.0%</td>
<td>46.0%</td>
<td>52.2%</td>
</tr>
<tr>
<td>disposition extrapolators</td>
<td>58.9%</td>
<td>48.3%</td>
<td>55.6%</td>
</tr>
<tr>
<td>pure extrapolators</td>
<td>56.3%</td>
<td>49.2%</td>
<td>54.5%</td>
</tr>
<tr>
<td>others</td>
<td>52.9%</td>
<td>43.8%</td>
<td>49.9%</td>
</tr>
<tr>
<td>Fraction of trading of “new” stocks</td>
<td>68.3%</td>
<td>52.9%</td>
<td>54.9%</td>
</tr>
</tbody>
</table>
Evidence on Prices
Empirical strategy

- models of extrapolation suggest that extrapolators are responsible for the rising prices
  - e.g., Barberis et al. 2018, DeFusco et al. 2018, and this paper
  - little direct empirical evidence → partially driven by reverse causality concerns
- suppose we run

\[
\text{Return}_{j,t+1} = \beta_0 + \beta_1 \overline{DOX}_{j,t+1} + \text{Controls} + \varepsilon_{j,t}
\]

- \( \beta_1 > 0 \): prices go up → attract trading from extrapolators → higher \( \overline{DOX} \)

Empirical strategy

- two specifications
  1. predictive regressions: \( \text{Return}_{j,t+1} = \beta_0 + \beta_1 \overline{DOX}_{j,t} + \text{Controls} + \varepsilon_{j,t} \)
  2. IV regressions: instrument \( \overline{DOX}_{j,t+1} \) using \( \overline{DOX}_{j,t} \)
- key assumption: \( \overline{DOX}_{j,t} \) is positively autocorrelated
  - AR(1) efficient of 0.45 at the weekly frequency
## Extrapolation and prices

<table>
<thead>
<tr>
<th></th>
<th>Return ((t + 1)), run-up (%)</th>
<th>Return ((t + 1)), crash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>(\overline{DOX} (t + 1))</td>
<td>3.09***</td>
<td>0.98**</td>
</tr>
<tr>
<td></td>
<td>(7.65)</td>
<td>(2.09)</td>
</tr>
<tr>
<td>(\overline{DOX} (t))</td>
<td>0.48**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.29)</td>
<td></td>
</tr>
<tr>
<td>Return ((t))</td>
<td>-0.10*</td>
<td>-0.05</td>
</tr>
<tr>
<td></td>
<td>(-1.75)</td>
<td>(-0.87)</td>
</tr>
<tr>
<td>(BETA (t))</td>
<td>0.08</td>
<td>-0.16</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(-0.51)</td>
</tr>
<tr>
<td>Turnover ((t))</td>
<td>-2.16</td>
<td>1.19</td>
</tr>
<tr>
<td></td>
<td>(-1.03)</td>
<td>(0.51)</td>
</tr>
<tr>
<td>(FLOAT (t))</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.96)</td>
<td>(1.40)</td>
</tr>
<tr>
<td>(VOL (t))</td>
<td>-0.00</td>
<td>-0.00</td>
</tr>
<tr>
<td></td>
<td>(-0.30)</td>
<td>(-0.43)</td>
</tr>
<tr>
<td>(SIZE)</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>(B/M)</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Time-clustered SE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.11</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Conclusion

- propose a framework of bubbles based on extrapolation and the disposition effect
  - a new channel for volume
- examine the model’s predictions about the sources of volume using detailed, account-level data
  - interaction of extrapolation and disposition
  - extensive-margin
  - the trading of “new” stocks
- empirically confirm the role of extrapolators in driving up prices
  - address reverse causality concerns
- support the model’s explanation for the joint dynamics of prices of volume
  - extrapolation drives up prices
  - extrapolation and the disposition effect together generate large volume