

# "Semi-Structural Credit Gap Estimation"

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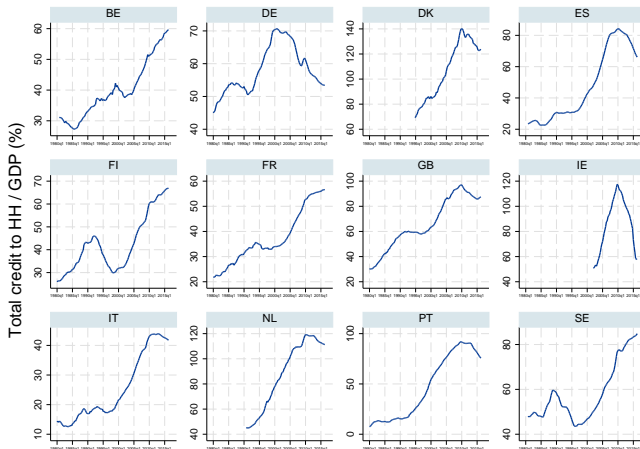
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# Background - Changes in trend levels of credit important

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



# Outline

- 1 Introduction
- 2 A structural model for the HH credit trend
- 3 Semi-structural econometric set-up
- 4 Empirical results for HH credit gaps
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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)
  - Credit trend modeled with fundamental economic factors from theory
  - Prominent in estimation of natural rate (Laubach and Williams (2003))
- Empirical results for semi-structural HH credit gaps are promising
  - Long HH credit cycles (20 years) with 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:

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

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 ( $\Theta_t$ )
- Equilibrium real interest rate ( $r_t^*$ )
- Real potential GDP ( $Y_t^*$ )
- Trend growth ( $d_t$ ), income inequality ( $\eta$ ), population growth ( $g_t$ )

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

$$c_t = c_t^* + \hat{c}_t$$

$$c_t^* = \alpha_0 + y_t^* + \theta_t + \alpha_1 r_t^* + dem_t + \epsilon_t^{c^*}$$

$$\hat{c}_t = \beta_1 \hat{c}_{t-1} + \beta_2 \hat{c}_{t-2} + \epsilon_t^{\hat{c}}$$

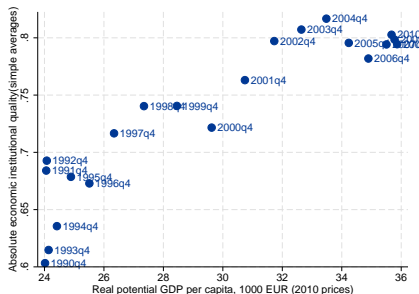
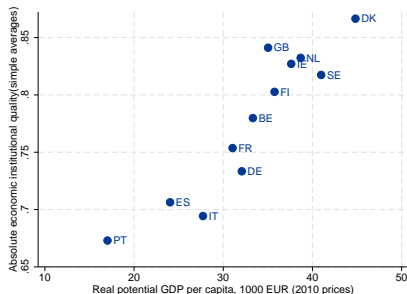
- We use a simplified version of the structural HH credit trend
- Coefficients for  $y_t^*$ ,  $\theta_t$ , and  $dem_t$  set to 1 based on theory
- Credit gaps are modeled as an AR(2) process
- We estimate the system in an unobserved components framework
- 12 EU countries: BE, DE, DK, ES, FI, FR, GB, 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 capita appears like a good proxy
- High correlation both across countries and across time

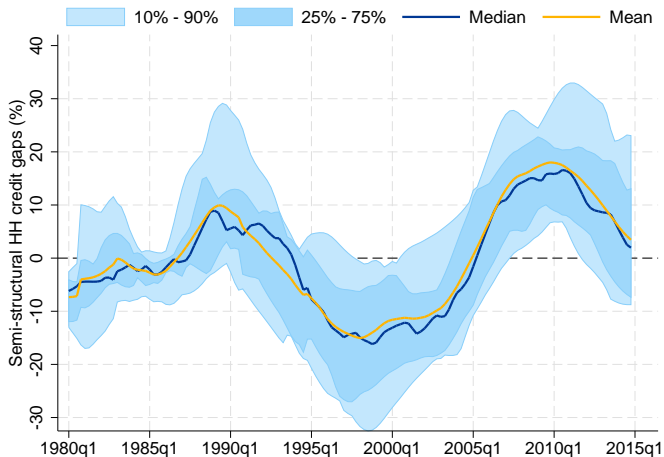


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# The semi-structural HH credit gaps display long cycles

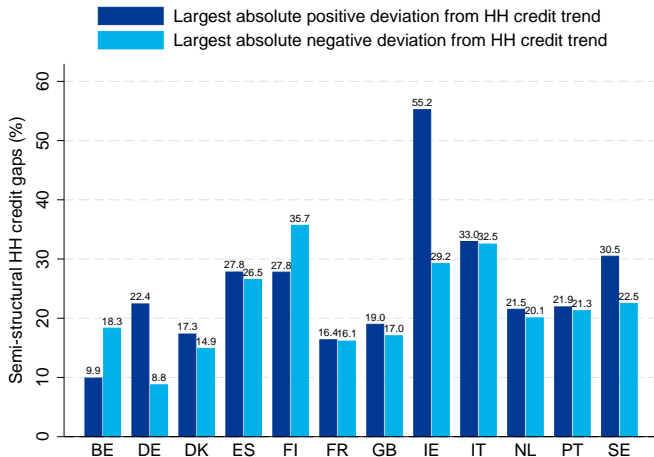
- Cycles last between 15-25 years. EU mean is around 20 years





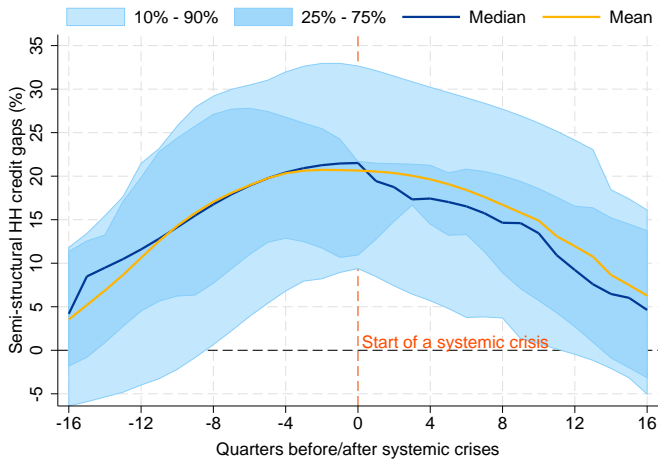
# The HH credit gaps display large amplitudes

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



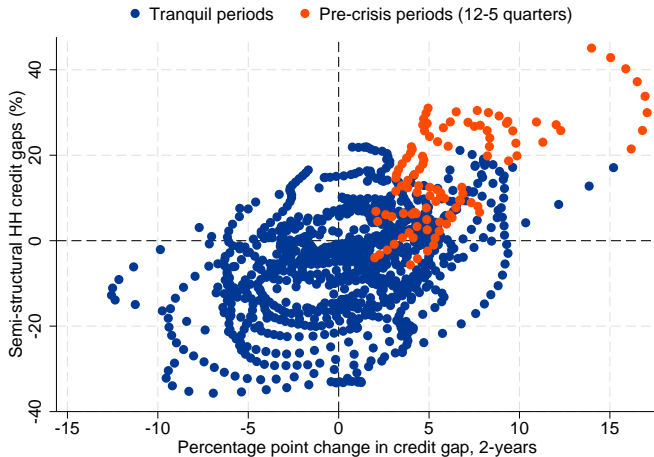
# The HH credit gaps increase well before financial crises

- 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 $\Delta$ in HH credit-to-GDP ratio	3-year growth rate of real HH credit
<b>Pooled results</b>						
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

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

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# Conclusion - Promising results and clear next steps

- 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
- Next steps:
  - Add additional (exogenous) variables to the credit trend equation
  - Estimate a full state space system with endogenous  $c^*$ ,  $y^*$ ,  $r^*$

Thank you for your attention!



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