Leveraged Bubbles

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[O]ver-investment and over-speculation are often important; but they would have far less serious results were they not conducted with borrowed money.

— Irving Fisher, 1933

What we ask
Should central banks care about bubbles?

What risks do bubbles pose to financial stability?

- Policymakers' views on bubbles have evolved: from benign neglect to activist predisposition

What are the economic costs of bursting bubbles?

- Realization that credit boom + bubble can be dangerous

Are all bubbles alike?

- So far, insufficient empirical evidence

What we do
Large empirical exercise in macro-financial history: new data and methods

Examine the consequences of asset price booms (in equity and house prices), credit booms, and their interaction

New datasets, 16/17 countries, 1870–2012:

- housing price data doubles available sample so far
- add equity price data
- aggregate credit (bank lending), earlier work revised/expanded to include commercial banks, savings banks, bldg. socs., credit unions, postal banks, etc.

What we find
Leverage and bubbles spell trouble...

Crisis risk

- Credit expansion + bubble $\Rightarrow$ financial crises
- Much weaker link with credit alone
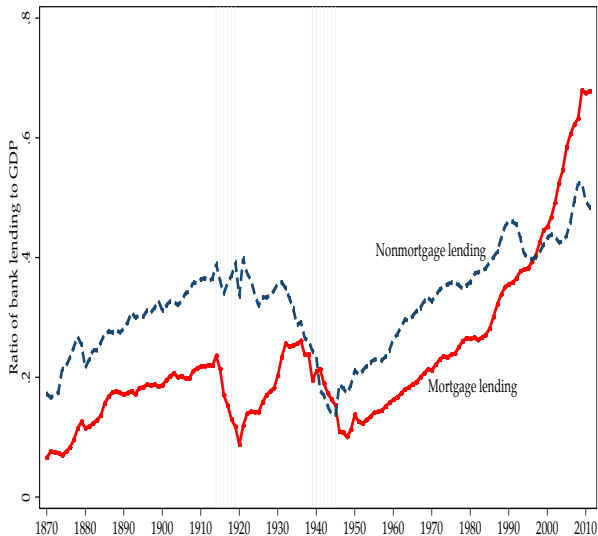- Refines JST (2011) findings

Output costs

- Housing bubble + credit buildup $\Rightarrow$
  deeper recession + slower recovery
- Equity bubbles less damaging

SECULAR TRENDS IN LENDING

Bank lending accelerates post-WW2
## Mortgage lending accelerates even more starting in the mid-1980s
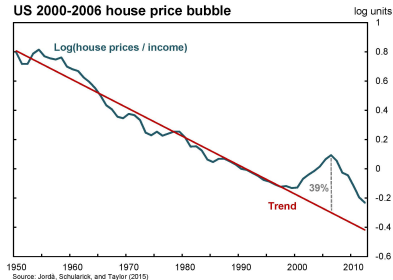
Home ownership rates in the 20th century
In percent

	CAN	GER	FRA	ITA	CHE	U.K.	U.S.	Avg.
1900							47	
1910							46	
1920						23	46	
1930							48	
1940	57					32	44	
1950	66	39	38	40	37	32	47	43
1960	66	34	41	45	34	42	62	46
1970	60	36	45	50	29	50	63	48
1980	63	39	47	59	30	58	64	51
1990	63	39	55	67	31	68	64	55
2000	66	45	56	80	35	69	67	60
2010	69	45	58	82	37	64	65	60

The Anglo-Saxon Housing Booms
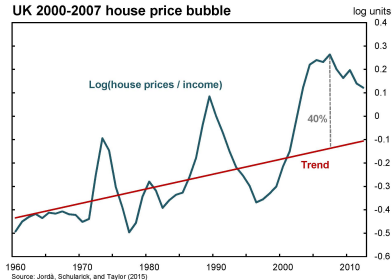
UK/US rates in 2000/2002: 6%/1%, vs. 14%/9%!!
$\rightarrow$ asset price control with interest rates is *expensive*

ASSET PRICES AND BUBBLES: THE DATA

What is an asset price bubble?
Deviation from fundamentals? Many definitions available...

Lack of consensus + lack of data $\Rightarrow$ a pragmatic solution

Let z be a log asset price, z^{HP} denotes its HP cycle

Price Elevation Signal$_{it}$ $=$

$$I(z_{it} > 1 \text{ standard deviation above } z_i^{HP})$$

Price Correction Signal$_{it}$ $=$

$$I(z_{i,t+3} - z_{it} < -15\% \text{ for some year } t \text{ within the episode})$$

Bubble Signal$_{it}$ $\equiv d_{it} =$

$$(\text{Price Elevation Signal}_{it} \times \text{Price Correction Signal}_{it})$$

Features of bubbles
Relative frequency by type of recession

	(1) Pre-WW2	(2) Post-WW2	(3) Full Sample
Financial Crisis Recessions			
No Bubble	10	1	11
Bubble in equity prices only	8	7	15
Bubble in house prices only	2	3	5
Bubbles in both	2	11	13
Total	*22*	*22*	*44*
Normal Recessions			
No Bubble	45	22	67
Bubble in equity prices only	3	29	32
Bubble in house prices only	2	5	7
Bubbles in both	2	6	8
Total	*52*	*62*	*114*

Notes: Recessions are the peaks of business cycles identified using Bry and Boschan (1971) algorithm. A recession is labeled *financial* if it is associated with a financial crisis within a 2 year window of the peak. Otherwise it is labeled *normal*. Bubble episodes are associated with recessions by considering the expansion over which the bubble takes place and using the subsequent peak.

AN ANSWER TO FISHER

Normal v. financial-crisis recessions
Basic logit model specifications to predict recession type

Benchmark, country-fixed effects only

$$Pr[F_{i,t(p)} = 1 | \alpha_i] = \frac{exp(\alpha_i)}{1 + exp(\alpha_i)}$$

Credit-only model

$$Pr[F_{i,t(p)} = 1 | \alpha_i, (x_{i,t(p)} - \bar{x}_i)] = \frac{exp(\alpha_i + \beta(x_{i,t(p)} - \bar{x}_i))}{1 + exp(\alpha_i + \beta(x_{i,t(p)} - \bar{x}_i))}$$

where
p is an index of all business cycle peaks
$F_{i,t(p)}$ is recession type (1=fin. crisis, 0=normal)
$x_{i,t(p)}$ is credit buildup in the expansion

Normal v. financial-crisis recessions
Full model to predict recession type

Full model: credit and bubbles interacted

$$Pr[F_{i,t(p)} = 1 | \alpha_i, (x_{i,t(p)} - \bar{x}_i), d^j_{i,t(p)}]$$

$$= \frac{exp(\alpha_i + \beta(x_{i,t(p)} - \bar{x}_i) + \sum_j \gamma_j d^j_{i,t(p)}(x_{i,t(p)} - \bar{x}_i))}{1 + exp(\alpha_i + \beta(x_{i,t(p)} - \bar{x}_i) + \sum_j \gamma_j d^j_{i,t(p)}(x_{i,t(p)} - \bar{x}_i))}$$

where
p is an index of all business cycle peaks
$F_{i,t(p)}$ is recession type (1=fin. crisis, 0=normal)
$x_{i,t(p)}$ is credit buildup in the expansion
$d^j_{i,t(p)}$ is a bubble type indicator, $j = no, eq., house, both$

Asset price bubbles and financial crises

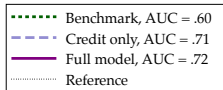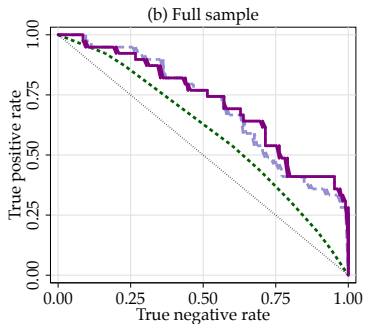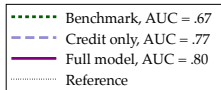|	Full sample			Post-WW2 sample		
	(1) Benchmark	(2) Credit Only	(3) Full model	(4) Benchmark	(5) Credit only	(6) Full model
Credit		0.43*** (0.11)			0.52*** (0.17)	
Housing bubble × credit			0.58*** (0.20)			0.67** (0.29)
Equity bubble × credit			0.41** (0.20)			0.24 (0.27)
No bubble × credit			0.14 (0.16)			0.17 (0.29)
Both bubbles × credit			0.76*** (0.28)			1.00** (0.40)
Pseudo R^2	0.02	0.14	0.17	0.07	0.22	0.27
AUC	0.60 (0.05)	0.71 (0.05)	0.72 (0.05)	0.67 (0.07)	0.77 (0.06)	0.80 (0.06)
Observations	144	144	144	85	85	85

Predictive ability testing using CCF tools

F = outcome (binary), $\widehat{\Phi} = \hat{\beta}X$ signal (continuous), c = threshold

CCF: Plot $TP(c) = P\left(\widehat{\Phi}_t > c | F_t = 1\right)$ v. $TN(c) = P\left(\widehat{\Phi}_t < c | F_t = -1\right)$
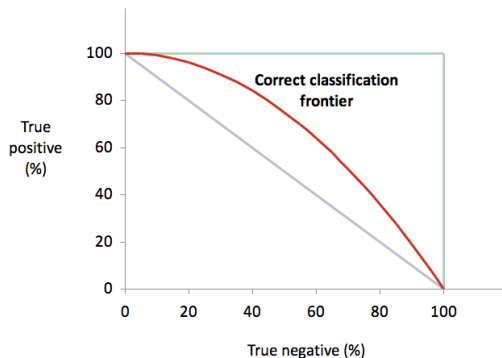
In reality, useful CCFs lie above simplex and inside the square

Bubbles and financial crises: CCFs

(a) Post-WW2 sample

(b) Full sample

Legend (a):
- Benchmark, AUC = .67
- Credit only, AUC = .77
- Full model, AUC = .80
- Reference

Legend (b):
- Benchmark, AUC = .60
- Credit only, AUC = .71
- Full model, AUC = .72
- Reference
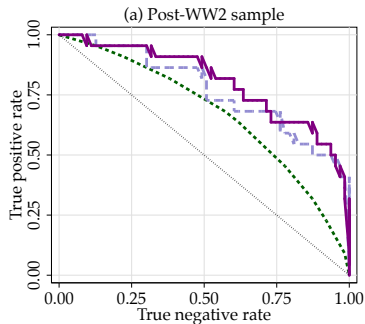
THE ECONOMIC COSTS OF BUBBLES

Benchmark model
Local projections for log GDP p.c. path relative to business cycle peak

$$\Delta_h y_{i,t(p)+h} = y_{i,t(p)+h} - y_{i,t(p)} \text{ for } h = 1, ..., 5$$

$d^j_{i,t(p)}$ for $j = (E)quities, (H)ouses$
 asset price bubble indicator

$\delta_{i,t(p)} = I[(x_{i,t(p)} - \bar{x}_i) > \overline{(x_{i,t(p)} - \bar{x}_i)}]$
 high-low credit buildup indicator

$D_{i,t(p)}$ country indicators, demeaned

$$\Delta_h y_{i,t(p)} = \overbrace{\sum_{i=1}^{I} \alpha_{i,h} D_{i,t(p)}}^{heterogeneity} + \overbrace{\mu_h}^{avg.\ effect} + \sum_j \gamma_h^{j,Hi} d^j_{i,t(p)} \times \delta_{i,t(p)}$$
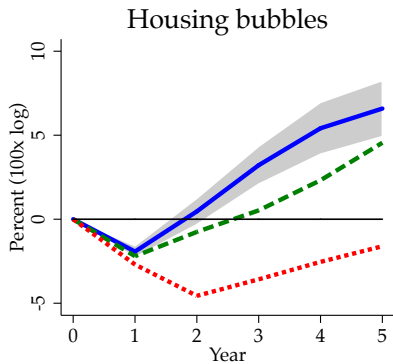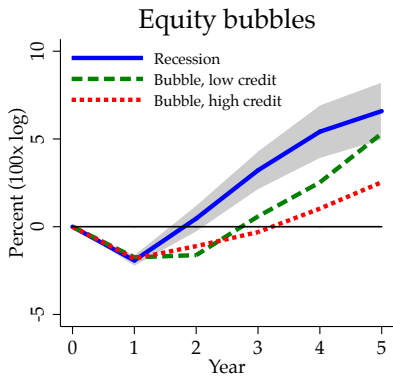$$+ \sum_j \gamma_h^{j,Lo} d^j_{i,t(p)} \times (1 - \delta_{i,t(p)}) + \epsilon_{i,t(p)} \quad \text{for } h = 1, ..., 5$$

Benchmark model. Full sample: 1870–2012

	(1) Year 1	(2) Year 2	(3) Year 3	(4) Year 4	(5) Year 5	(6) Sum
Recession	-1.93 (0.21)	0.46 (0.48)	3.21 (0.69)	5.41 (0.94)	6.59 (1.02)	14.19 (3.43)
Equity bubble, low credit	0.18 (0.46)	-2.09** (0.87)	-2.63* (1.38)	-2.89* (1.40)	-1.27 (1.79)	-8.30 (5.47)
Housing bubble, low credit	-0.27 (0.71)	-1.22 (0.92)	-2.69 (1.64)	-3.10 (2.35)	-2.04 (2.17)	-9.15 (7.33)
Equity bubble, high credit	0.11 (0.64)	-1.57 (1.03)	-3.52** (1.40)	-4.38*** (1.45)	-4.05** (1.64)	-12.82** (5.27)
Housing bubble, high credit	-0.77 (1.64)	-5.03* (2.73)	-6.79** (2.35)	-7.95** (3.69)	-8.20** (3.15)	-29.80** (13.22)
Macro controls	no	no	no	no	no	no
R^2	0.14	0.18	0.22	0.21	0.24	0.23
Observations	139	132	131	131	123	123

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Benchmark LP path

Full sample: 1870–2012

Model specification with controls

Add a control set X consisting of macro controls at time $h = 0, -1$:

$$\Delta_h y_{i,t(p)} = \sum_{i=1}^{I} \alpha_{i,h} D_{i,t(p)} + \mu_h + \beta_h \delta_{i,t(p)} + \sum_j \gamma_h^{j,Hi} d_{i,t(p)}^j \times \delta_{i,t(p)}$$

$$+ \sum_j \gamma_h^{j,Lo} d_{i,t(p)}^j \times (1 - \delta_{i,t(p)}) + X_{i,t(p)} \Psi + \epsilon_{i,t(p)} \quad \text{for } h = 1, ..., 5$$

Controls are:

1. real GDP per capita growth rate
2. real investment per capita growth rate
3. real private loans per capita growth rate
4. CPI inflation rate
5. short-term interest rate
6. long-term interest rate
7. current account to GDP ratio

Benchmark + controls: 1870–2012

	(1) Year 1	(2) Year 2	(3) Year 3	(4) Year 4	(5) Year 5	(6) Sum
Recession	-2.00 (0.31)	-0.72 (0.77)	1.18 (0.66)	4.41 (1.58)	4.48 (1.49)	6.63 (4.68)
Equity bubble, low credit	0.16 (0.54)	-1.40 (0.95)	-1.98 (1.22)	-2.78* (1.43)	-0.96 (1.40)	-6.26 (4.97)
Housing bubble, low credit	-0.45 (0.69)	-1.79 (1.07)	-3.21* (1.73)	-4.06 (2.51)	-3.32 (2.33)	-12.55 (7.64)
Equity bubble, high credit	-0.36 (0.50)	-1.52 (1.56)	-4.00*** (1.30)	-4.08** (1.67)	-4.22* (2.12)	-13.48** (5.71)
Housing bubble, high credit	-0.66 (1.91)	-4.68 (2.80)	-5.89** (2.37)	-7.56* (3.80)	-7.56** (2.78)	-26.82** (12.53)
Macro controls	yes	yes	yes	yes	yes	yes
R^2	0.23	0.30	0.44	0.39	0.50	0.43
Observations	139	132	131	131	123	123

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Benchmark + controls LP path

Full sample: 1870–2012
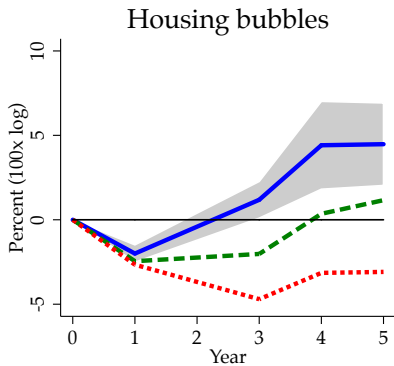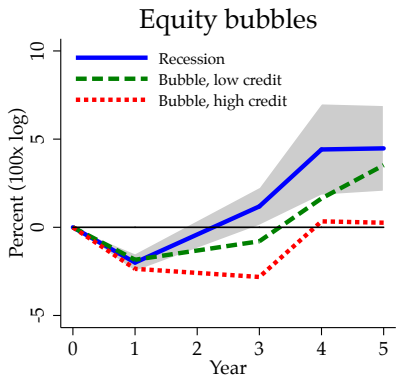
Benchmark + controls: Post-WW2 sample

	(1) Year 1	(2) Year 2	(3) Year 3	(4) Year 4	(5) Year 5	(6) Sum
Recession	-1.50 (0.36)	-0.13 (0.70)	2.50 (1.04)	4.86 (1.80)	7.88 (1.51)	12.86 (4.44)
Equity bubble, low credit	0.40 (0.63)	-0.32 (0.85)	0.09 (1.34)	-0.05 (1.97)	-0.67 (1.62)	0.58 (4.87)
Housing bubble, low credit	-0.47 (0.72)	-2.14* (1.18)	-2.99 (1.89)	-3.62 (2.45)	-3.25 (3.37)	-11.74 (9.90)
Equity bubble, high credit	-0.91* (0.44)	-2.33** (0.95)	-2.17 (1.57)	-2.62 (2.06)	-1.41 (2.54)	-8.92 (6.81)
Housing bubble, high credit	0.62 (0.71)	-3.38** (1.48)	-6.39*** (1.98)	-8.35*** (2.81)	-9.96** (4.27)	-27.37** (12.34)
Macro controls	yes	yes	yes	yes	yes	yes
R^2	0.40	0.61	0.64	0.67	0.70	0.67
Observations	84	77	76	76	68	68

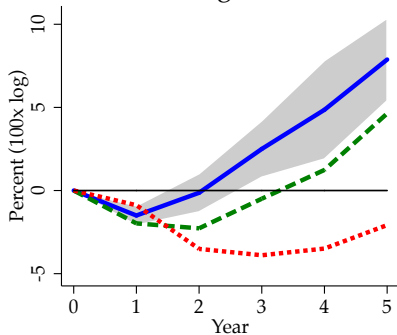*Notes*: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Benchmark + controls LP path

Post-WW2 sample: 1950–2012

Equity bubbles

Housing bubbles

Legend:
- Recession
- Bubble, low credit
- Bubble, high credit
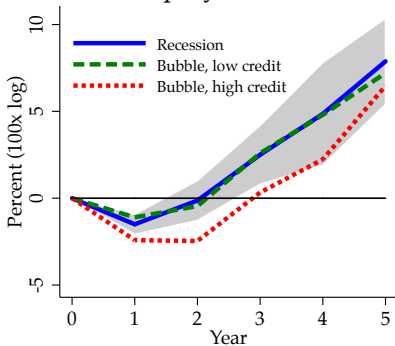
ROBUSTNESS CHECKS

Check 1: financial crisis confounding

Add financial crisis dummy interacted with credit. Sample: 1870–2012

	(1) Year 1	(2) Year 2	(3) Year 3	(4) Year 4	(5) Year 5	(6) Sum
Recession	-1.81	-0.03	1.83	5.01	4.93	9.10
	(0.38)	(0.97)	(0.86)	(1.62)	(1.48)	(5.11)
Equity bubble, low credit	0.44	-0.76	-1.34	-2.21	-0.56	-4.39
	(0.47)	(0.70)	(0.95)	(1.58)	(1.37)	(4.32)
Housing bubble, low credit	-0.20	-1.44	-2.80	-3.72	-2.63	-9.46
	(0.85)	(1.11)	(1.66)	(2.64)	(2.31)	(7.83)
Equity bubble, high credit	-0.34	-1.03	-3.62***	-3.69**	-4.17*	-12.70**
	(0.59)	(1.49)	(1.22)	(1.56)	(2.05)	(5.00)
Housing bubble, high credit	-0.44	-2.21	-3.88*	-5.59	-6.65*	-20.02
	(1.67)	(2.07)	(2.10)	(3.21)	(3.14)	(11.98)
Financial recession, low credit	-1.44	-3.70**	-3.61*	-3.25	-3.52	-17.45*
	(0.82)	(1.66)	(1.90)	(2.62)	(2.28)	(9.67)
Financial recession, high credit	-0.53	-4.46**	-3.70***	-3.60**	-2.13	-14.21**
	(1.03)	(1.67)	(1.20)	(1.56)	(2.33)	(5.90)
Macro controls	yes	yes	yes	yes	yes	yes
R^2	0.27	0.42	0.49	0.42	0.52	0.48
Observations	139	132	131	131	123	123

Check 2: excluding the interwar period
Sample: 1870–1909, 1950–2012

	(1)	(2)	(3)	(4)	(5)	(6)
	Year 1	Year 2	Year 3	Year 4	Year 5	Sum
Recession	-1.46	0.47	1.75	6.25	6.79	12.66
	(0.45)	(1.12)	(0.95)	(2.07)	(1.59)	(6.24)
Equity bubble, low credit	0.25	-1.12	-0.29	-2.33	-0.99	-1.56
	(0.65)	(1.30)	(1.59)	(2.63)	(1.62)	(7.00)
Housing bubble, low credit	-0.94	-2.73*	-4.58*	-5.77*	-5.68*	-18.62*
	(1.02)	(1.30)	(2.16)	(3.11)	(2.72)	(9.80)
Equity bubble, high credit	-0.34	-0.46	-2.79**	-2.36	-3.05	-9.77*
	(0.54)	(1.49)	(1.22)	(1.45)	(1.80)	(5.30)
Housing bubble, high credit	-1.48	-5.00*	-6.09**	-7.05*	-7.23***	-25.64**
	(1.85)	(2.67)	(2.21)	(3.45)	(2.42)	(9.88)
Macro controls	yes	yes	yes	yes	yes	yes
R^2	0.36	0.37	0.49	0.47	0.58	0.54
Observations	123	116	115	115	107	107

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Check 3: excluding the global financial crisis
Sample: 1870–2008

	(1) Year 1	(2) Year 2	(3) Year 3	(4) Year 4	(5) Year 5	(6) Sum
Recession	-2.26	-0.27	1.65	5.17	5.55	9.85
	(0.37)	(0.84)	(0.77)	(1.59)	(1.32)	(4.36)
Equity bubble, low credit	0.44	-1.64	-2.25	-3.13**	-1.47	-8.05
	(0.53)	(1.11)	(1.42)	(1.42)	(1.39)	(4.93)
Housing bubble, low credit	-0.35	-1.57	-3.02	-4.00	-3.18	-12.12
	(0.63)	(1.14)	(1.77)	(2.54)	(2.38)	(7.83)
Equity bubble, high credit	0.06	-1.01	-3.89**	-3.62*	-3.87	-12.34*
	(0.47)	(1.48)	(1.55)	(1.77)	(2.28)	(6.01)
Housing bubble, high credit	-0.73	-4.57	-5.80**	-7.40*	-7.25**	-25.74*
	(1.77)	(2.83)	(2.25)	(3.64)	(2.85)	(12.64)
Macro controls	yes	yes	yes	yes	yes	yes
R^2	0.29	0.30	0.44	0.40	0.49	0.42
Observations	123	123	123	123	123	123

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Conclusion

Leveraged bubbles spell trouble: ignore at your peril

- The combination of asset price bubbles and credit booms substantially increases crisis risks: this refines earlier results on the role of credit alone

- House price bubbles are less frequent than equity bubbles and more often end up in financial crises

- Credit fueled housing bubbles are particular costly: they lead to deeper recessions and slower recoveries