"Semi-Structural Credit Gap Estimation"

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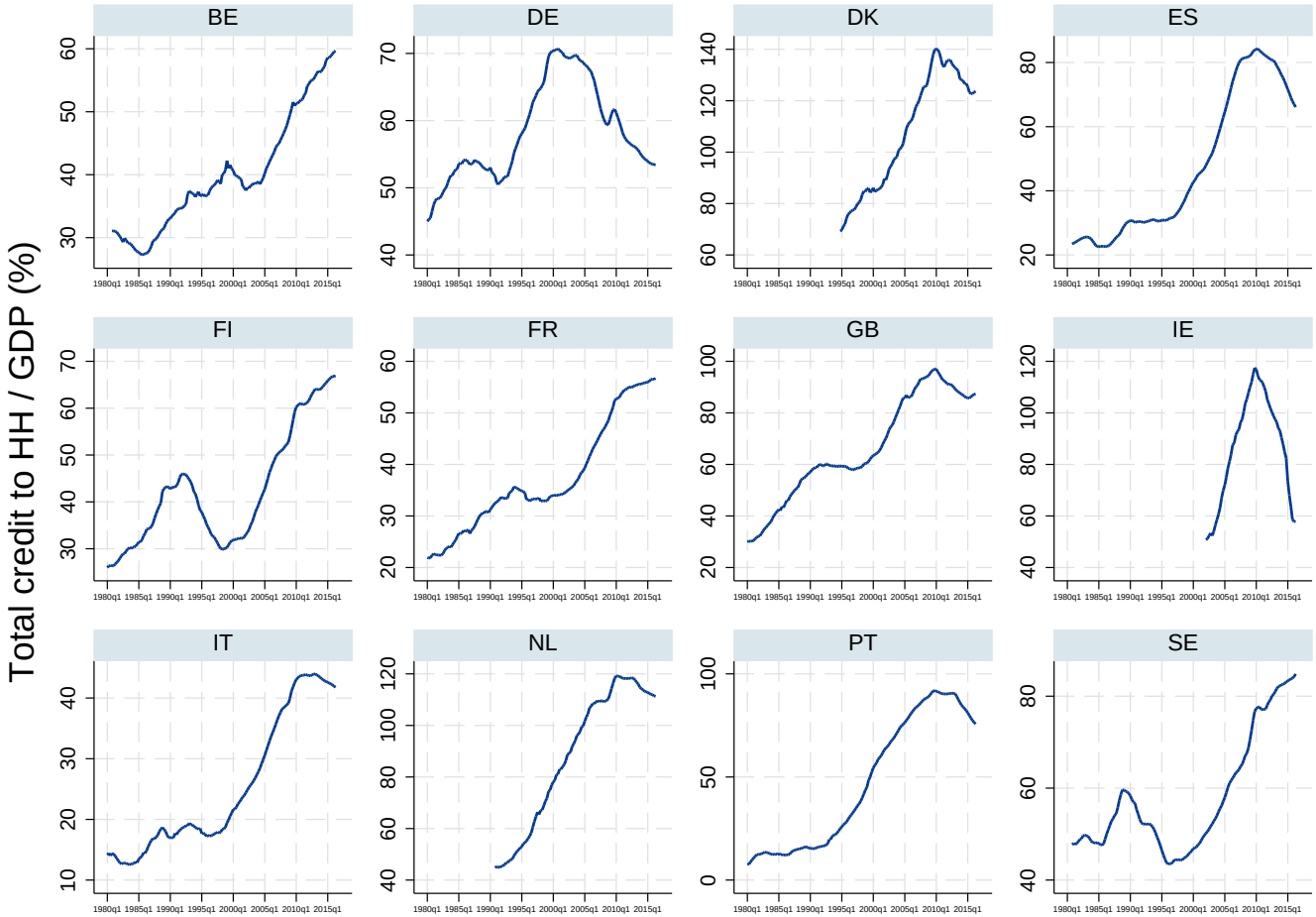
Background - Changes in trend levels of credit important

Need a theory of the trend to determine when credit is excessive



Outline

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Motivation - How to identify excessive leverage is key

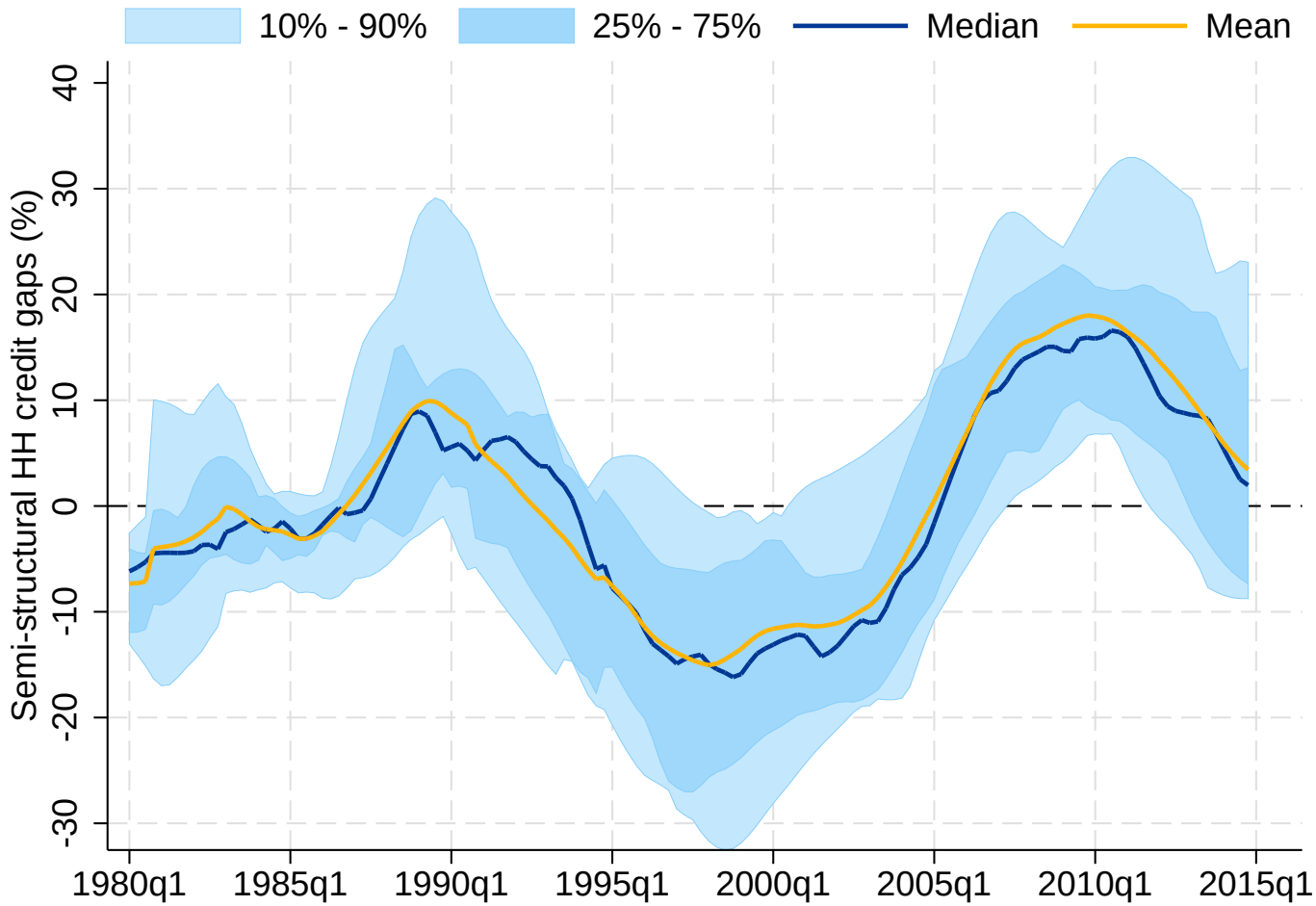
- Excessive credit growth and leverage key drivers of financial crises
- How to measure what part of credit is "excessive" is unclear however
- Empirical literature has mostly used purely statistical approaches
  - Useful starting point but with various drawbacks
  - No economic interpretation. Cannot account for catch-up processes
- Some papers try to estimate equilibrium credit, but issues remain
  - Cottarelli et al. (2005), Buncic and Melecky (2014), Juselius and Drehmann (2015), Albuquerque et al. (2015) use co-integration
  - Use of observed endogenous variables (e.g. RRE prices, GDP)

Our paper - Credit gap estimation based on theory

- Use of economic theory to derive a trend equation for HH credit
  - OLG model by Eggertsson and Mehrotra (2014) + assumptions
- Use of unobserved components model for empirical implementation
  - Trend-cycle decomposition using economic theory (semi-structural)
  - Prominent in estimation of natural rate (Laubach and Williams (2003))
  - Credit trend modeled with fundamental economic factors from theory
  - Credit cycle modeled as an AR(2) process (no restrictions)

Results preview - Long cycles (20y), large amplitudes(20%)

- Very good early warning properties for financial crises (AUROC 0.90)



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A simple structural model for the HH credit trend 1/2

OLG model by Eggertsson and Mehrotra (2014) + additional assumptions:

- Aggregate equilibrium quantity of credit (from model)

$$C_t^{d*} = \left(1 + \frac{\eta}{1+g_t}\right) N_t \frac{D_t}{1+r_t^*}$$

- Borrowing constraint: fraction of future expected income (added)

$$D_t = \Theta_t \mathbb{E}_t[Y_{t+1}^{hh}]$$

- Tightness of constraint: function of institutional quality (added)

$$\Theta_t = \bar{\Theta} \frac{1}{1 + e^{-k(IQ_t - x_0)}}$$

A simple structural model for the HH credit trend 2/2

Structural equilibrium household credit equation in logs:

$$ln(C_t^{d*}) = ln(\frac{N_t}{P_{t+1}}) + ln(\Theta_t) - ln(1 + r_t^*) + ln(Y_t^*) + d_t + ln(1 + \frac{\eta}{1 + g_t}) + constant$$

The model implies that real aggregate household credit is a function of:

- Demographics / Share of young and middle-aged (N_t/P_{t+1})
- Non-linear transformation of institutional quality (Θ_t)
- Equilibrium real interest rate (r_t^*)
- Real potential GDP (Y_t^*)
- Trend growth (d_t), income inequality (η), population growth (g_t)

Outline

State space set-up for semi-structural HH credit gaps

$$
\begin{aligned}
c_t &= c_t^* + \hat{c}_t \\
c_t^* &= \alpha_0 + y_t^* + \theta_t + \alpha_1 r_t^* + dem_t + \epsilon_t^{c^*} \\
\hat{c}_t &= \beta_1 \hat{c}_{t-1} + \beta_2 \hat{c}_{t-2} + \epsilon_t^{\hat{c}}
\end{aligned}
$$

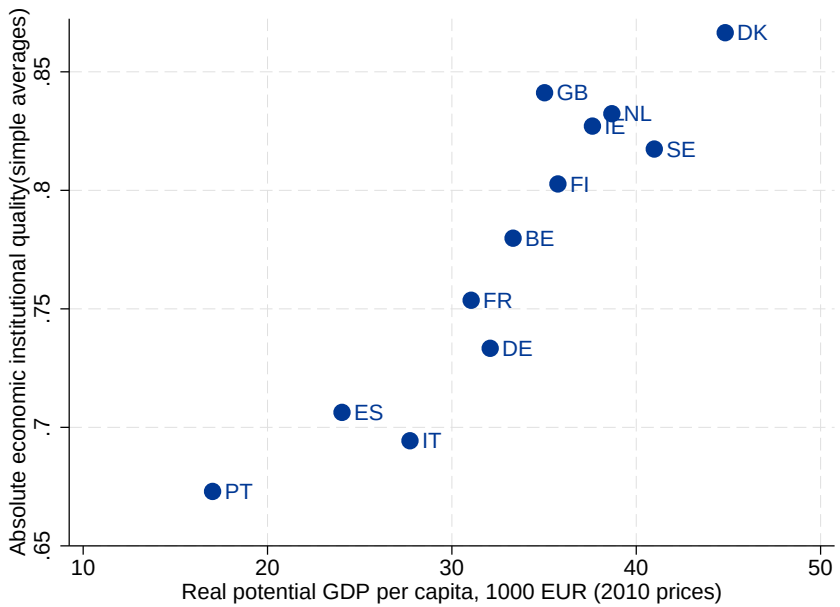
- We use a simplified version of the structural HH credit trend
- Coefficients for y_t^*, θ_t, and dem_t set to 1 based on theory
- Credit gaps are modeled as an AR(2) process (no restrictions)
- We estimate the system in an unobserved components framework
- 12 EU countries: BE, DE, DK, ES, FI, FR, GB, IE, IT, NL, PT, SE

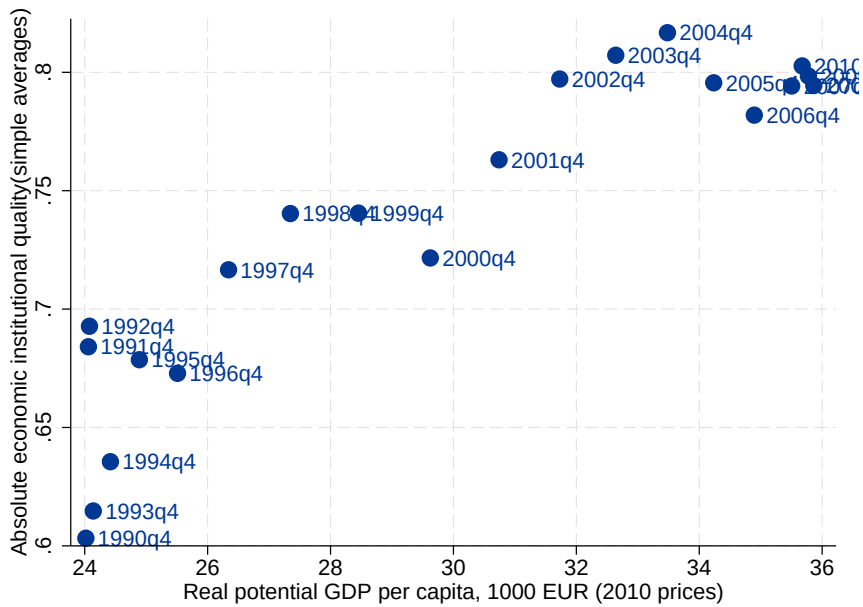
Proxy for real potential GDP and equilibrium real rate

- y_t^* and r_t^* are unobserved in reality
- Ultimate aim is to estimate them jointly with c_t^*
- For the moment: treat y_t^* and r_t^* as observed
- For y_t^* we take AMECO estimates
- For r_t^* we take HP-filtered trend of r_t ($\lambda = 1,600$)
- For r_t we use realised real 10-year sovereign yields until 2004q4
- We subtract 1.9% inflation from 10-year yields after 2004q4

Proxy for quality of institutions: real GDP per capita

- No long panel datasets available for institutional quality
- Real potential GDP per capity appears like a good proxy
- High correlation both across countries and across time





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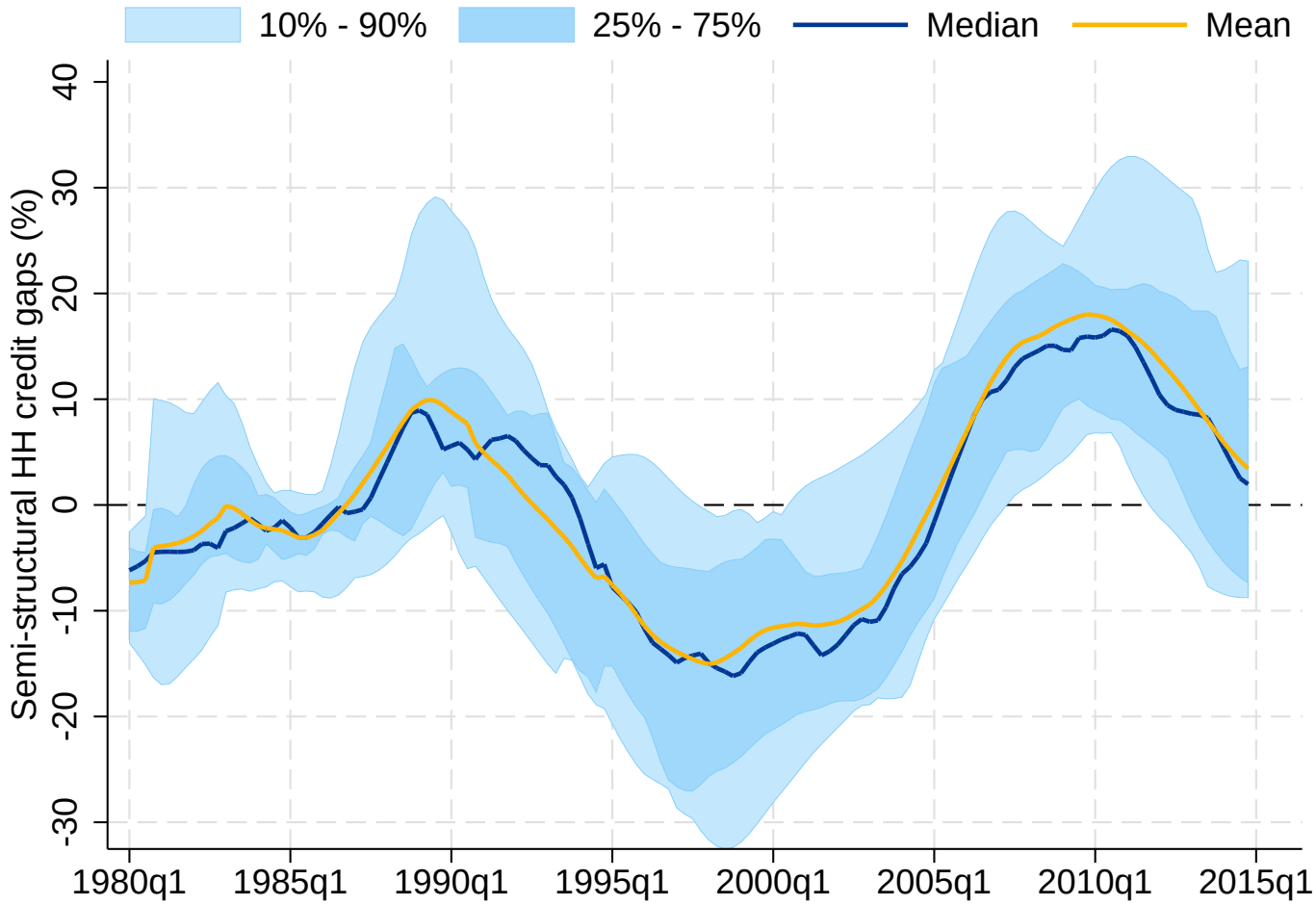
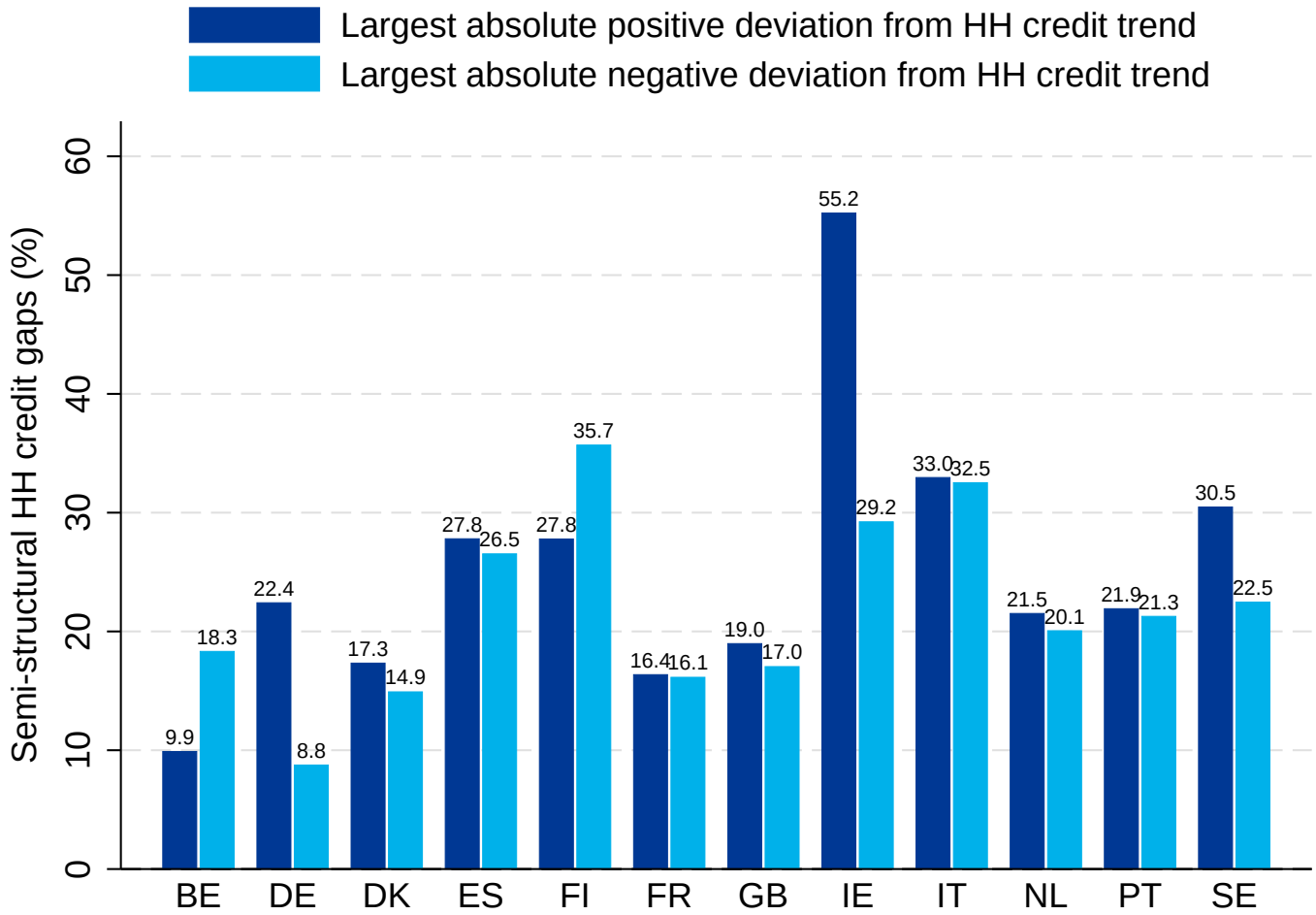
The semi-structural HH credit gaps display long cycles

- Cycles last between 15-25 years. EU mean is around 20 years



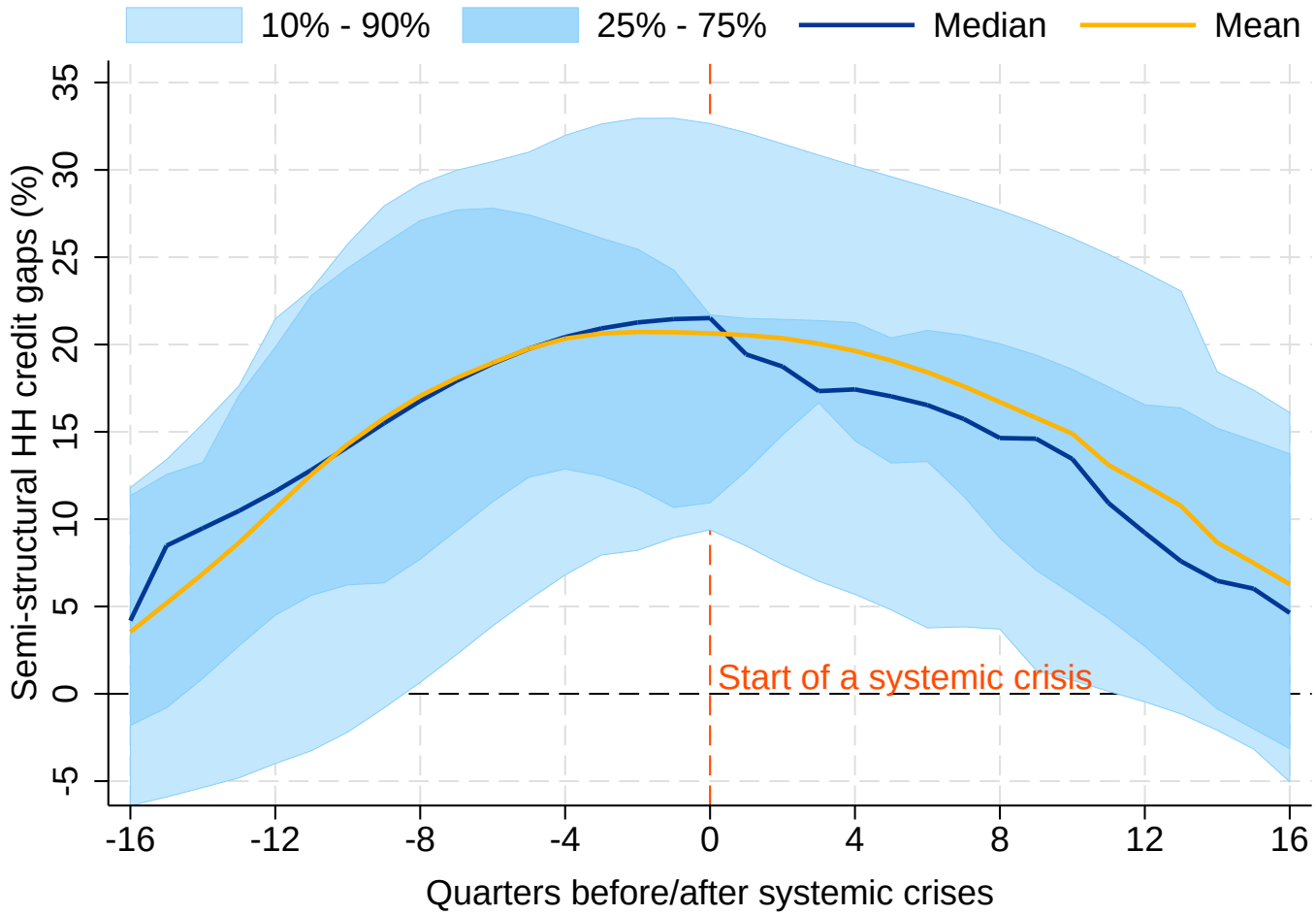
The HH credit gaps display large amplitudes

- In most EU countries cycles vary between +/- 15% to +/- 30%



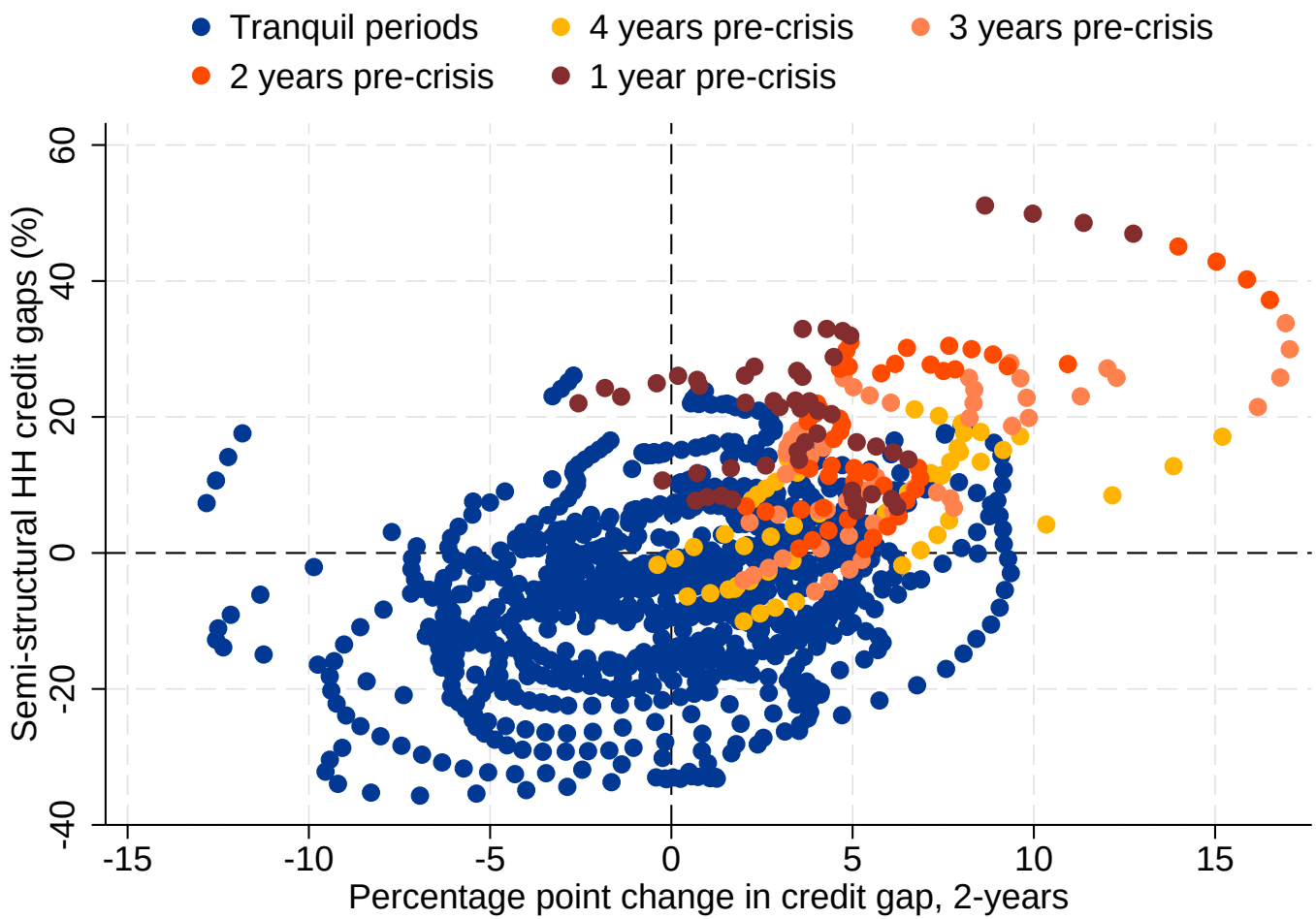
The HH credit gaps increase well before financial crises

- On average gaps turn positive more than 4 years before systemic crises



The level and change of credit gaps contain information

- HH credit gaps are positive and increasing before systemic crises



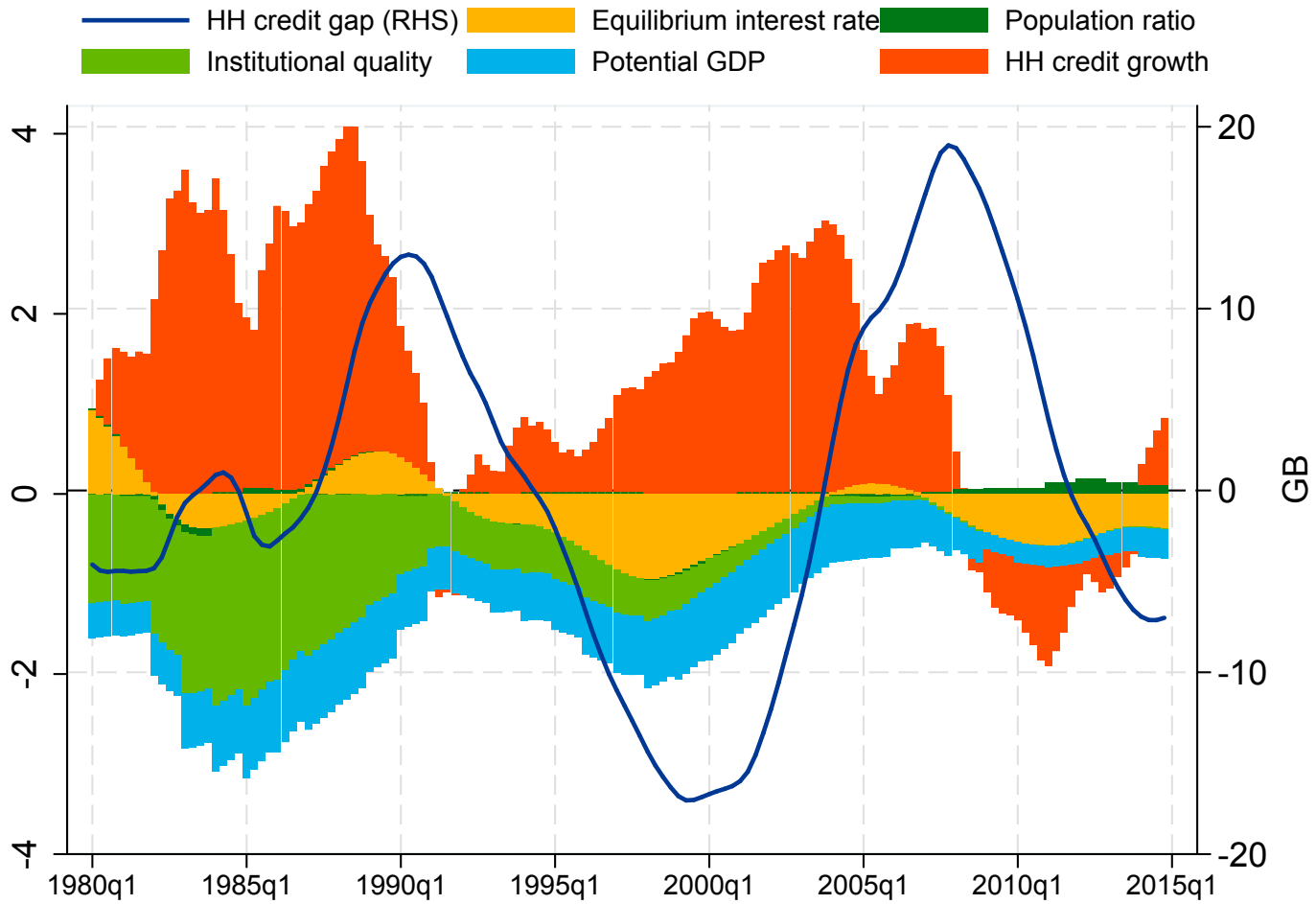
Semi-structural credit gaps have very good signalling power

- Early warning exercises performed for various pre-crisis horizons
- Domestic systemic financial crises considered (Lo Duca et al. (2017))
- Better signalling power than various statistical credit transformations

	Semi-structural HH credit gap	Basel total credit-to-GDP gap	Basel bank credit-to-GDP gap	Basel HH credit-to-GDP gap	3-year Δ in HH credit-to-GDP ratio	3-year growth rate of real HH credit
Pooled results						
AUROC 16-9q	0.80	0.72	0.76	0.78	0.80	0.69
AUROC 12-5q	0.90	0.78	0.79	0.77	0.84	0.74
AUROC 8-1q	0.90	0.75	0.74	0.72	0.76	0.66
AUROC 4-1q	0.90	0.74	0.72	0.66	0.72	0.60
Pseudo R2 12-5q	0.39	0.14	0.15	0.09	0.22	0.07
Observations	1,204	1,196	1,204	1,116	1,055	1,055

The framework allows for economic interpretation

- Changes in credit gaps can be decomposed into driving factors



Outline

Conclusion - Promising results that are useful for policy

- Theory is used to derive a trend equation for HH credit
- A semi-structural estimation approach is used for HH credit gaps
- The framework yields long HH credit cycles with large amplitudes
- The semi-structural credit gaps have very good signalling properties
- Semi-structural credit gaps allow for economic interpretation
- The framework could be useful for macroprudential policy
- Complement to purely statistical cycle measures

Thank you for your attention!

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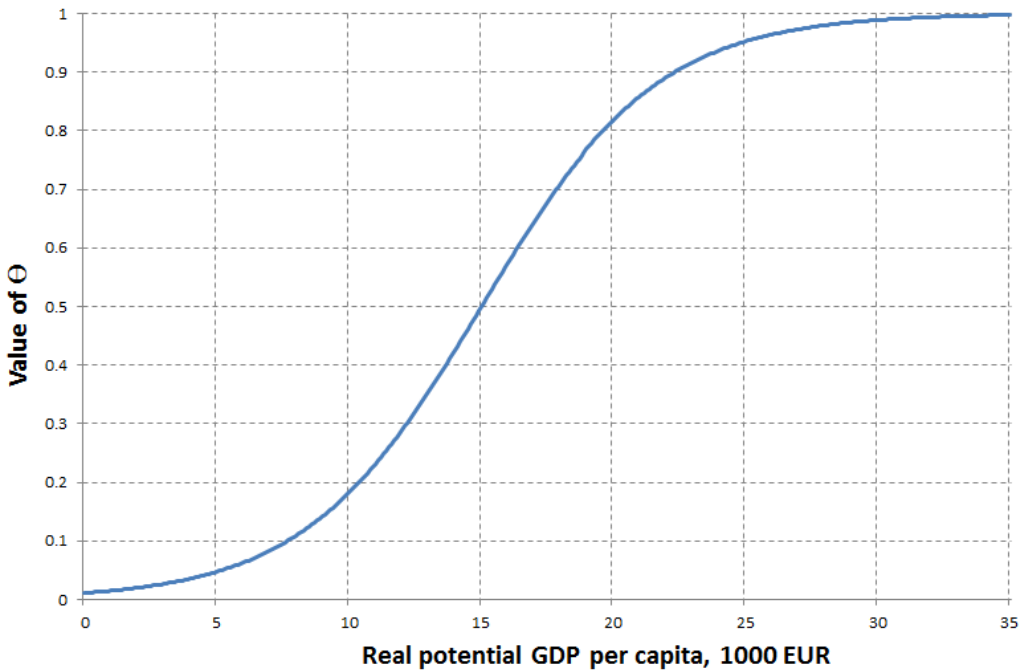
Background slides

Modelling strategy for the borrowing constraint

- Θ_t (tightness of constraint) should have a lower and an upper limit
- Modeled as an S-curve of institutional quality $\Theta_t = \bar{\Theta}\frac{1}{1+e^{-k(IQ_t - x_0)}}$
- Institutional quality proxied with real potential GDP per capital



Estimated coefficients all have the expected signs

- Interest rate coefficients mostly in the range of -2.4 to -6.3
- SD of shocks to HH credit cycle 0.004 to 0.008 (0.4% – 0.8%)

	BE	DE	DK	ES	FI	FR	GB	IE	IT	NL	PT	SE
Real interest rate	-5.121***	-0.845	-11.786***	-1.436	-2.356	-2.497*	-5.288***	-3.654	-4.987***	-8.828**	-6.310***	-4.874***
	(0.948)	(1.550)	(1.586)	(1.837)	(3.035)	(1.441)	(1.193)	(2.895)	(1.923)	(4.108)	(1.598)	(1.831)
Intercept	-0.155***	-0.252***	0.618***	0.382***	-0.326**	-0.282***	0.260***	0.372***	-0.496***	0.395***	2.154***	-0.055
	(0.046)	(0.068)	(0.045)	(0.089)	(0.130)	(0.084)	(0.057)	(0.140)	(0.106)	(0.113)	(0.083)	(0.087)
Shock SD	0.009***	0.006***	0.007***	0.011***	0.006***	0.004***	0.006***	0.013***	0.018***	0.011***	0.008***	0.004***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
AR(1) coefficient	1.907***	1.912***	1.958***	1.920***	1.906***	1.710***	1.914***	1.957***	1.920***	1.962***	1.799***	1.906***
	(0.041)	(0.041)	(0.028)	(0.032)	(0.048)	(0.087)	(0.035)	(0.026)	(0.041)	(0.029)	(0.068)	(0.037)
AR(2) coefficient	-0.919***	-0.916***	-0.971***	-0.929***	-0.912***	-0.716***	-0.926***	-0.963***	-0.925***	-0.967***	-0.819***	-0.913***
	(0.041)	(0.041)	(0.028)	(0.033)	(0.049)	(0.088)	(0.035)	(0.026)	(0.042)	(0.029)	(0.067)	(0.037)
Shock SD	0.004***	0.002***	0.003***	0.005***	0.006***	0.007***	0.004***	0.005***	0.005***	0.002***	0.010***	0.005***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)