Detrending and financial cycle facts across G7 countries:

Mind a spurious medium term!

Yves S. Schüler

Deutsche Bundesbank, Research Centre

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Motivation and research question

Analysis of expansions and contractions in financial variables (or, financial cycles):

- Critical to inform about the build-up of imbalances in the financial sector

For example,

- Basel III credit-to-GDP gap: Cycles guide the setting of countercyclical capital buffers (CCyBs)
- Here, identification of cycles:
  - HP filter with smoothing parameter 400,000 applied to trending credit-to-GDP ratio (medium-term cycles),
  - where 1,600 is the commonly employed smoothing parameter

Motivation and research question

Such and similar identification of cycles common practice for financial variables[1]

What are the consequences of these different detrending approaches for the analysis of cycles?

- Are extracted cycles spurious? (literature on spurious (business) cycles, e.g., Cogley and Nason (1995))
- Are financial cycle facts robust (differ to business cycles in amplitude, duration, and cross-country synchronisation)[2]? (literature on detrending and non-robustness of business cycle facts, e.g., Canova (1998))

[1] e.g., Borio and Lowe (2004), Drehmann et al. (2012), Behn et al. (2013), Borio (2014), Meller and Metiu (2015, forthcoming), Stremmel (2015), Anundson et al. (2016), Bauer and Granziera (2016)

[2] e.g., Claessens et al. (2011, 2012), Aikman et al. (2015), Schüler et al. (2017)

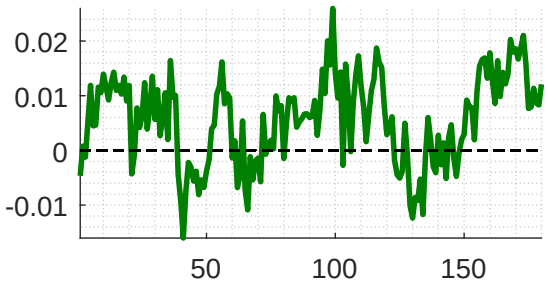
Preview of main results

Main results:

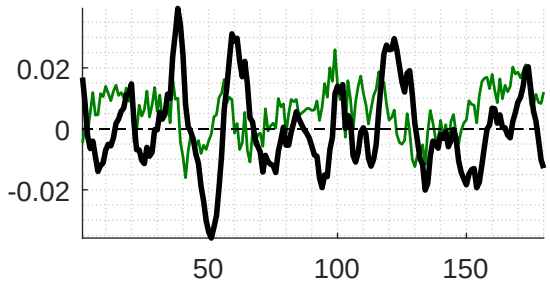
- Significant evidence of spurious cycles for
  - HP and band pass filters,
  - but not difference filters
- Effects of spurious cycles particularly stark when extracting medium-term cycles (e.g., Basel III credit-to-GDP gap) (factor of amplification of a specific cycle: up to 204)

- Financial cycle facts broadly robust!
  - Differences marginal for HP and band pass filters (due to spurious cycles)

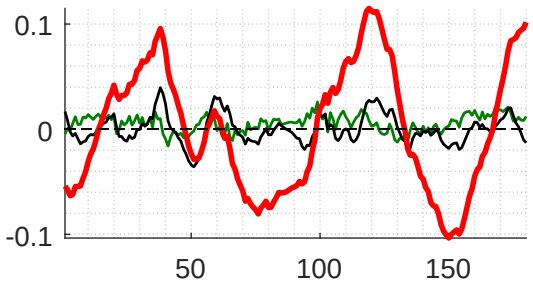
Illustration of main result



(a) True gap



(b) HP (1600) gap

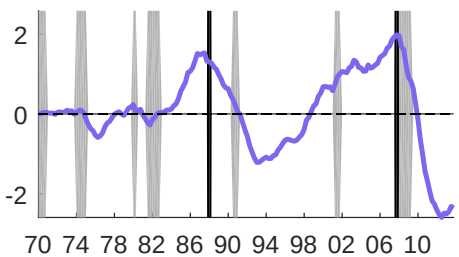


(c) HP (400000) gap

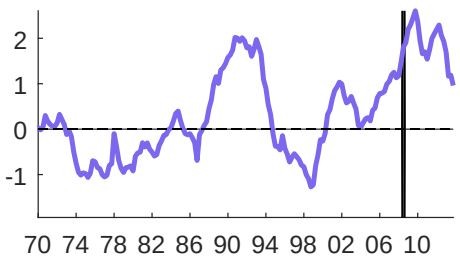
Simulated data: Estimated dynamics in changes in US credit-to-GDP

*Spurious cycles: cycle duration determined by smoothing parameter

*Stronger distortion the $\uparrow \lambda$ in HP (λ) (no short-term fluctuations)



(a) US



(b) France

Basel III credit-to-GDP gap ($\lambda = 400,000$), 1970Q1-2013Q4

*Abrupt risk materialisation? *Changes in frequency of crises?

*400,000 right parameter for French case?

Outline of the remaining parts

1. Methods of detrending
2. Theory of detrending
3. Empirical evidence
4. Summary and policy implications

Methods of detrending

Difference filters (y_t is time series of interest, $t = 1, \ldots, T$):

- Δ filter:[3] $\Delta y_t = y_t - y_{t-1}$,
- Δ_4 filter:[4] $\Delta_4 y_t = y_t - y_{t-4}$.

HP filter:

- $\lambda = 1600$ and
- $\lambda = 400000$.[5]

Baxter and King (1999)'s (BK) filter ($K = 40$, lags):

- 1.5 to 8 years and
- 8 to 30 years.[6]

[3] e.g., Schularick and Taylor (2012), Aikman et al. (2015), Schüler et al. (2015, 2017)
[4] e.g., Drehmann et al. (2012), Strohsal et al. (2015), Verona (2016)
[5] Basel III and, e.g., Borio and Lowe (2004), Behn et al. (2013), Bauer and Granziera (2016)
[6] similar to Drehmann et al. (2012), Stremmel (2015), Meller and Metiu (2015)

Theory of detrending

Effects of detrending on trend (TS) and difference stationary (DS) time series

Let

$$y_t = \tau_t + \psi_t \tag{1}$$

- τ_t is non-stationary component (trend)
- ψ_t is stationary, non-deterministic, and possibly cyclical

Assumptions on τ_t:[7]

$$\text{TS: } y_t = \alpha + \beta t + \psi_t \tag{2}$$

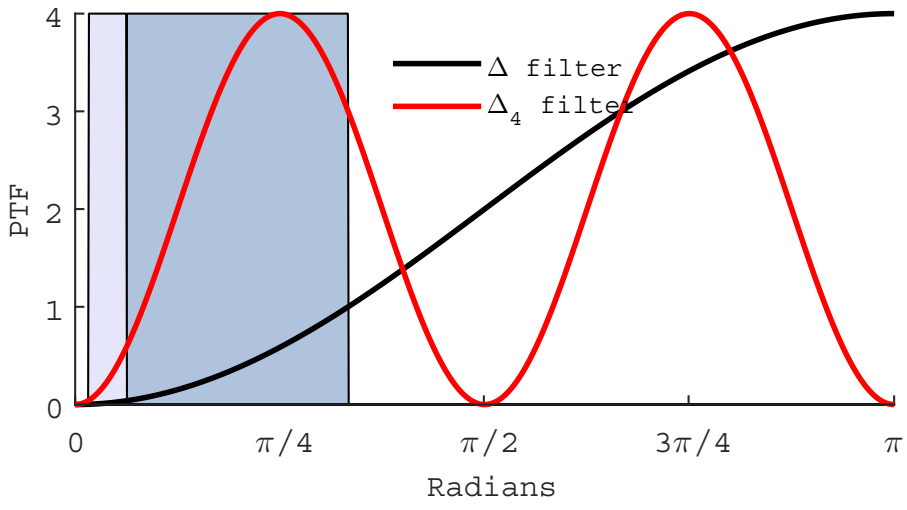
$$\text{DS: } y_t = \alpha + y_{t-1} + \psi_t \tag{3}$$

α is intercept (drift), t deterministic trend, and β slope coefficient of trend.

Goal: Extract ψ_t (also called "gap", $y_t - \tau_t$)

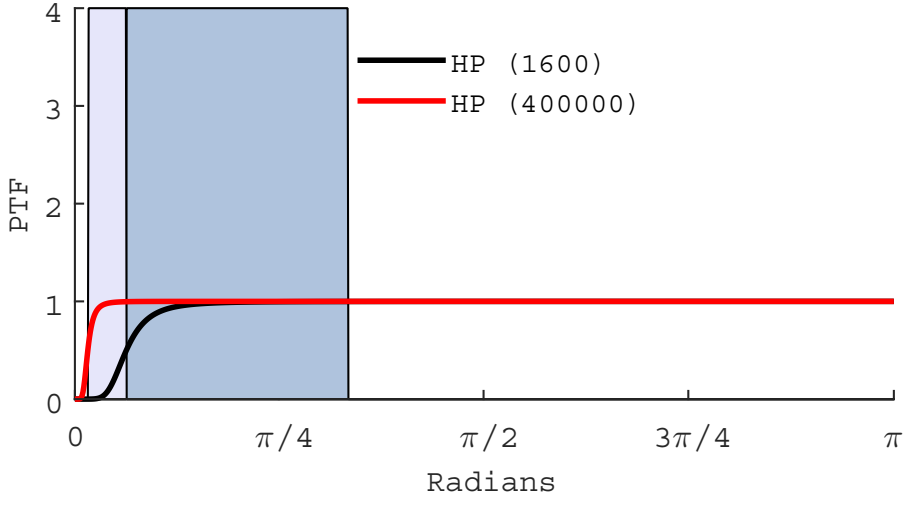
[7] e.g., Nelson and Plosser (1982)

TS: Effect on ψ_t (power transfer functions)

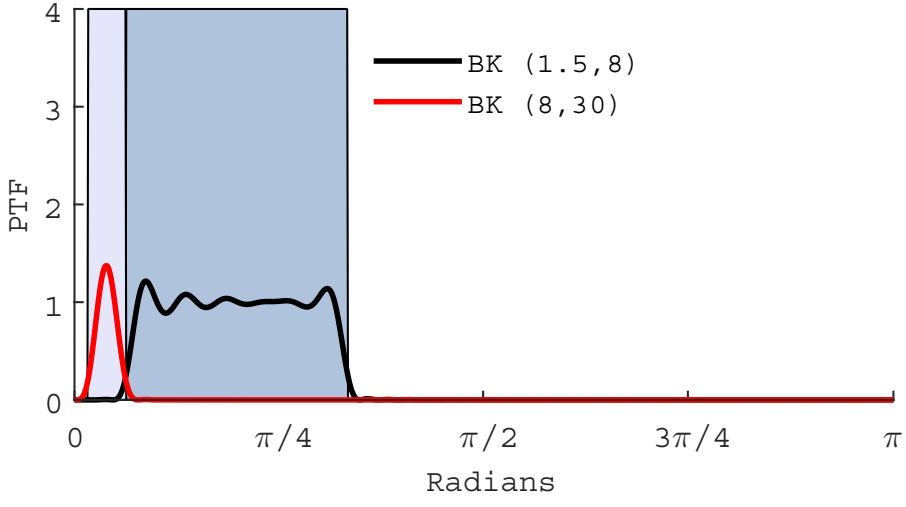


(a) Difference filters

Notes: The blue area marks business cycle frequencies (1.5-8 years) and the purple area medium term cycles (8-30 years) assuming quarterly frequency.

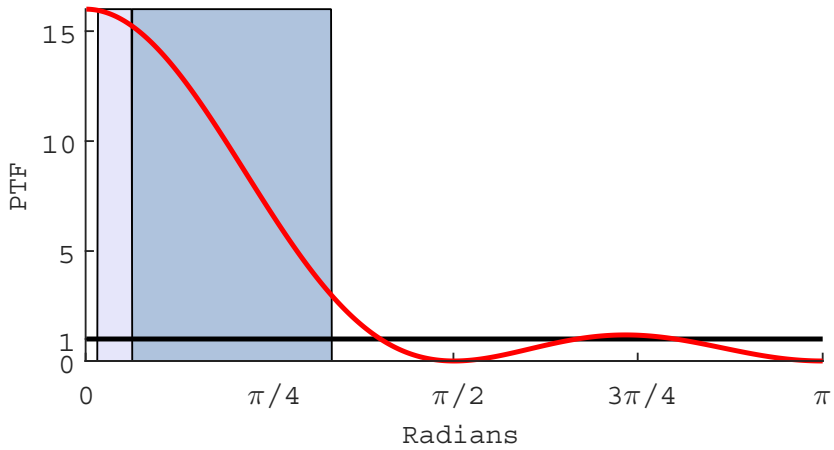


(b) HP filter

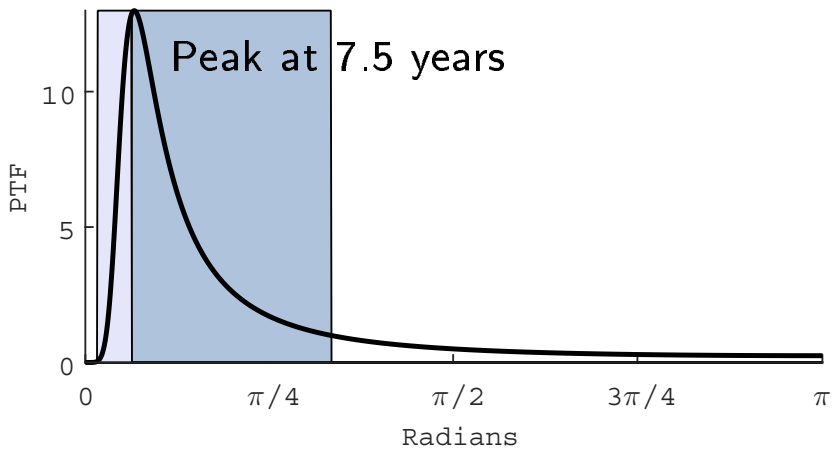


(c) BK filter

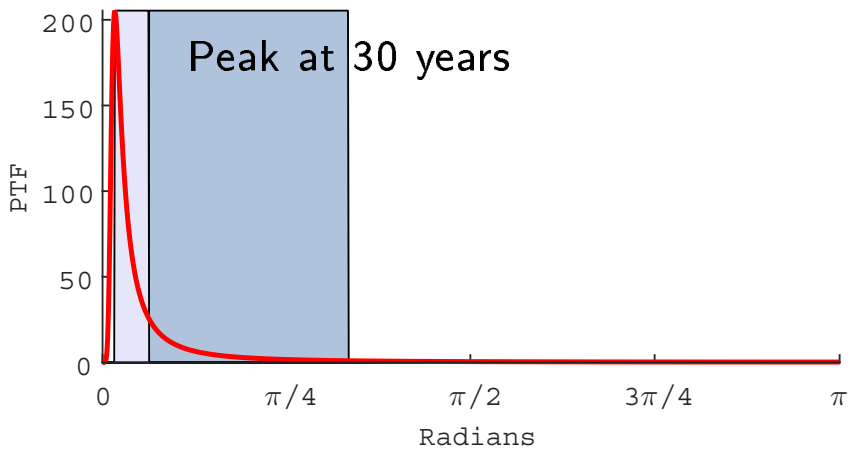
DS: Effect on ψ_t (power transfer functions)



(d) Δ filter (black) and Δ_4 filter (red)

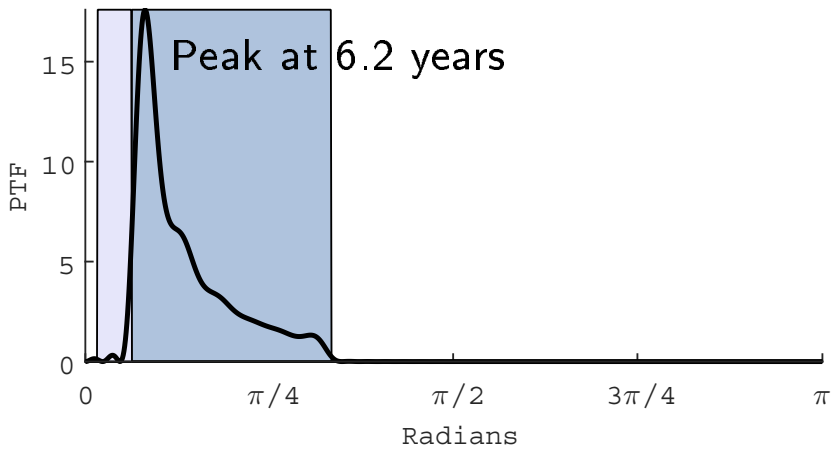


(e) HP (1600)

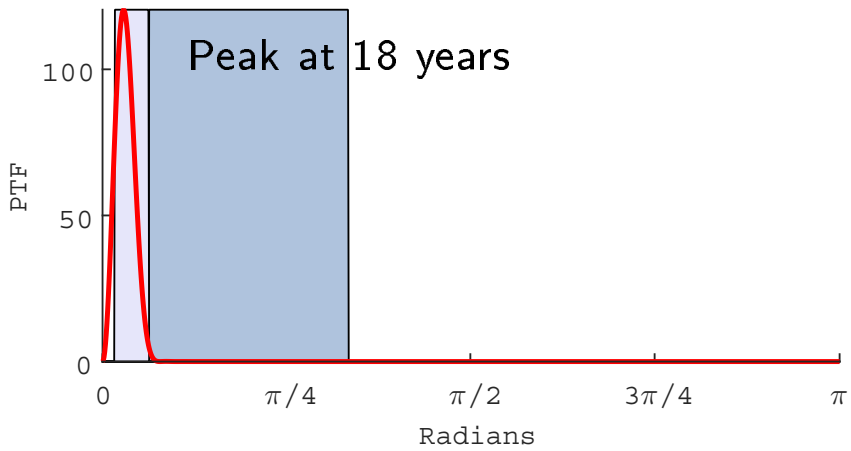


(f) HP (400000)

DS: Effect on ψ_t (power transfer functions, cont'd)



(g) BK (1.5,8)



(h) BK (8,30)

Note: DS case has broad implications: near unit root trend stationary cases similar effects (Cogley and Nason (1995))

Empirical evidence

Setup

Data:

- G7 countries
- Financial cycle variables: credit (c), credit-to-GDP (c/q), house prices (p_h), equity prices (p_e), bond prices (p_b)
- Business cycle variable: GDP (q)
- 1970Q1-2013Q4, real terms and seasonally adjusted

ADF test

Trend or difference stationary?

- H0: $y_t = \alpha + y_{t-1} + \sum_{i=1}^{p} \theta_i \Delta y_{t-1} + \eta_t, \quad \eta_t$ iid normal
- H1: $y_t = \alpha + \beta t + \rho y_{t-1} + \sum_{i=1}^{p} \theta_i \Delta y_{t-1} + \eta_t$
- F-test: $\beta = 0, \rho = 1$

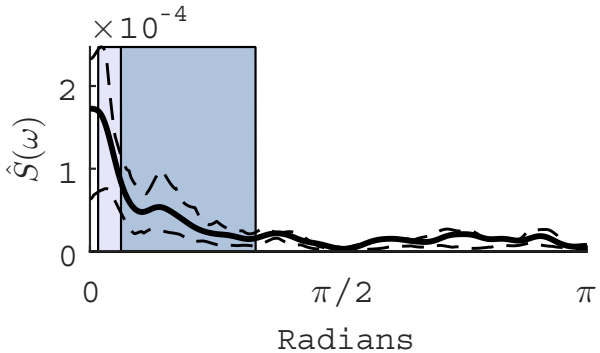
At 5% level, cannot reject H0:

- 30 out of 42 cases
  (c: 5/7, c/q: 7/7, p_h: 5/7, p_e: 7/7, p_b: 2/7, q: 4/7)

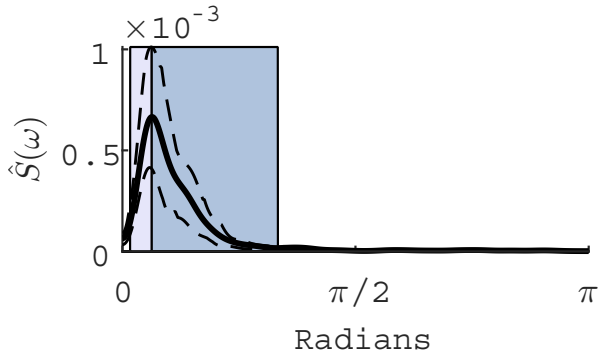
$\Rightarrow$ Distortions under DS relevant?

Estimated spectral densities ($\hat{S}(\omega)$) of detrended credit-to-GDP

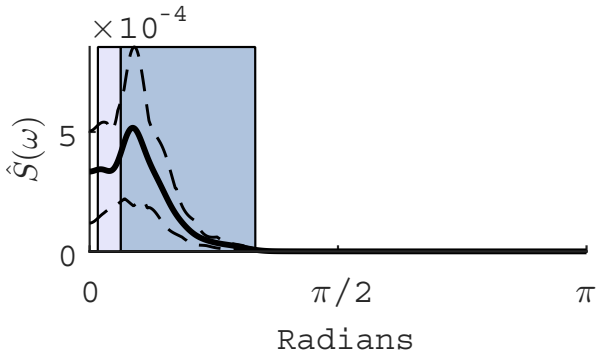
*Distortions in line with DS (shape and amplification)



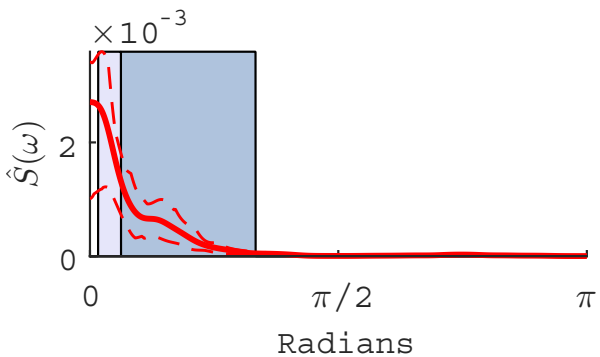
Δ



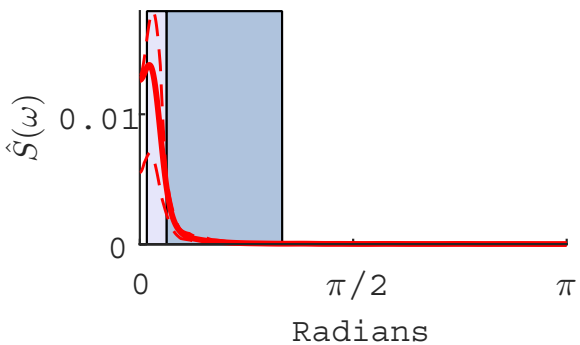
HP (1600)



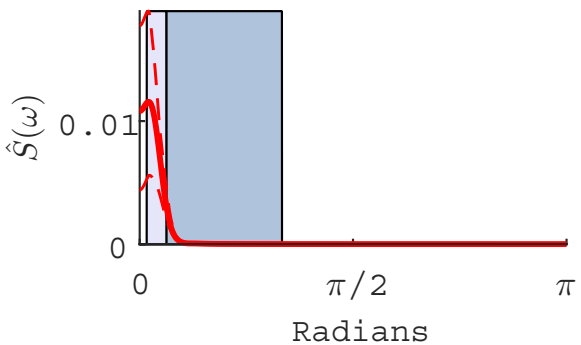
BK (1.5,8)



Δ_4



HP ($4 \cdot 10^5$)



BK (8.30)

Notes: Solid line is median across countries at frequency ω; dashed lines depict the 25% and 75% quantiles.

Predicted cycle duration under DS relevant?

*Yes! Estimated durations roughly coincide with predicted durations

Cycle duration in years. Average across G7 countries.

	Predicted duration under DS	c	c/q	p_h	p_e	p_b	q
Δ	–	15.1	15.3	10.8	4.8	∞	6.7
		(4.3)	*(3.1)*	*(2.4)*	*(1.9)*	∞	*(5.4)*
Δ_4	–	15.0	15.5	11.0	6.1	∞	7.9
		(4.0)	*(3.3)*	*(2.4)*	*(1.9)*	∞	*(4.1)*
HP (1600)	7.5	7.4	7.3	7.8	6.8	6.9	6.2
		(1.1)	*(1.8)*	*(0.9)*	*(0.3)*	*(0.7)*	*(0.4)*
HP ($4{\cdot}10^5$)	30.0	21.3	17.7	14.4	17.1	44.2	15.1
		(14.1)	*(3.6)*	*(1.4)*	*(5.5)*	*(34.5)*	*(0.7)*
BK (1.5,8)	6.2	6.3	5.3	6.2	6.2	6.0	5.8
		(0.6)	*(0.8)*	*(0.4)*	*(0.2)*	*(0.4)*	*(0.2)*
BK (8,30)	18.0	20.3	21.4	18.8	17.7	38.6	17.1
		(6.0)	*(5.0)*	*(9.5)*	*(3.9)*	*(32.5)*	*(2.7)*

Notes: Table reports average of most important (w.r.t overall variance) cycle duration across countries. Standard deviation in parentheses. c is total credit, c/q credit-to-GDP, p_h house prices, p_e equity prices, p_b bond prices, q GDP.

Summary and policy implications

Summary and policy implications

Aim:

- Shed light on the effects of (popular) detrending methods for financial variables and financial cycle facts.

Main conclusions:

- Strong evidence for spurious cycles using HP and band pass filters
- Distortions especially strong when extracting medium-term frequencies

- Robust empirical differences between financial variables and GDP

Summary and policy implications

Policy implications:

1. Caution, when extracting medium-term financial cycles (as in Basel III): Completely erases short-term fluctuations
   - Relevant for signalling of crises?
   - Abrupt materialisation of systemic risk?
   - If frequency of financial crises changes, relevant fluctuations missing
2. Same smoothing parameter (or frequency window) across countries most likely wrong:
   - US credit-to-GDP gap peaks before crises, US GDP gap same duration as NBER estimate, but other countries?
3. Robust empirical differences between financial cycle and business cycle variables
   - Substantiate argument of a complementary role of macroprudential policy

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