EUROPEAN CENTRAL BANK

EUROSYSTEM

Characterising the financial cycle: *A multivariate and time-varying approach*

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***Disclaimer**: The views expressed in this presentation are those of the presenter and do not necessarily represent those of the ECB*

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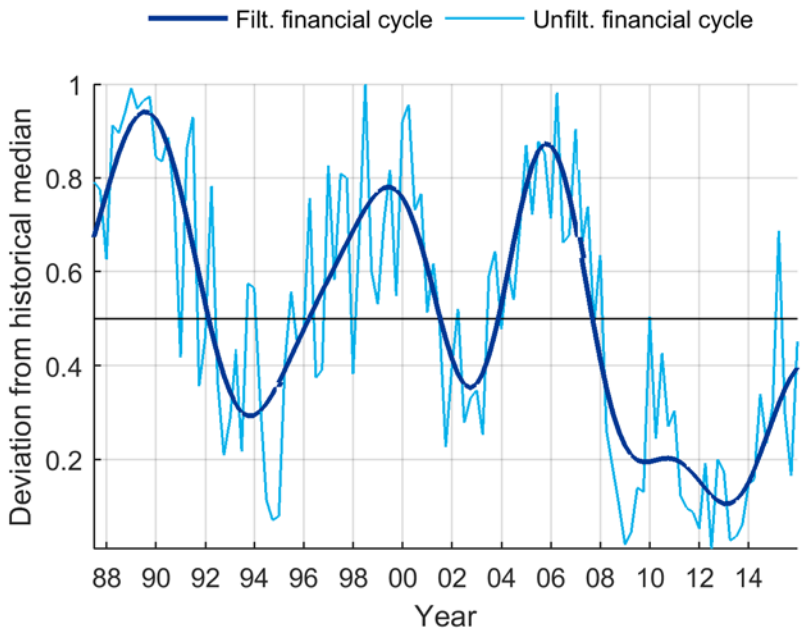


1 **Background**

2 **Measuring financial cycles**

Schüler, Hiebert, Peltonen (2015), "*Characterising the financial cycle: a multivariate and time-varying approach*" ECB Working Paper No. 1846.

3 ***Extensions:* Financial cycles (i) and business cycles (ii) across countries**

Hiebert, Jaccard, Schüler (2016), "*Contrasting financial and business cycles: Squaring stylised facts with structural determinants*" ECB Mimeo.

4 **Summary**

Systemic risk, the buildup of country risk, and the scars of crisis…

Policy domain	**Objective**	
Macroprudential oversight	Limit systemic risk through:	Increased system resilience *(cross sectional dimension)*
		Mitigating the financial cycle *(time series dimension)*

… with three related questions:

1 – Can we generate reference financial cycles for broad set of countries?

… and can such cycles contribute to prediction of systemic events?

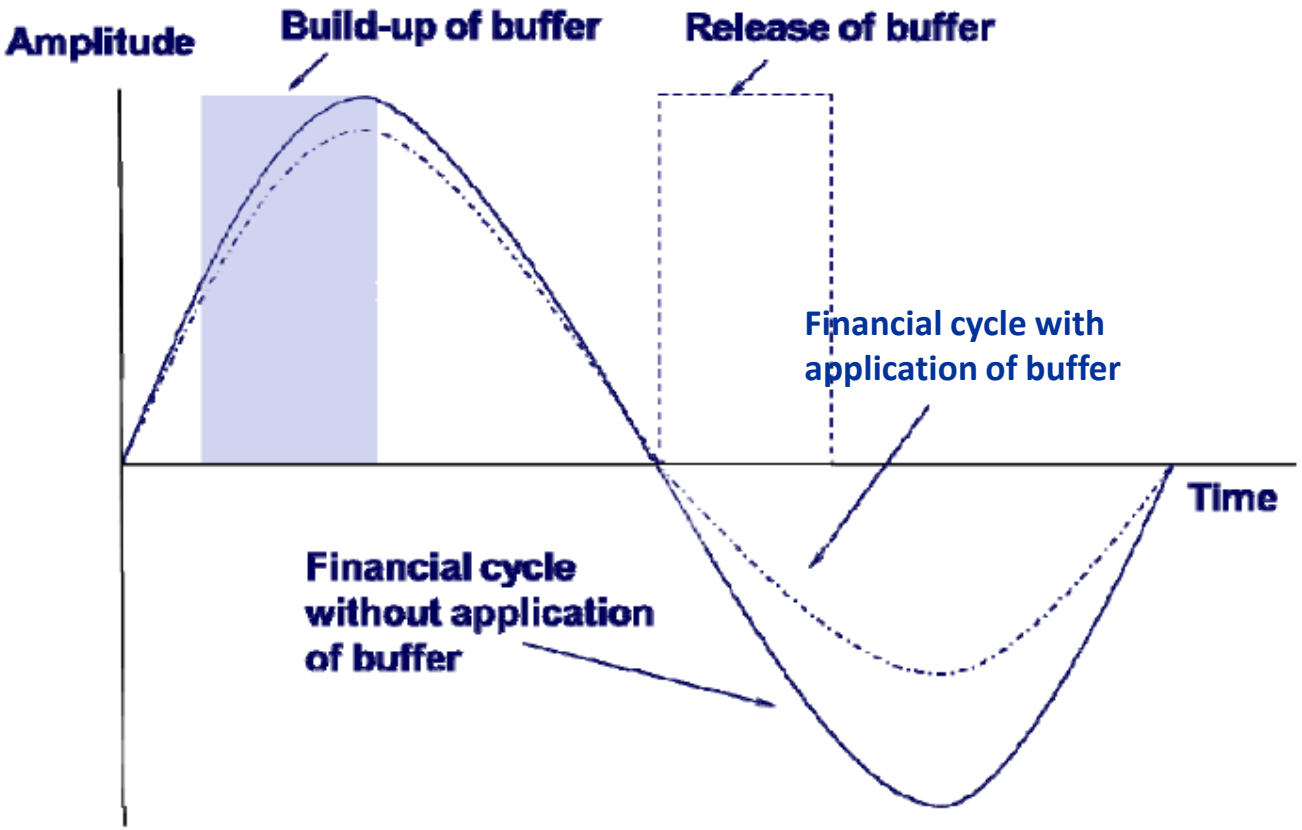
2 - Are these financial cycles distinct from business cycles?

… and augur for differentiated countercyclical policies (macroprudential vs macroeconomic)?

3 - Do these financial cycles differ across countries?

… to justify a country specific countercyclical macroprudential policy setting?

Stylised representation of financial cycle



- *amplitude?*
- *duration?*
- *(a)symmetry?*

Source: Flagship report on macro-prudential policy in the banking sector, ESRB March 2014

Measurement at national level …

From credit / leverage cycles …

- *Aikman, Haldane, and Nelson (2015) : Curbing the credit cycle, The Economic Journal*
- *Schularick & Taylor (2012) : Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises 1870–2008. AER*

… to expanded set of variables capturing financial cycle

- *Drehmann, Borio, & Tsatsaronis (2012): Characterising the financial cycle: don't lose sight of the medium term!, BIS WP*
- *Claessens, Kose, & Terrones (2012): How do financial and business cycles interact?, Journal of International Economics*

… and at international level

Global financial cycles (global factor in risky asset prices)

- *Rey (2013): Dilemma not trilemma: the global cycle and monetary policy independence, Jackson Hole Proceedings*
- *Miranda-Agrippino & Rey (2015): World asset markets and the global financial cycle, NBER Working Paper No. 21722*

1 **Background**

2 **Measuring financial cycles**

(Schüler, Hiebert & Peltonen, 2015)

i. General methodology

ii. Application to EU countries and euro area aggregate

iii. Evaluation (early warning properties)

3 ***Extensions:* Financial cycles (i) and business cycles (ii) across countries**

4 **Summary**

"The following definition seems to capture what experts refer to as the business cycle:

The business cycle is the phenomenon of a number of important economic aggregates … being characterized by high pairwise coherences

This definition captures the notion of the business cycle as being a condition symptomizing the common movements of a set of aggregates."

- T. Sargent (1987), *Macroeconomic Theory*, p. 282 *[emphasis added]*

Step 1 - Common cyclical frequencies for set of indicators (multivariate, "power cohesion")

a. Derive normalized cross-spectra for each pair of indicators

b. Average across absolute value of cross-spectra for given frequency: *power cohesion*

$$\mathrm{PCoh}_X(\omega) = \frac{1}{(M-1)M} \sum_{i \neq j} \left| \frac{1}{2\pi} \sum_{k=-\infty}^{\infty} \frac{\mathrm{Cov}[x_{i,t}, x_{j,t+k}]}{\sigma_{x_i} \sigma_{x_j}} e^{-ik\omega} \right|$$

Normalised cross-spectral density

Average (absolute value)

c. Identify peak co-movement in resulting frequency domain, and span a window around it

Step 2 - Composite financial cycle index with time varying weights, and filter for reference cycles

a. Aggregation of standardised indicators using time-varying weights (emphasising directional co-movements across indicators)

b. Band pass filter all series using the country-specific financial cycle frequencies in Step 1

Methodology

Step 1: Common cyclical frequencies for set of indicators (multivariate, "power cohesion")
Step 2: Composite financial cycle index with time varying weights, and filter for reference cycles

Sample

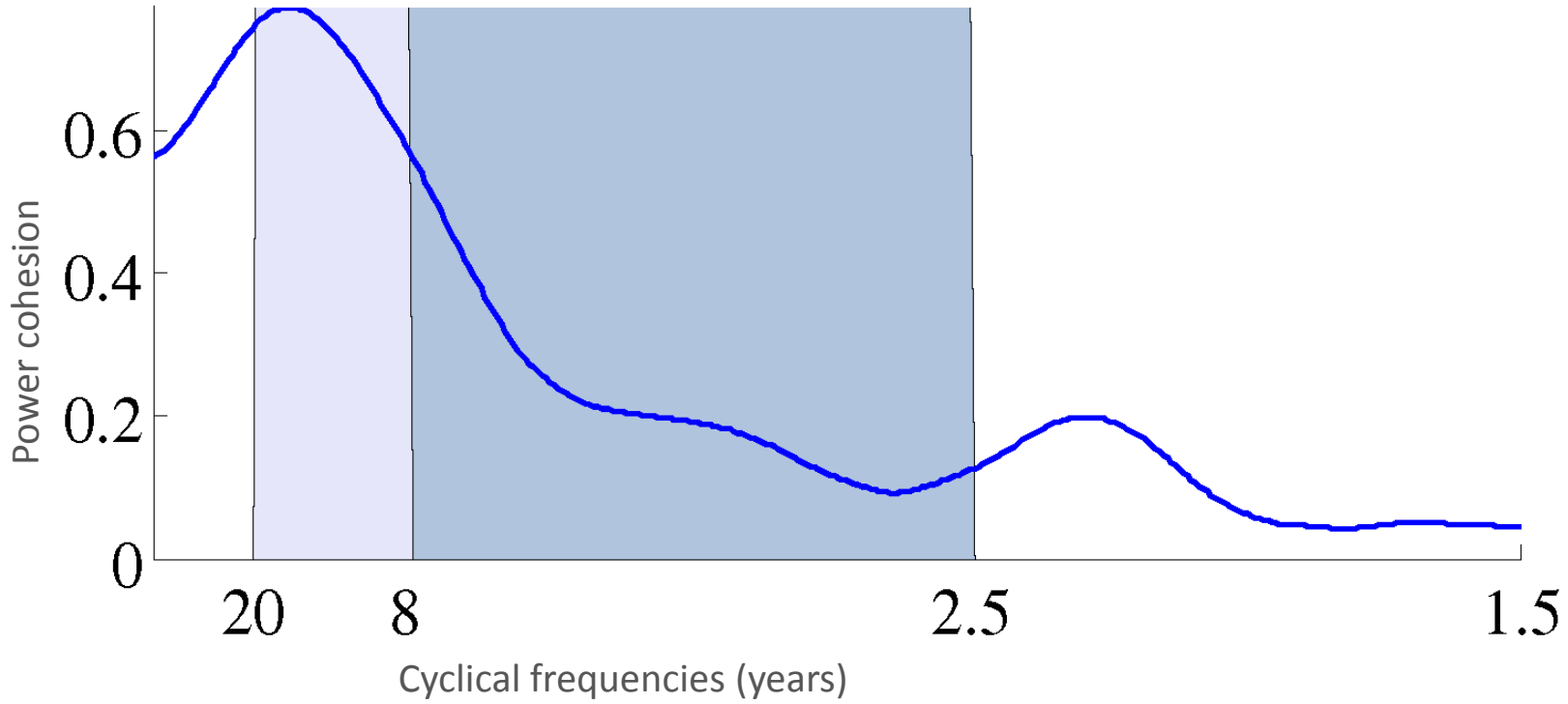
- Start 1970 (for IE and ES 1971; AT 1986; EA 1987;,PT 1988)
- Euro area aggregate + 13 European Union countries (AT, BE, DE, DK, ES, FI, FR, IE, IT, NL, PT, SE, UK)

Variables

Financial cycle	Business cycle
Volumes Total credit Prices Residential property prices Equity prices Benchmark gvt. bond yields	Volumes GDP Unemployment Prices Consumer price inflation Yield curve slope (leading indic.)

Note: All variables in quarterly differences, and in real terms

Power cohesion *(euro area)*



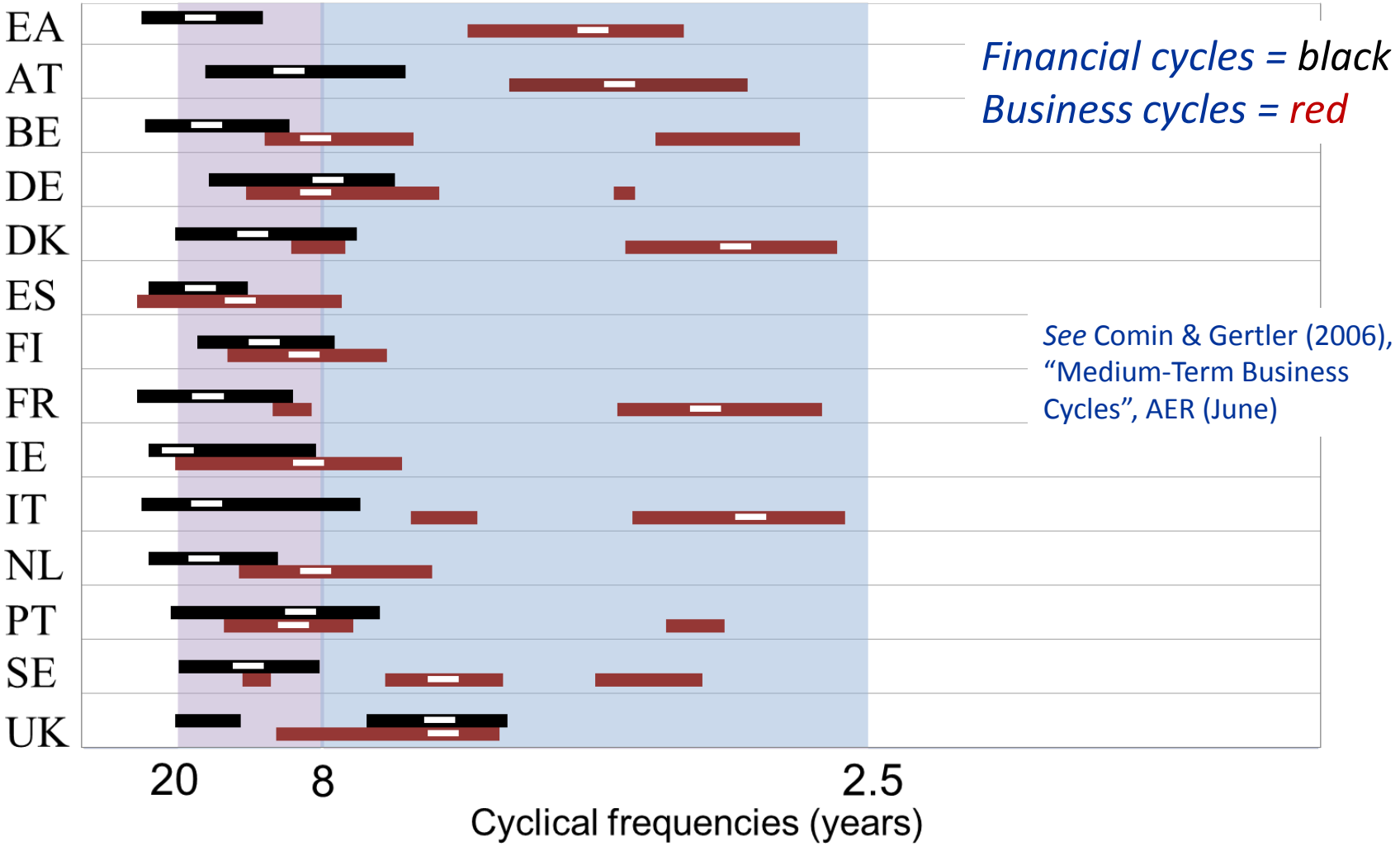
Determine maximum co-movement of indicators in frequency domain

Peak of power cohesion for euro area (15 years) …

… span frequency window capturing other important co-movement (2/3 around peak)

→ *[infinity, 4.6] years*

Power cohesion *(euro area and selected EU countries)*



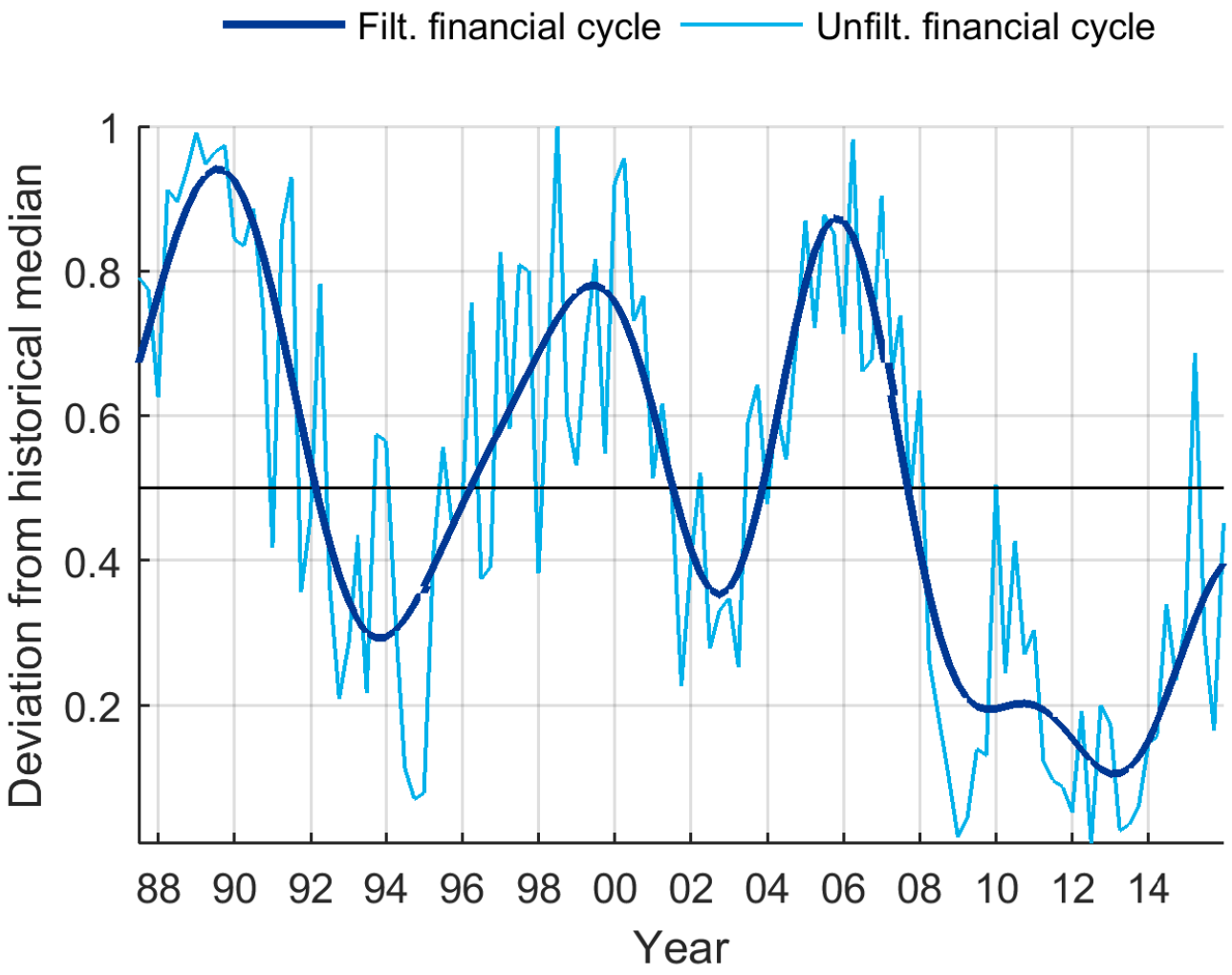
Financial cycles = black

Business cycles = red

See Comin & Gertler (2006), "Medium-Term Business Cycles", AER (June)

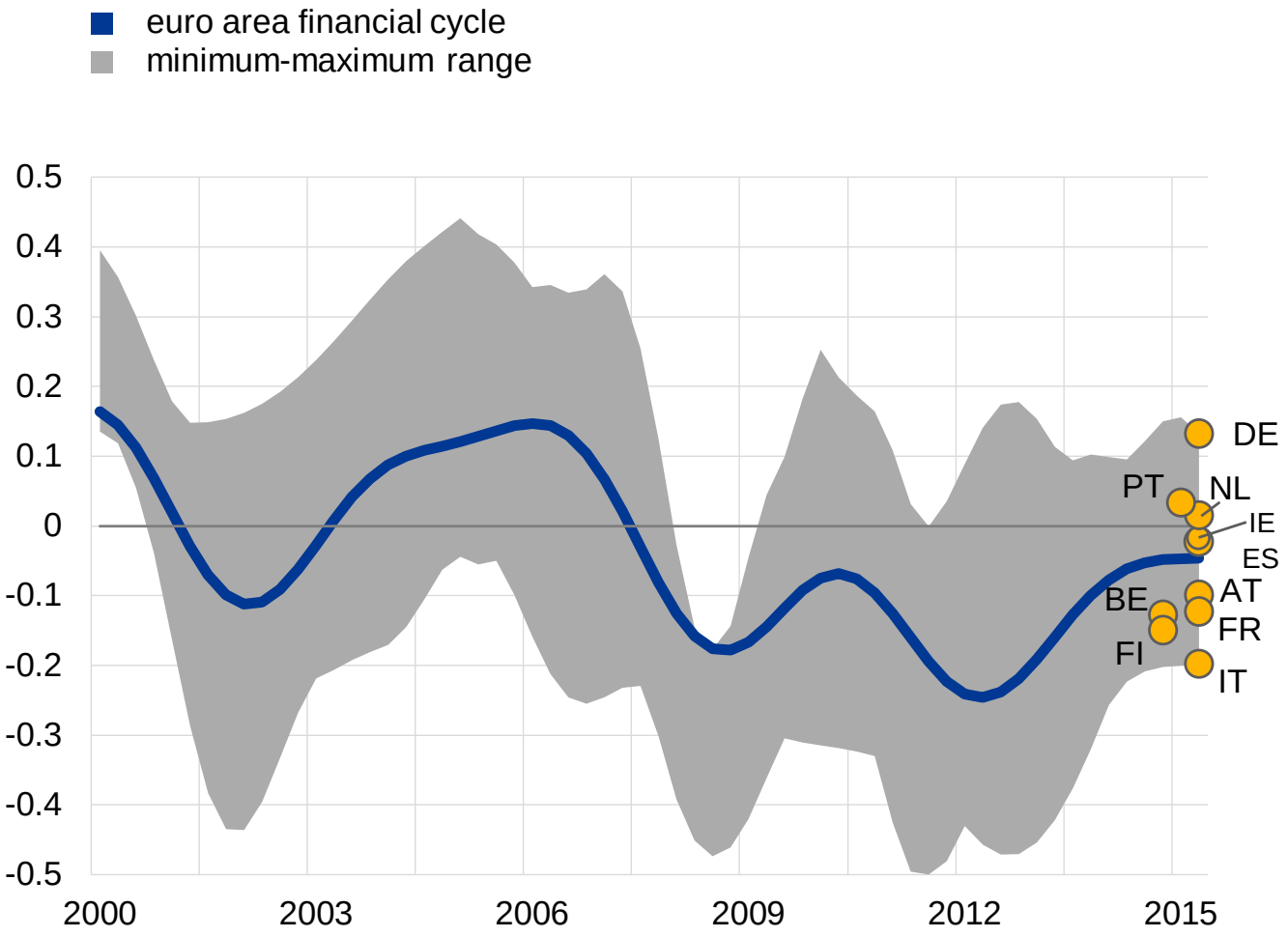
Note: This graph depicts the 25% highest density region of power cohesion excluding cycles lower than 5 quarters for financial and business cycle indicators. The white dash locates the peak of power cohesion. The purple region marks medium term frequencies and the blue area short term fluctuations.

Euro area financial cycle … *before* and *after* filtering



Notes: Scale is in standardised units, 0.5 = historic median.

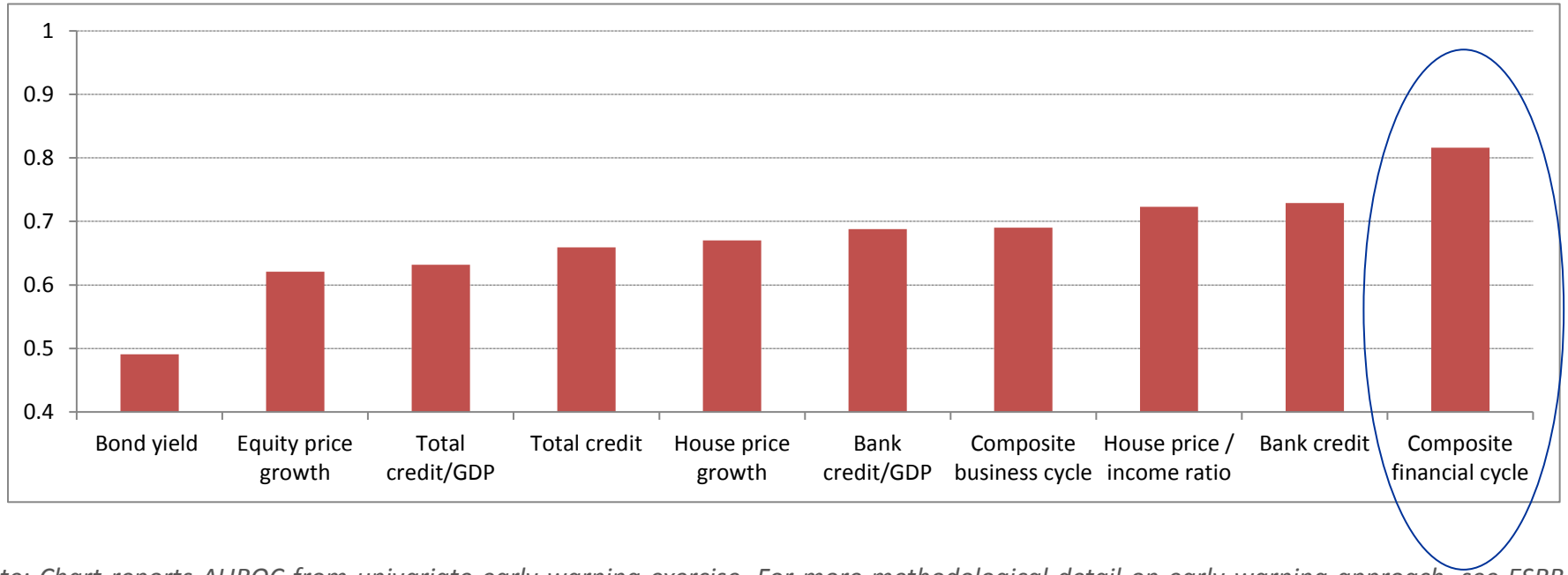
Country cycles heterogeneous



Notes: (Q1 2000 – Q2 2015; normalised deviation from historical median). The shaded area marks the locations of financial cycles of ten euro area countries (AT, BE, DE, ES, FI, FR, IE, IT, NL and PT). Figures for BE and FI refer to Q4 2014, while figures for PT refer to Q1 2015.

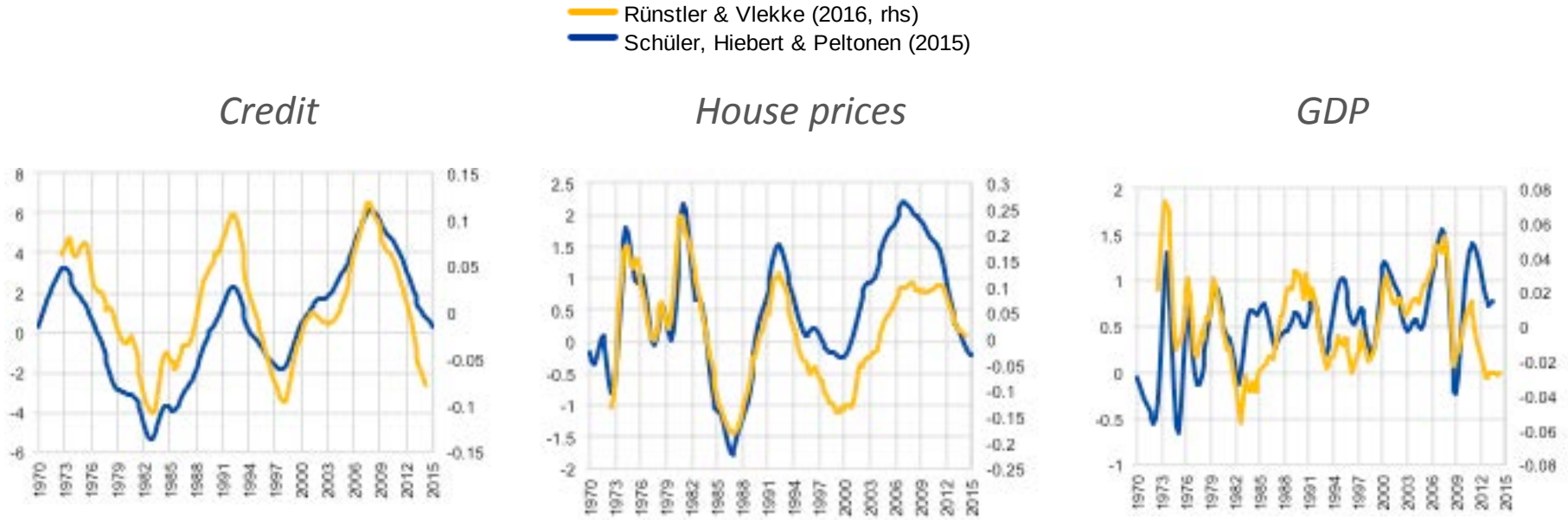
Can these cycles predict systemic stress? *Results of early warning analysis*

- ***Goal**: Predict crises (Laeven-Valencia) pseudo-real time out of sample, vulnerable state 1-3y ahead*
- ***Method**: Signalling (univariate), LASSO shrinkage and selection method (multivariate)*
- ***Evaluation**: AUROC for range of preferences → Type I (missed crises) vs Type II errors (false alarms)*
- Results:
  - ✓***For univariate signalling performance, financial cycle best indicator***
  - ✓***For multivariate, financial cycle adds at the margin to set of macro-financial indicators***



Note: Chart reports AUROC from univariate early warning exercise. For more methodological detail on early warning approach, see ESRB Occasional Paper No. 5 (2014).

Comparison with Rünstler and Vlekke (2016)*



Sources:

- *Schüler, Hiebert, Peltonen (2015), "Characterising the financial cycle: a multivariate and time-varying approach" ECB WP No. 1846*
- *Rünstler and Vlekke (2016), Business and Financial Cycles: an Unobserved Components Models Perspective, ECB WP (forthcoming)*

Notes:

**Rünstler and Vlekke (2016) results from multivariate structural time models to estimate trend and cyclical components of real GDP, real total credit volumes and real residential property prices for the U.S. and the 5 largest economies in Europe, with quarterly estimation 1973-2014.*

1 **Background**

2 **Measuring financial cycles**

3 ***Extensions:* Financial cycles (i) and business cycles (ii) across countries**
(*Hiebert, Jaccard & Schüler, 2016)*

i. Reduced form analysis (Turning point analysis)

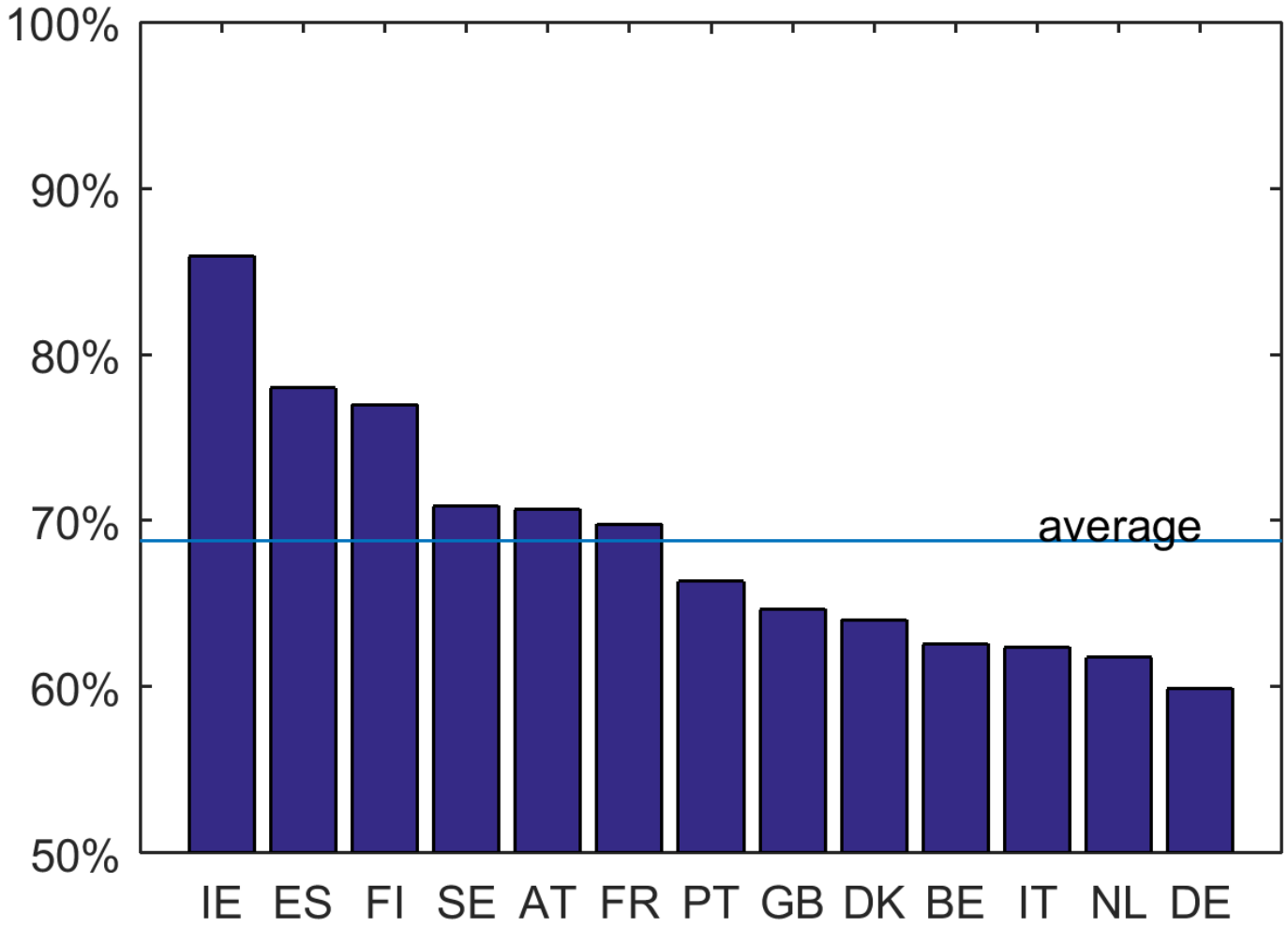
ii. What are driving mechanisms (DSGE model)

iii. Capturing international aspect of financial cycle shocks (SVAR + PCA analysis)

4 **Summary**

Concordance of national financial and business cycles

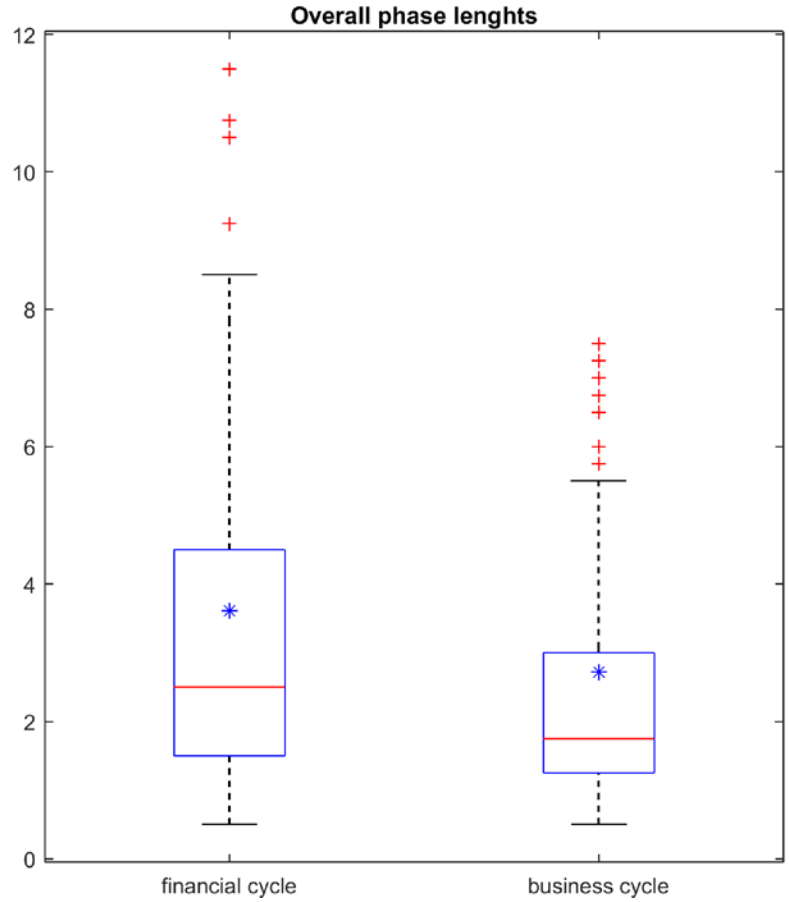
"Mildly procyclical" = concordance 2/3 on average (albeit with country heterogeneity)

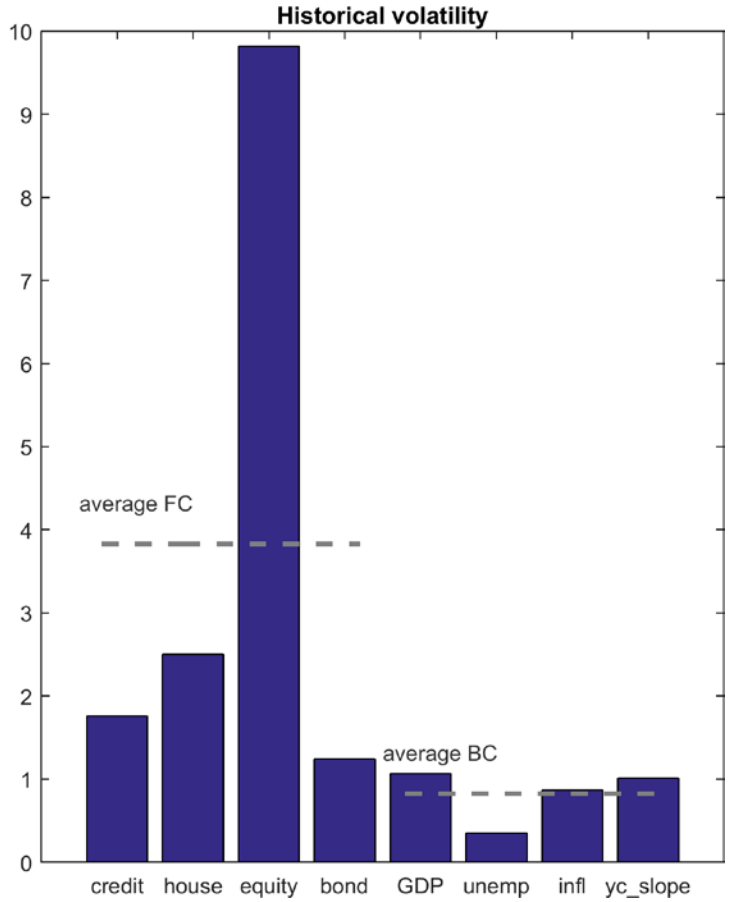


Source: Schüler, Hiebert, Peltonen (2015), "Characterising the financial cycle: a multivariate and time-varying approach" ECB WP No. 1846

Note: Results shown are derived from a standard turning point analysis on the smoothed financial and business cycle indicators.

- *Persistence*: Financial cycles on average 7.2 years versus 5.4 for business cycles (33% longer)
- *Amplitude*: Average historic volatility of financial cycle 4x that of business cycle variables





Source: Schüler, Hiebert, Peltonen (2015), "Characterising the financial cycle: a multivariate and time-varying approach" ECB WP No. 1846

Note: Results shown are derived from a turning point analysis on the smoothed financial and business cycle indicators.

- *LHS chart: Boxplots show the distribution of length in years of the filtered series.*
- *RHS chart: Historical standard deviation, bars reflect average across countries for specific indicators, dotted line represents average across indicators.*

Standard macro models fail to account for observed dynamics of financial cycle variables

Challenge:

Generate endogenous propagation mechanisms yielding higher *persistence* and *volatility* of financial cycle variables in a standard DSGE model still useful to study business cycles

Approach:

Interact two mechanisms to capture data dynamics:

→ Financial frictions

→ Time-varying risk aversion

Mechanisms to capture data dynamics in DSGE model …

- Financial frictions*
  - Introduce credit into the analysis by assuming that firms need to pay workers and other production inputs in advance of production.
  - Capital adjustment costs to generate fluctuations in Tobin's Q.
  - Model with moral hazard in which banks take into account the borrower's willingness to reimburse:

$$\text{Size of the loan in period t} \leq \text{NPV from operating the firm}$$

where the NPV from operating the firm is the discounted sum of future profits.

** See credit-in-advance and incentive compatibility constraints (e.g., Gertler and Karadi 2011; Jermann and Quadrini 2012; De Fiore and Uhlig 2015).*

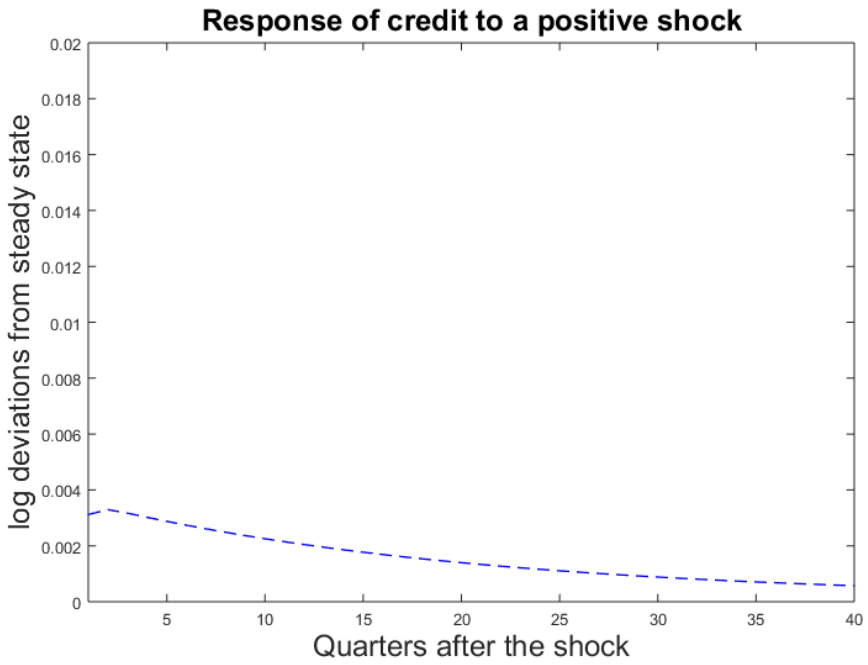
Mechanisms to capture data dynamics in DSGE model …

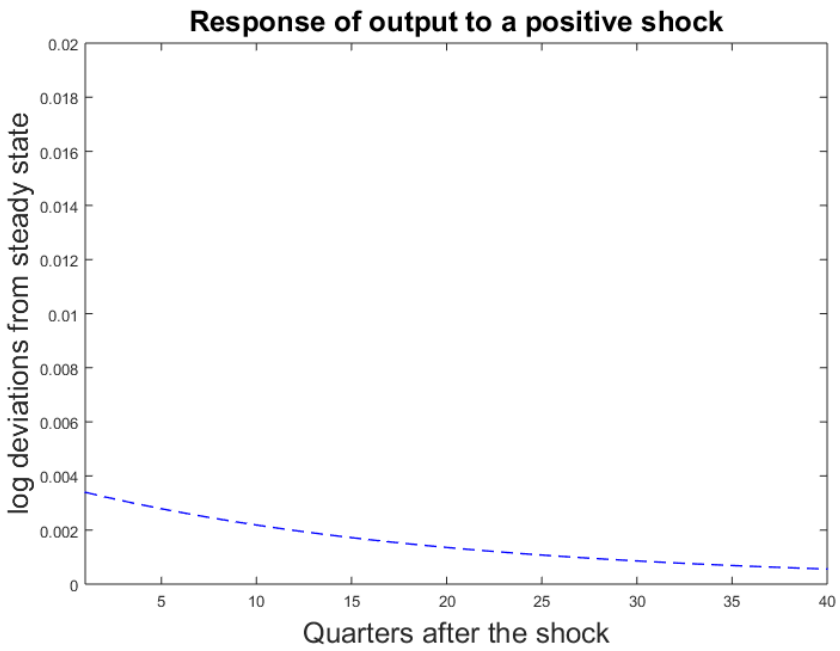
- Interacting financial frictions with time-varying risk aversion
  - The discounting of future profits opens the possibility that changes in risk aversion could influence credit creation.
  - Habit formation generates time-varying risk aversion*
  - Stochastic discount factor used to assess the firm's incentive to repay its debt *interacts* with incentive constraint.
  - Mechanism propagates and amplifies the effects of standard technology shocks.

** See specification of habits used in DSGE models to resolve standard asset pricing puzzles (e.g., Jermann 1998; Jaccard 2014)..*

Generating model-based persistence and volatility …

Impulse responses of credit and output to a one standard deviation technology shock

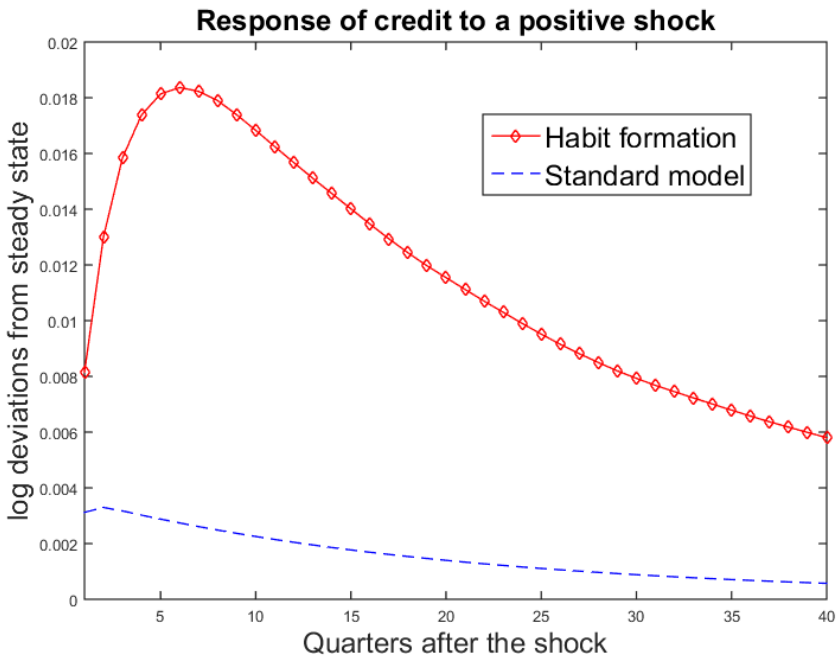


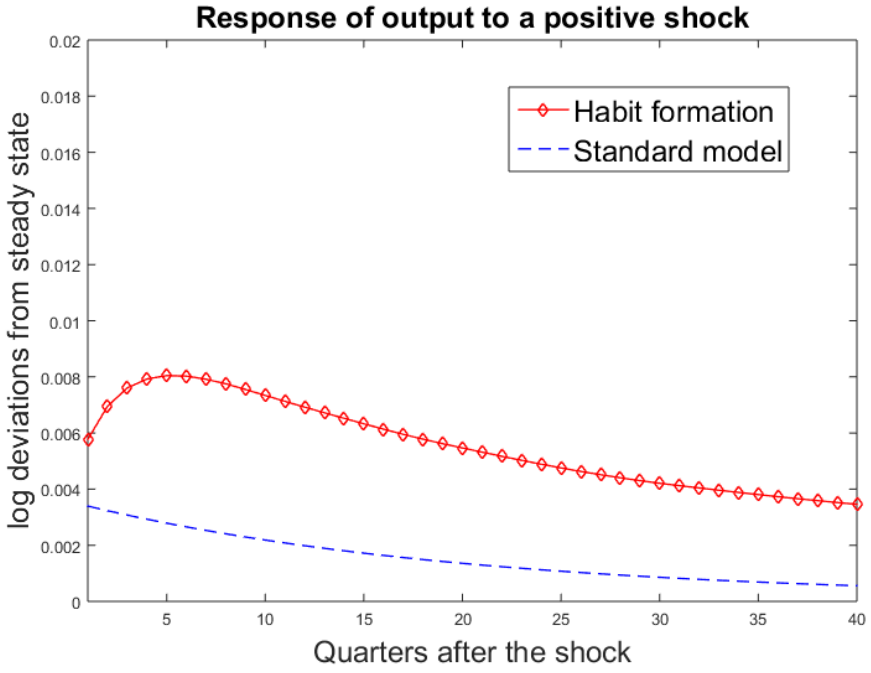


Model with *financial frictions* only (credit-in-advance and agency problems).

Generating model-based persistence and volatility …

Impulse responses of credit and output to a one standard deviation technology shock

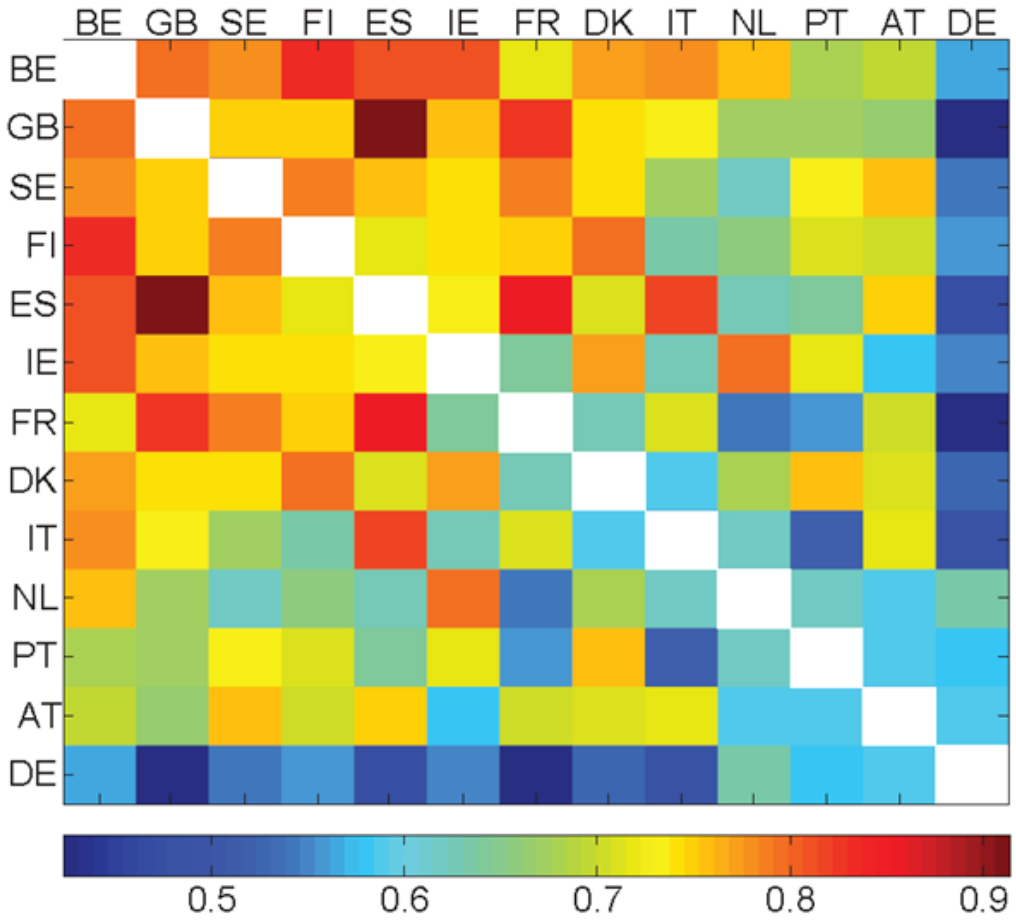




Model with *time-varying risk aversion* and *financial frictions*
… vs. standard model with financial frictions only.

Concordance across countries

"Mildly procyclical" = concordance 2/3 on average (albeit with clustering)



Source: Schüler, Hiebert, Peltonen (2015), "Characterising the financial cycle: a multivariate and time-varying approach" ECB WP No. 1846

Note: Figures reflect cross-country concordance, obtained using the maximum common sample, i.e., 1988Q1-2013Q4.

Principal component (PC) and correlation analysis

Correlation of financial variable with financial cycle

First principal component of financial cycle shocks captures 45% of common variation across countries…

… which correlates strongly with financial asset prices *(see Rey, 2013)*

Notes: Based on Bivariate Bayesian structural VAR including the financial and business cycle for each country (or region)with 9 lags, lag-decay prior to reduce risk of over-fitting . Structural shock identification consists of production sector only reacting with 1 quarter lag to shocks in the domestic financial sector – see Hubrich & Tetlow (2015) or Fink & Schüler (2015). Gauge international dimension of national shocks combining principal component across countries on national financial shock series with correlation analysis of underlying financial variables

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4 **Summary**

1. ***Can we generate reference financial cycles for broad set of countries?***

   - ✓ Estimates from *multivariate* (credit and asset prices) and *time varying (*aggregation) approach suggest shared cyclicality and medium-term frequencies
   - ✓ Financial cycles strong predictors of systemic banking crises

2. ***Are these financial cycles distinct from business cycles?***

   - ✓ Financial cycles only mildly procyclical with respect to business cycles, less at shorter frequencies (scope for countercyclical policy specialisation)
   - ✓ Financial cycles exhibit higher *amplitude* and *persistence* than business cycles…
   - ✓ Interacting financial frictions and time varying risk aversion strong candidate underlying mechanism for distinct financial cycle properties

3. ***Do these financial cycles differ across countries?***

   - ✓ Concordance of country cycles in EU limited (scope for country specific policies)
   - ✓ Financial asset prices key common driver of movements specific to financial cycle

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