When to lean against the wind

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Credit booms: two sides of the same coin

Credit deepening is associated with...

- ...improvements in financial intermediation and economic growth (King and Levine 1993; Rousseau and Wachtel 1998)

as well as

- ...higher risk of experiencing a financial crisis (Schularick and Taylor 2012).

Macroprudential policy

Monetary or macroprudential policies to deal with booms?

- Large literature on the output and inflation effects of monetary policy: Ramey (2016).
- Costs and benefits of leaning against the wind still debated (Svensson (2017), Adrian and Liang (2016)).
- Large set of macroprudential policies to deal with booms (Cerutti et al. 2015).
- Some evidence on the real economic effects of macroprudential policy: Richter, Schularick, Shim (2018).

One step back: before taking action can we tell if a credit boom is good or bad?

Good booms and bad booms - mixed evidence

Are bad credit booms detectable?

- Mendoza and Terrones (2012): credit growth and capital inflows more pronounced for crisis observations.
- Gorton and Ordonez (2018): dynamics of productivity matter.
- In general Dell'Arricia et al. (2016): difficult to tell crisis and non-crisis booms apart.

What we do

- We use a sample of 17 countries from 1870 to 2013,
- Use a new and promising procedure for detrending proposed by Hamilton (2017)
- Apply country-specific thresholds to identify credit booms
- Identify 112 credit booms of which 29 are followed by a financial crisis (bad)
- Analyze whether there are observable differences between the two types of credit booms.

What we find

- **There are clear markers of good and bad booms.**
- Bad booms are characterized by:
  - House price booms
  - Rising loan-to-deposit ratios in the banking sector
  - Deteriorating current account balances
- These characteristics have high predictive ability.
- **And central banks can detect them in REAL TIME.**

Detrending procedure

We use a detrending procedure recently proposed by Hamilton (2017).

Intuition: The credit cycle is the component in credit that could not be predicted $h = 3$ years ago.

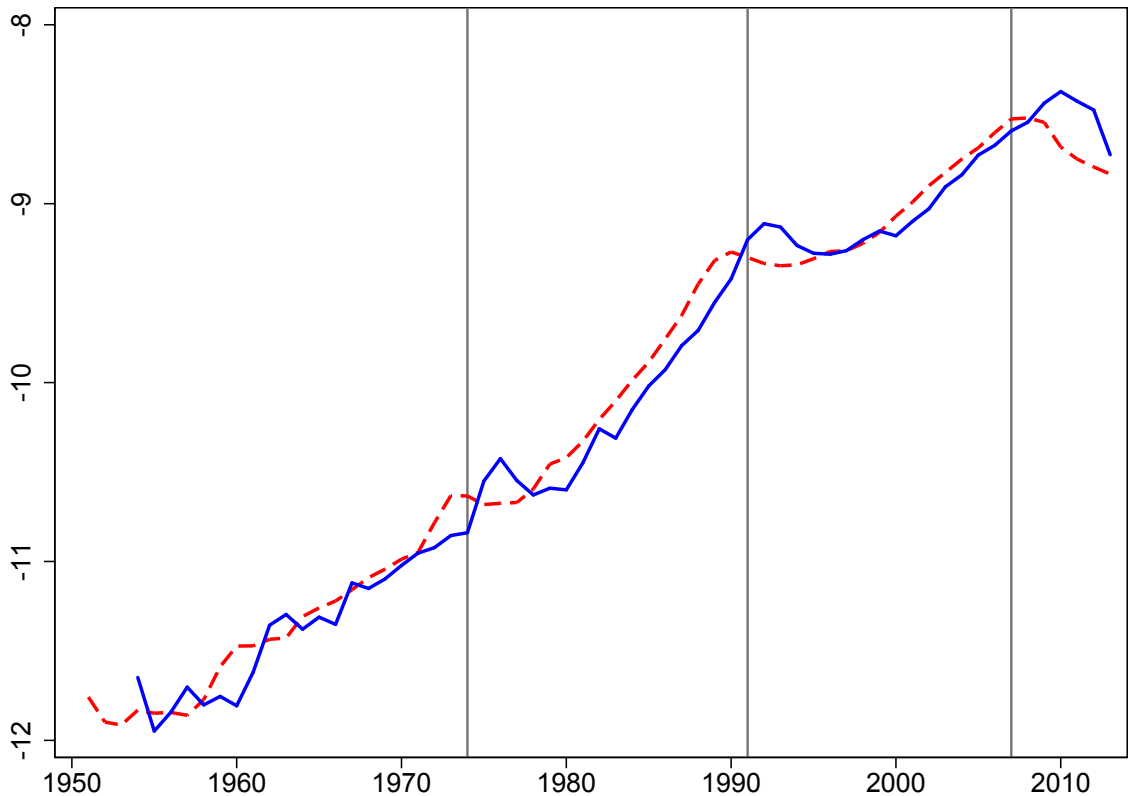
Formally: We estimate a regression of credit (y) at time t on the 4 most recent values at time $t - h$.

$$y_t = \beta_0 + \beta_1 y_{t-h} + \beta_2 y_{t-h-1} + \beta_3 y_{t-h-2} + \beta_4 y_{t-h-3} + v_t$$

Detrended credit c_t is the residual $\hat{v}_t$ of this regression.

Example UK

Figure: Raw data (red) and trend (blue) of log real private credit per capita in the United Kingdom



Boom definitions

To identify booms we apply the following procedure:

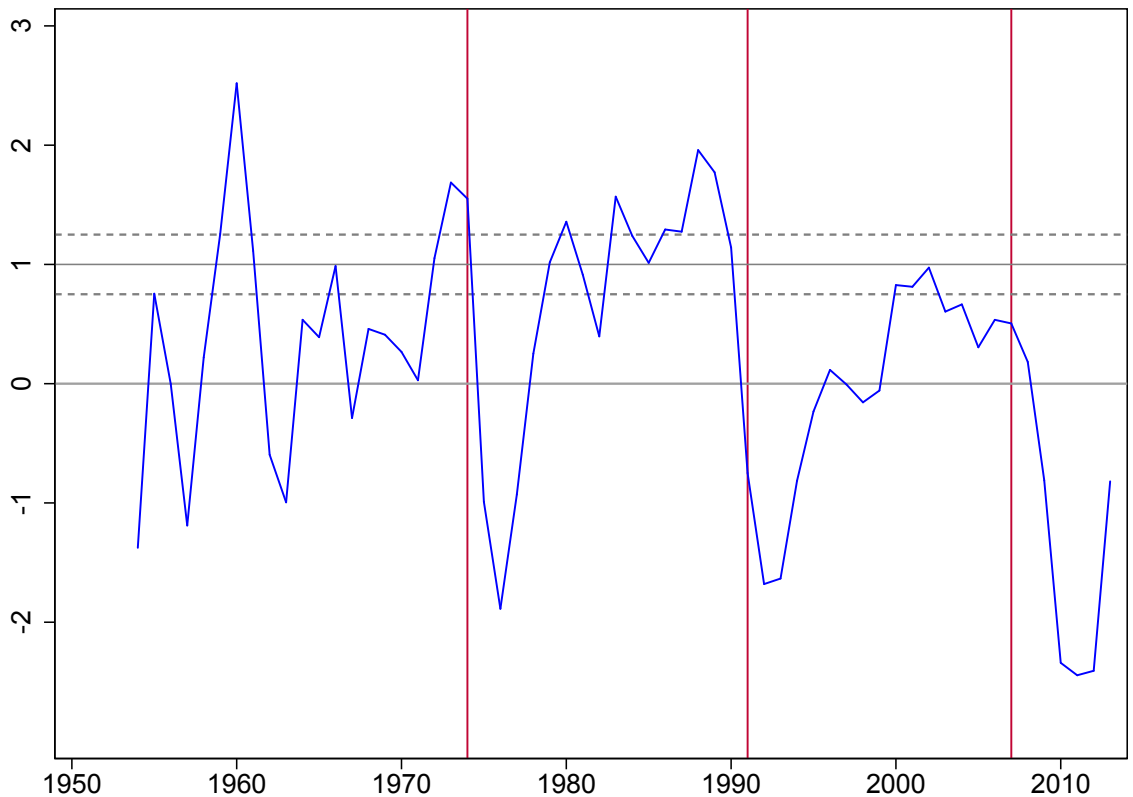
- Normalize detrended credit ($c_{i,t}$) by country specific standard deviation to identify unusually large deviations.
- A country-year observation is a boom observation if normalized measure is larger than 1, i.e., $c_{i,t}$ greater $\sigma(c_i)$:

$$\text{Credit Boom}_{i,t} = I(c_{i,t} > \text{standard deviation of c in country i})$$

- Subsequent boom observations are combined into one boom episode.
- Country-year observations that are preceeded and followed by a boom are integrated into the boom episode.

Identifying booms

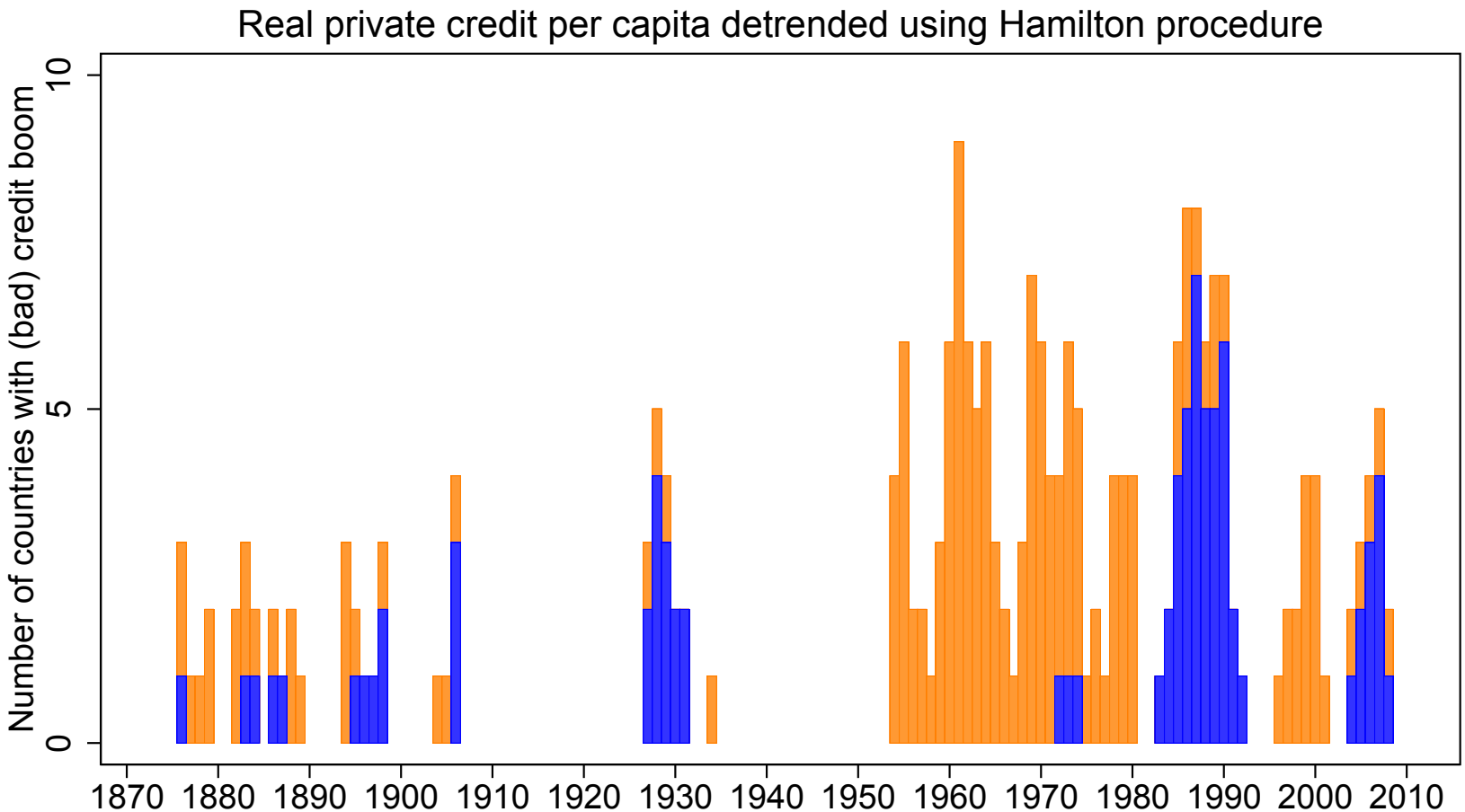
Figure: Detrended credit in the United Kingdom



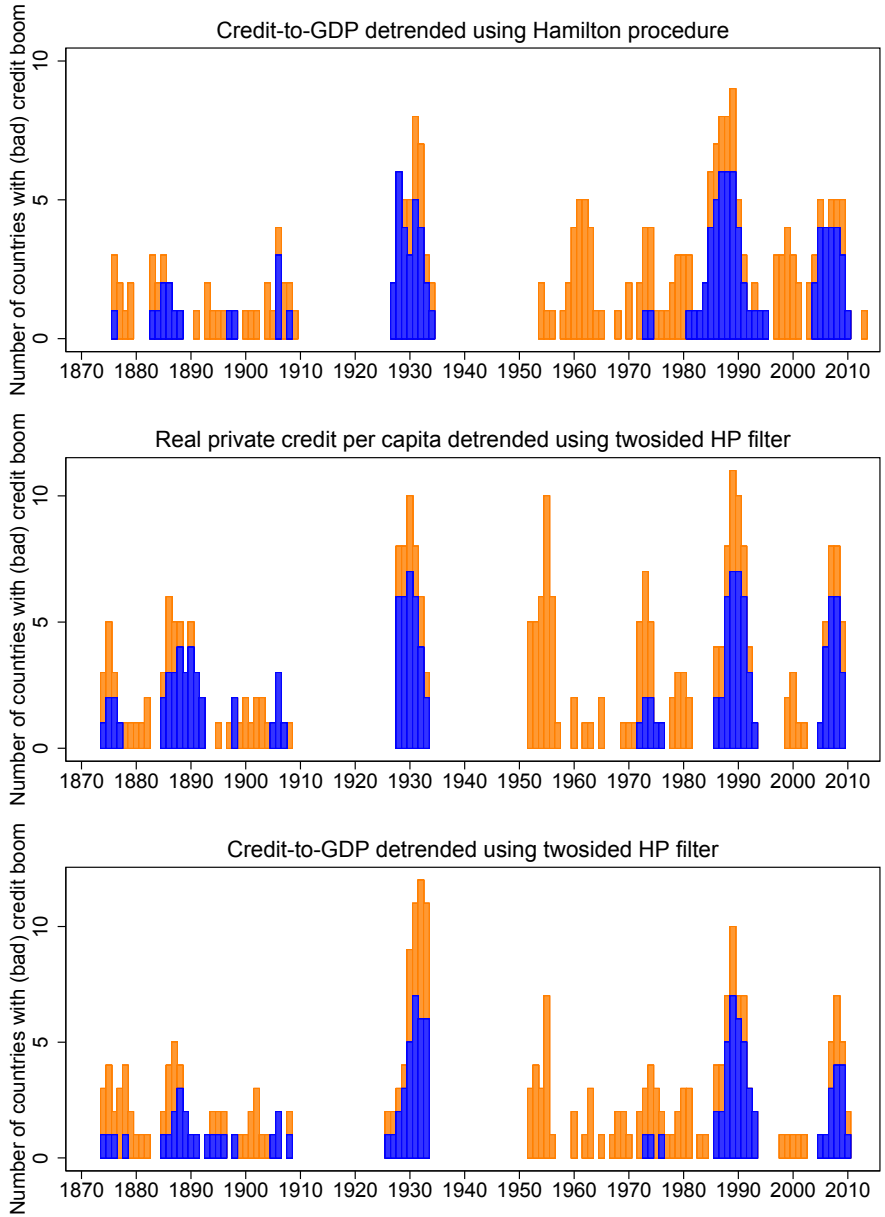
Notes: This figure presents the normalized cyclical component of real private credit per capita in the UK. Red vertical lines indicate dates of systemic financial distress defined in Jordà et al. (2016).

Credit booms: 1870-2013

Figure: Number of ongoing credit booms by year



Alternative boom definitions



Crisis definition

Definition of systemic financial crises follows Laeven and Valencia (2008): "major bank failures, substantial losses, recapitalization, or government intervention..."

AUS:	1893, 1989.
BEL:	1870, 1885, 1925, 1931, 1934, 1939, 2008.
CAN:	1907.
CHE:	1870, 1910, 1931, 1991, 2008.
DEU:	1873, 1891, 1901, 1907, 1931, 2008.
DNK:	1877, 1885, 1908, 1921, 1931, 1987, 2008.
ESP:	1883, 1890, 1913, 1920, 1924, 1931, 1978, 2008.
FIN:	1878, 1900, 1921, 1931, 1991.
FRA:	1882, 1889, 1930, 2008.
GBR:	1890, 1974, 1991, 2007.
ITA:	1873, 1887, 1893, 1907, 1921, 1930, 1935, 1990, 2008.
JPN:	1871, 1890, 1907, 1920, 1927, 1997.
NLD:	1893, 1907, 1921, 1939, 2008.
NOR:	1899, 1922, 1931, 1988.
PRT:	1890, 1920, 1923, 1931, 2008.
SWE:	1878, 1907, 1922, 1931, 1991, 2008.
USA:	1873, 1893, 1907, 1929, 1984, 2007.

Binary classification models

The log-odds ratio of a crisis in country i at time t conditional on observables:

$$\log\left(\frac{Pr[S_{i,t}=1|X_{i,t}]}{Pr[S_{i,t}=0|X_{i,t}]}\right)=\alpha_i+\beta X_{i,t}\,,$$

where:

$S_{i,t}$ is the financial crisis dummy (Jordà et al. (2016)).

α_i is a country fixed effect.

$X_{i,t}$ includes either the detrended and normalized credit variable or the boom indicator (one-period lagged values).

Credit booms and banking crises

	All years	All years	Pre-WW2	Pre-WW2	Post-WW2	Post-WW2
Detrended credit	0.61***		0.70***		0.86***	
	(0.15)		(0.18)		(0.23)	
Credit boom		1.27***		1.61***		1.54***
		(0.30)		(0.52)		(0.42)
Pseudo R^2	0.054	0.054	0.082	0.078	0.080	0.072
AUC	0.69	0.68	0.72	0.69	0.73	0.69
s.e.	0.04	0.04	0.05	0.05	0.06	0.07
Observations	1517	1517	516	516	942	942

Notes: Logit models for banking crises. Detrended credit is standardized at the country level, see text. Credit boom is a dummy that is 1 if detrended credit exceeds the boom threshold, 0 otherwise. Both variables are included as first lag. Country fixed effects are included. Clustered standard errors reported in parentheses. AUC is the area under the receiver operating curve, and s.e. is its standard error.

Boom characteristics

- **Peak** refers to the observation with the highest value of detrended credit within a boom episode.
- **Duration** refers to the number of years until the peak is reached.
- **Size** refers to the average of detrended credit in the years until the peak is reached.
- A boom is characterized as **bad** if there is a financial crisis during the boom or in the 3 years after the peak.
- **Other variables** are detrended and normalized using the same procedure as for credit.

Variables included

1. Baseline: Duration (until peak) of the credit boom and size (averaged until peak).
2. Real economic fundamentals: Detrended and normalized GDP, consumption, investment, the current account balance and interest rates.
3. Bank balance sheets: Credit-to-GDP in levels, detrended and normalized capital, noncore funding, and loan-to-deposit ratios.
4. Asset prices: Detrended and normalized stock and house prices.

Summary statistics

	Bad booms					Good booms				
	Mean	Min.	Max.	S.D.	Obs.	Mean	Min.	Max.	S.D.	Obs.
Boom with crisis	1.00	1.00	1.00	0.00	29	0.00	0.00	0.00	0.00	83
Size	1.77	1.03	3.11	0.48	29	1.51	1.00	3.44	0.51	83
Duration	2.69	1.00	8.00	1.79	29	1.93	1.00	7.00	1.27	83
Duration to peak	1.90	1.00	6.00	1.32	29	1.52	1.00	4.00	0.77	83
GDP	0.64	-1.47	1.77	0.72	29	0.71	-3.54	2.81	0.91	83
Consumption	0.75	-1.23	2.98	0.97	29	0.70	-2.63	2.46	0.77	81
Current Account	-0.76	-2.99	1.58	1.15	28	-0.25	-2.17	2.47	0.84	80
Investment	0.71	-0.92	3.26	0.94	27	0.53	-2.44	2.64	0.90	81
Short term rate	0.16	-1.57	4.07	1.21	26	0.21	-1.66	3.70	1.07	76
Long term rate	0.10	-1.35	1.86	0.81	29	0.14	-2.63	2.88	1.00	82
Loans-to-GDP	4.09	2.43	5.14	0.67	29	3.84	1.04	4.72	0.66	83
Capital ratio	-0.10	-5.19	3.60	1.57	28	-0.25	-3.02	3.63	0.84	79
Noncore	0.05	-2.45	3.86	1.24	27	0.04	-2.16	2.46	0.78	79
Loans-to-deposits	1.13	-1.42	3.68	1.37	27	0.26	-3.28	2.41	0.91	79
House price index	1.30	-0.46	4.18	1.10	22	0.34	-1.21	4.33	0.94	72
Stock price index	0.50	-2.40	2.89	1.17	23	0.23	-2.73	4.71	1.05	75

Do good and bad booms differ?

	Coefficient	t-stat
Boom with crisis	1.00	.
Size	0.26*	2.40
Duration	0.76*	2.49
Duration to peak	0.38	1.86
GDP	-0.06	-0.33
Consumption	0.06	0.32
Current Account	-0.51*	-2.49
Investment	0.19	0.92
Short term rate	-0.05	-0.20
Long term rate	-0.05	-0.22
Credit-to-GDP	0.25	1.77
Capital ratio	0.15	0.62
Noncore	0.01	0.05
Loans-to-Deposits	0.87***	3.73
House price index	0.96***	4.05
Stock price index	0.28	1.08
Observations	112	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Classification models for good and bad booms

The log-odds ratio of boom b in country i being bad, conditional on observables:

$$log\left(\frac{Pr[B_{i,b}=1|Z_{i,b}]}{Pr[B_{i,b}=0|Z_{i,b}]}\right)=\alpha+\beta Z_{i,b}\,,$$

where:

$B_{i,b}$ is the bad boom dummy variable.

$Z_{i,b}$ includes boom characteristics.

Boom characteristics: baseline

	Size (1)	Duration (2)	Both (3)
Panel A: Full sample			
Size of boom	1.38**		1.26**
	(0.62)		(0.63)
Duration to peak		0.38*	0.30
		(0.20)	(0.21)
Pseudo R^2	0.047	0.025	0.062
AUC	0.68	0.56	0.68
s.e.	0.06	0.06	0.06
Observations	112	112	112
Panel B: Reduced sample —including country fixed effects			
Size of boom	2.28**		2.09*
	(1.12)		(1.15)
Duration to peak		0.49**	0.33
		(0.24)	(0.24)
Pseudo R^2	0.149	0.100	0.162
AUC	0.76	0.70	0.78
s.e.	0.06	0.06	0.06
Observations	98	98	98

Adding economic fundamentals

	Base	GDP	Cons.	Invest.	Current account	Short-rate	Long-rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Full sample							
Size of boom	1.12	1.12	1.14	1.03	1.25	1.05	1.08
	(0.82)	(0.81)	(0.84)	(0.89)	(0.91)	(0.76)	(0.76)
Duration to peak	0.35	0.35	0.37*	0.31	0.35	0.36	0.35
	(0.22)	(0.22)	(0.22)	(0.23)	(0.22)	(0.23)	(0.22)
Real variable (see column header)		-0.04	-0.13	0.52**	-0.76**	-0.21	-0.14
		(0.27)	(0.32)	(0.26)	(0.31)	(0.40)	(0.30)
Pseudo R^2	0.063	0.063	0.064	0.081	0.144	0.067	0.066
AUC	0.68	0.68	0.69	0.71	0.76	0.69	0.67
s.e.	0.07	0.07	0.06	0.06	0.06	0.06	0.06
Observations	90	90	90	90	90	90	90
Panel B: Reduced sample							
Size of boom	2.03	2.05	2.14	1.96	2.51	1.73	1.88
	(1.40)	(1.35)	(1.39)	(1.45)	(1.56)	(1.41)	(1.29)
Duration to peak	0.42	0.50*	0.56*	0.40	0.60*	0.46	0.43
	(0.30)	(0.30)	(0.29)	(0.31)	(0.36)	(0.34)	(0.30)
Real variable (see column header)		-0.36	-0.59	0.26	-1.25***	-0.35	-0.18
		(0.42)	(0.54)	(0.27)	(0.40)	(0.65)	(0.35)
Pseudo R^2	0.162	0.169	0.178	0.165	0.299	0.169	0.165
AUC	0.77	0.77	0.77	0.77	0.83	0.76	0.76
s.e.	0.07	0.07	0.06	0.07	0.05	0.06	0.07
Observations	72	72	72	72	72	72	72

Adding bank variables

	Base (1)	Credit-to-GDP (2)	Cap. Ratio (3)	Noncore (4)	Loan-to-Dep. (5)
Panel A: Full sample					
Size of boom	1.19	1.22	1.26*	1.19	1.31*
	(0.73)	(0.75)	(0.74)	(0.73)	(0.71)
Duration to peak	0.31	0.26	0.30*	0.30	0.07
	(0.19)	(0.20)	(0.18)	(0.20)	(0.26)
Banking variable (see column header)		0.49	0.35	0.02	0.66***
		(0.57)	(0.31)	(0.18)	(0.22)
Pseudo R^2	0.060	0.070	0.082	0.060	0.116
AUC	0.68	0.67	0.68	0.68	0.74
s.e.	0.06	0.07	0.07	0.06	0.06
Observations	101	101	101	101	101
Panel B: Reduced sample					
Size of boom	2.07	2.04	2.11	2.07	2.16
	(1.45)	(1.44)	(1.44)	(1.47)	(1.47)
Duration to peak	0.41	0.37	0.38	0.37	0.16
	(0.28)	(0.28)	(0.27)	(0.26)	(0.33)
Banking variable (see column header)		0.30	0.23	0.08	0.65**
		(0.71)	(0.34)	(0.21)	(0.26)
Pseudo R^2	0.169	0.172	0.179	0.170	0.208
AUC	0.78	0.79	0.79	0.78	0.80
s.e.	0.06	0.06	0.06	0.06	0.06
Observations	86	86	86	86	86

Adding asset prices

	Baseline (1)	House prices (2)	Stock prices (3)	Both (4)
Panel A: Full sample				
Size of boom	1.61	1.61	1.81*	2.00*
	(0.99)	(1.13)	(0.98)	(1.15)
Duration to peak	0.49**	0.42	0.51**	0.47
	(0.23)	(0.28)	(0.24)	(0.31)
House Price Index		0.84**		0.91**
		(0.38)		(0.38)
Stock Price Index			-0.20	-0.40
			(0.28)	(0.34)
Pseudo R^2	0.111	0.207	0.116	0.223
AUC	0.72	0.82	0.73	0.82
s.e.	0.07	0.05	0.07	0.05
Observations	85	85	85	85
Panel B: Reduced sample				
Size of boom	2.36	2.59	3.73**	6.12**
	(1.75)	(1.66)	(1.79)	(2.46)
Duration to peak	0.75**	0.71	0.91**	0.97
	(0.35)	(0.46)	(0.40)	(0.68)
House Price Index		1.43**		2.14***
		(0.57)		(0.65)
Stock Price Index			-0.95**	-1.86***
			(0.41)	(0.68)
Pseudo R^2	0.232	0.380	0.283	0.499
AUC	0.81	0.89	0.84	0.92
s.e.	0.07	0.04	0.06	0.03
Observations	64	64	64	64

All

	Baseline	House prices	LtD ratio	Full	Full (lower threshold)
	(1)	(2)	(3)	(4)	(5)
Panel A: Full sample					
Size of boom	1.42	1.27	1.18	1.48	1.55**
	(1.00)	(1.08)	(1.10)	(1.11)	(0.66)
Duration to peak	0.43*	0.39	0.15	0.18	0.05
	(0.22)	(0.27)	(0.33)	(0.30)	(0.19)
House price index		0.86**	0.80**	0.83**	0.92**
		(0.39)	(0.39)	(0.42)	(0.42)
Loan-to-deposits			0.72**	0.61*	0.44
			(0.30)	(0.34)	(0.37)
Current account				-0.81**	-0.87**
				(0.39)	(0.36)
Pseudo R^2	0.089	0.185	0.242	0.287	0.261
AUC	0.70	0.80	0.85	0.87	0.86
	0.07	0.05	0.05	0.04	0.05
Observations	86	86	86	86	101

GDP after credit booms

Do these variables also predict output conditional on credit booms?

Let us denote: $\Delta_3 y_{i,t} = log(realGDP_{i,t+3}) - log(realGDP_{i,t})$

We then run the following specification on the set of 86 boom observations in the full model

$$\Delta_3 y_{i,t(p)} = \alpha + \beta Z_{i,b} + \epsilon_{i,b}.$$

3-year GDP growth

	(1)	(2)	(3)	(4)
Panel A: Full sample				
Size of boom	-0.03	-0.02	-0.02	-0.02
	(0.03)	(0.03)	(0.02)	(0.02)
Duration to peak	-0.01	-0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
House price index		-0.03***	-0.03***	-0.03**
		(0.01)	(0.01)	(0.01)
Loan-to-deposits			-0.02***	-0.01*
			(0.01)	(0.01)
Current account				0.02
				(0.01)
R^2	0.028	0.124	0.151	0.173
Observations	86	86	86	86
Panel B: Reduced sample				
Size of boom	-0.03	-0.01	-0.02	-0.02
	(0.03)	(0.04)	(0.03)	(0.03)
Duration to peak	-0.01	-0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
House price index		-0.03**	-0.03*	-0.03*
		(0.01)	(0.01)	(0.01)
Loan-to-deposits			-0.02**	-0.02**
			(0.01)	(0.01)
Current account				0.02
				(0.02)
R^2	0.252	0.338	0.378	0.398
Observations	86	86	86	86

Can we spot the danger in real time?

So far: data used at peak of credit boom.

Problem: policy-maker does not know whether the peak of a credit boom has already been reached.

Real time information:

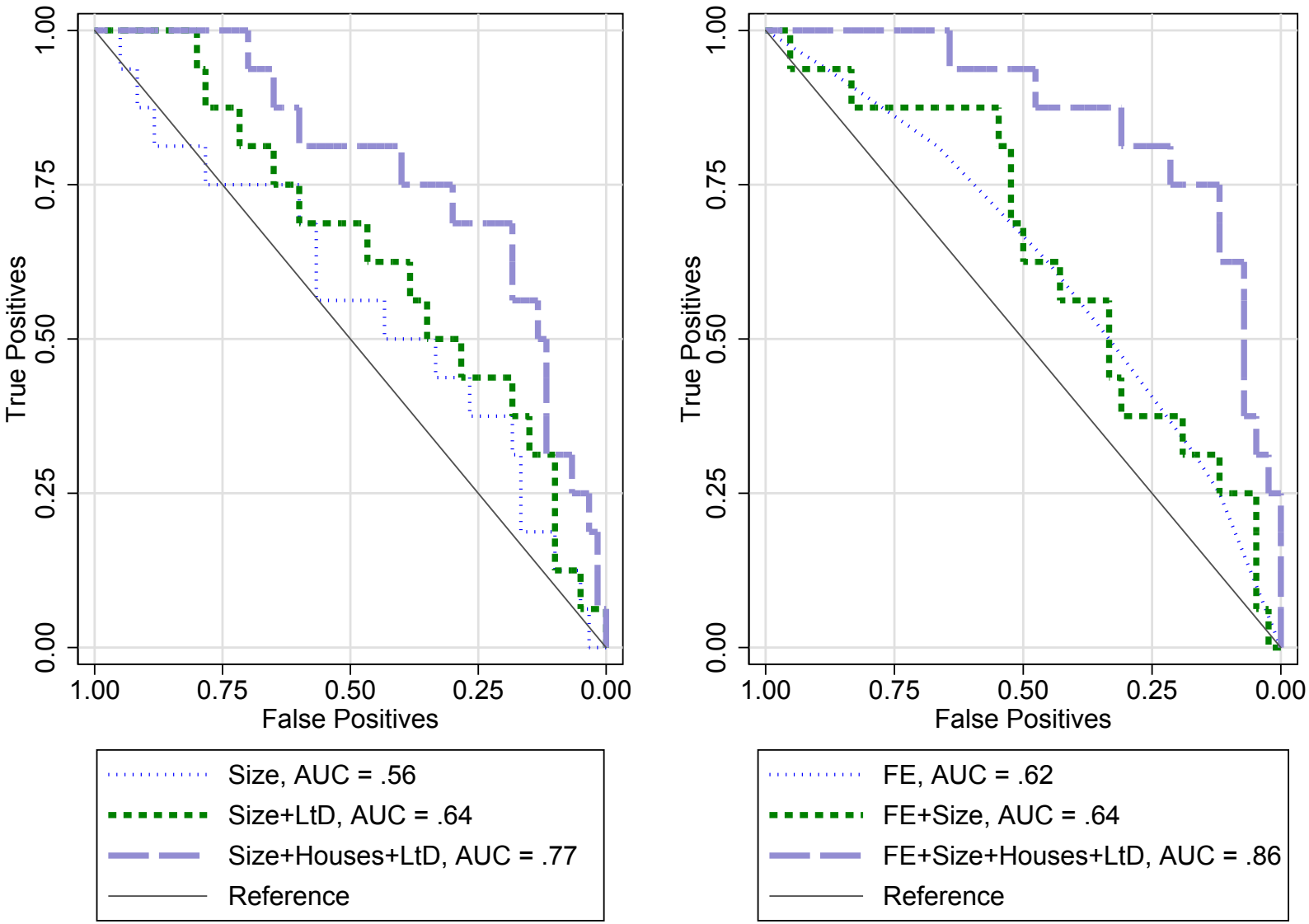
- Use information at the time when the credit boom threshold is first reached (observable in real time).
- Drop booms that turn into a financial crisis in the first year of the boom.
- The loan-to-deposit and house prices contain again valuable information.

Real time

	(1)	(2)	(3)	(4)
Panel A: Full sample				
Initial size of boom	0.48	0.51	0.62	0.68
	(0.61)	(0.60)	(0.77)	(0.71)
Loans-to-deposits		0.48**		0.30
		(0.20)		(0.23)
House price index			0.73***	0.68***
			(0.23)	(0.22)
Pseudo R^2	0.006	0.047	0.144	0.156
AUC	0.56	0.64	0.76	0.77
	0.09	0.08	0.06	0.07
Observations	76	76	76	76
Panel B: Reduced sample				
Initial size of boom	0.74	0.86	1.61	1.75
	(0.83)	(0.76)	(1.25)	(1.08)
Loans-to-deposits		0.99***		0.82*
		(0.31)		(0.45)
House price index			1.24***	1.16***
			(0.37)	(0.32)
Pseudo R^2	0.046	0.157	0.282	0.332
AUC	0.64	0.76	0.83	0.86
	0.08	0.08	0.06	0.05
Observations	58	58	58	58

Can bad booms be identified in real time?

Figure: Correct classification frontiers.



Real time - post WW2 data

	(1)	(2)	(3)	(4)
Panel A: Full sample				
Initial size of boom	0.67	0.82	0.82	0.93
	(0.69)	(0.69)	(0.91)	(0.87)
Loans-to-deposits		0.62**		0.40
		(0.26)		(0.32)
House price index			0.87***	0.80**
			(0.31)	(0.31)
Pseudo R^2	0.014	0.082	0.201	0.220
AUC	0.56	0.69	0.80	0.83
	0.11	0.10	0.07	0.06
Observations	59	59	59	59
Panel B: Reduced sample				
Initial size of boom	0.95	2.70**	3.42	7.92***
	(1.08)	(1.07)	(2.20)	(2.32)
Loans-to-deposits		2.18***		3.98***
		(0.70)		(1.30)
House price index			2.16**	2.79*
			(0.93)	(1.50)
Pseudo R^2	0.063	0.335	0.414	0.650
AUC	0.64	0.85	0.90	0.96
	0.10	0.06	0.06	0.03
Observations	39	39	39	39

Real time - robustness

	Real Credit Booms			Credit-to-GDP Booms		
Boom threshold	0.75	1	1.25	0.75	1	1.25
Panel A: Full sample						
Initial size of boom	0.90*	0.68	2.20**	0.19	0.19	0.53
	(0.54)	(0.71)	(0.89)	(0.58)	(0.97)	(1.39)
House price index	0.74***	0.68***	0.79***	0.48***	0.54***	0.77***
	(0.21)	(0.22)	(0.28)	(0.17)	(0.21)	(0.27)
Loans-to-deposits	0.42	0.30	0.58	0.32	0.70***	0.58
	(0.33)	(0.23)	(0.37)	(0.32)	(0.25)	(0.37)
Pseudo R^2	0.155	0.156	0.261	0.072	0.147	0.228
AUC	0.76	0.77	0.85	0.70	0.76	0.80
	0.07	0.07	0.06	0.07	0.07	0.07
Observations	79	76	57	82	68	54
Panel B: Reduced sample						
Initial size of boom	1.33*	1.75	3.80*	0.48	3.60	3.51
	(0.75)	(1.08)	(2.11)	(0.88)	(2.85)	(2.97)
House price index	0.82**	1.16***	1.53*	0.70**	1.03**	1.25**
	(0.38)	(0.32)	(0.91)	(0.30)	(0.46)	(0.59)
Loans-to-deposits	0.91*	0.82*	0.71	0.89	1.70***	1.26**
	(0.52)	(0.45)	(0.51)	(0.62)	(0.51)	(0.54)
Pseudo R^2	0.248	0.332	0.417	0.183	0.363	0.377
AUC	0.82	0.86	0.89	0.75	0.85	0.86
	0.06	0.05	0.05	0.07	0.06	0.06
Observations	65	58	35	72	46	36

Second exercise

Booms in the 2000s: can we predict out of sample?

- Run logit model on data until 1999
- Use coefficients to calculate probabilities for booms after 2000 to end badly
- The model attaches low probabilities to good booms and high probabilities to bad booms

Booms after 1999

	Start	Outcome	(1) Initial Size	(2) Size + House Prices	(3) Size+ House Prices + LtD
Finland	2000	good	0.190	0.221	0.237
Finland	2003	good	0.189	0.241	0.265
Italy	2007	bad	0.176	0.195	0.279
Denmark	2000	good	0.185	0.251	0.284
Spain	2005	bad	0.231	0.358	0.412
USA	2004	bad	0.182	0.459	0.416
Norway	2005	good	0.229	0.425	0.464
Sweden	2005	bad	0.188	0.559	0.493
Denmark	2005	bad	0.267	0.558	0.642

Notes: This table presents predicted probabilities of a boom after the year 2000 being bad based on information available in the first year of the boom. Probabilities are based on coefficients from logit classification models estimated using available data until 1999. Models are including the size of the boom (1) and adding house prices (2) and additionally loan-to-deposits (3).

Robustness

Results are robust to varying...

- The credit measure to identify a boom: credit-to-GDP instead of real credit per capita;
- The detrending procedure: two-sided HP filter instead of the Hamilton (2017) method;
- The crisis chronology: Baron, Verner and Xiong (2018);
- The horizon h: $h = 5$ instead of $h = 3$.

Conclusions

- Policy-makers can distinguish between good and bad booms and can do so in real time.
- Most important markers of bad credit booms are house price booms and elevated loan-to-deposit ratios.