

Introducing a composite indicator of cyclical systemic risk in Croatia: possibilities and limitations

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The views expressed in this study reflect the author's opinions and are not necessarily those of the Croatian National Bank or Bank of England. The paper was written at a time when the author was affiliated with the Croatian National Bank.

Content

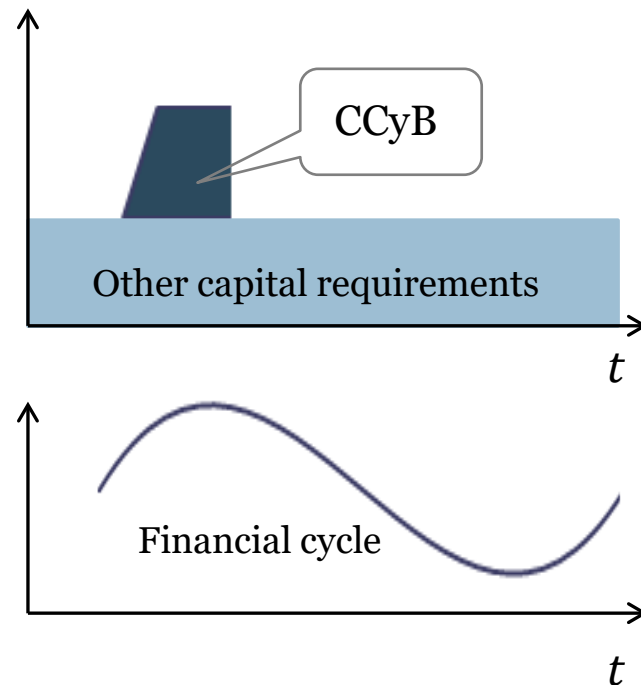
1. Motivation for composite indicators
2. Cyclical indicators and variable selection
3. Empirical analysis of selected composite indicators
4. Conclusions

Content

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1. Motivation for composite indicators

- Financial cycle tracking and CCyB
- ESRB (2014) and BCBS (2011) guidelines:
 - Basel credit gap - problems (solved in Škrinjarić & Bukovšak; 2022 a, b; Škrinjarić 2022 a, b, 2023)
 - 6 categories of risk accumulation tracking
 - Overvaluation of property prices
 - Credit dynamics
 - External imbalances
 - CI balance sheet strength
 - Private sector debt burden
 - Risk mispricing



Tölö et al. (2018)

	Ferrari and Pirovano (2015)	Holopainen and Sarlin (2015)	Jordà, Schularick, and Taylor (2016)	Derken et al. (2014)	Anundsen, Gerdrup, and Hansen (2014)	Babeky et al. (2014)	Drehmann and Juselius (2014)	Lainà, Nyholm, and Sarlin (2014)	Behn et al. (2013)	Bonfim and Monteiro (2013)	Hahn, Shin, and Shin (2013)	Lo Duca and Peltonen (2013)	Bordo and Meissner (2012)	Kauko (2012a)	Kauko (2012b)	Roy and Kemme (2012)	Schularick and Taylor (2012)	Alessi and Detken (2011)	Drehmann, Borio, and Tsatsaronis (2011)	Barrell et al. (2010)	Bunda and Ce' Zorzi (2010)	Büyükkarabacak and Valev (2010)	Joyce (2011)	Borio and Drehmann (2009)	Davis and Karim (2008)	Von Hagen and Ho (2007)	Domas and Peris (2008)	Demirgüç-Kunt and Detragiache (2000)	Kaminsky and Reinhart (1999)	Hardy and Pazarbaşıoğlu (1998)					
Crisis Data Set / Target Variable:	B	L	C	D	C	B	L	C	B	D	O	FSI	C	NPL	NPL	R	C	O	C	L	R	C	CK	C	C	O	DD	DD	R	LI					
No. of Countries:	15	15	17	28	16	40	26	11	23	9	30	28	14	25	34	14	14	18	36	14	76	37	20	18	105	47	88	34	20	38					
1. Credit Developments																																			
Total Credit to Private Sector		x	x	x	x	x	x	x	x	x	x	o	x	x	x	x	x	x	x	x	x	x	x	x					x						
Bank Credit to Private Sector																																			
Household Credit						z																x	x	x											
Mortgage Loans																																			
Corporate Credit																																			
Public Credit																																			
Global Credit																																			
Credit-to-GDP Ratio		x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x											
Bank Credit-to-GDP Ratio																																			
Household Credit-to-GDP Ratio		x	x	x	x	x	x	x	x	x	x																								
Mortgage Loans-to-GDP Ratio																																			
Corporate Credit-to-GDP Ratio																																			
Public Credit-to-GDP Ratio																																			
Global Credit-to-GDP Ratio																																			
Differenced Relative Total Credit Loans-to-Income Ratio															x																				
2. Private-Sector Debt Burden																																			
Real Mortgage Interest Rate		x																																	
Debt-Service Ratio			x																																
Household Debt-Service Ratio																																			
Corporate Debt-Service Ratio																																			

- Over 90 variables
- 6 to 35 individual indicators (Arbatli-Saxegaard & Muneer, 2020)

- Sintetisation + transparency

- Contribution?

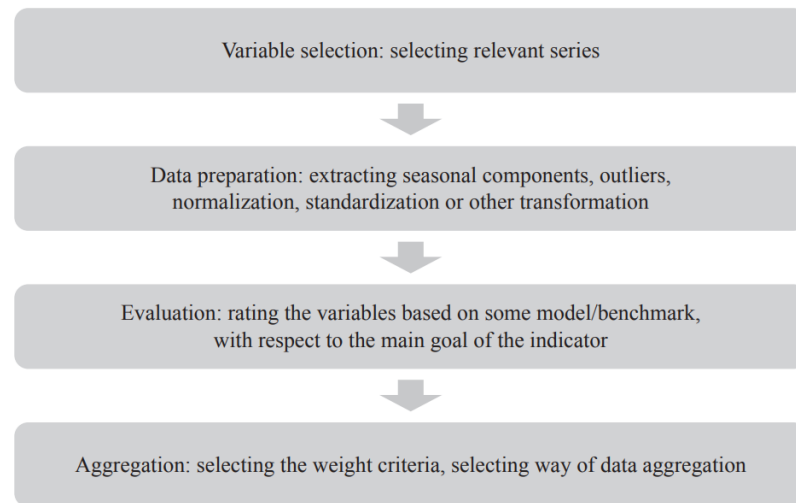
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2. Cyclical indicators and variable selection

- EU & UN handbook (2017): objectivity and unbiasedness, methodological soundness, clarity, transparency, interpretability and readability, consistency and comparability
- Variables:
 - 6 categories + macro, over 260 variables
 - Transformations
 - 1- and 2-year growth rates, changes,
 - 1HP gap, lambda 1.600, 25K, 85k, 125K, 400K,
 - CF filter, BK filter, Hamilton filter
 - nominal/real,
 - gross/net,
 - current values, moving sums
 - Adjusted such that increase means risk accumulation (upward vs downward phase of the cycle)

Composite indicator construction steps



Source: Author's adjustment based on OECD (2012).

- Credit dynamics – most common one, best predictor of previous crises (Borio & Lowe, 2002; Borio & Drehmann, 2009); Minsky hypothesis (1982,1986)
- Overvaluation of property prices – second best, Borio, 2012; Jordá et al., 2015; wealth effect in Bakker (2015)
- Private sector debt burden – reduces consumption and growth, Jordá et al. (2013, 2017)
- External imbalances – Tölö et al., 2018; 39 out of 41 economies had CA deficit before financial crises, Laeven & Valencia (2008)
- CI balance sheet strength – opposed results (Detken et al. 2014 – bad predictor, Laina et al., 2015; Kamin & DeMarco, 2012, good)
- Risk mispricing – perception of risk depends on the financial cycle phase; banks in Bordalo et al. (2018), López-Salido et al. (2017), Gross (2022); investors in Plašil et al. (2015)

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1) Financial cycle indicator (FCI) – Plašil et al. (2014, 2018)

- Portfolio selection based: $FCI_t = (w \odot s_t)' \cdot C_t \cdot (w \odot s_t)$
- C ... EWMA
 - $\sigma_{ij,t} = \lambda \sigma_{ij,t-1} + (1-\lambda) \tilde{s}_{i,t} \tilde{s}_{j,t}$
 - $\sigma_{i,t}^2 = \lambda \sigma_{i,t-1}^2 + (1-\lambda) \tilde{s}_{i,t}^2$
 - $\rho_{ij,t} = \sigma_{ij,t} / (\sigma_{i,t} \sigma_{j,t})$

- Stationary variables, order stats

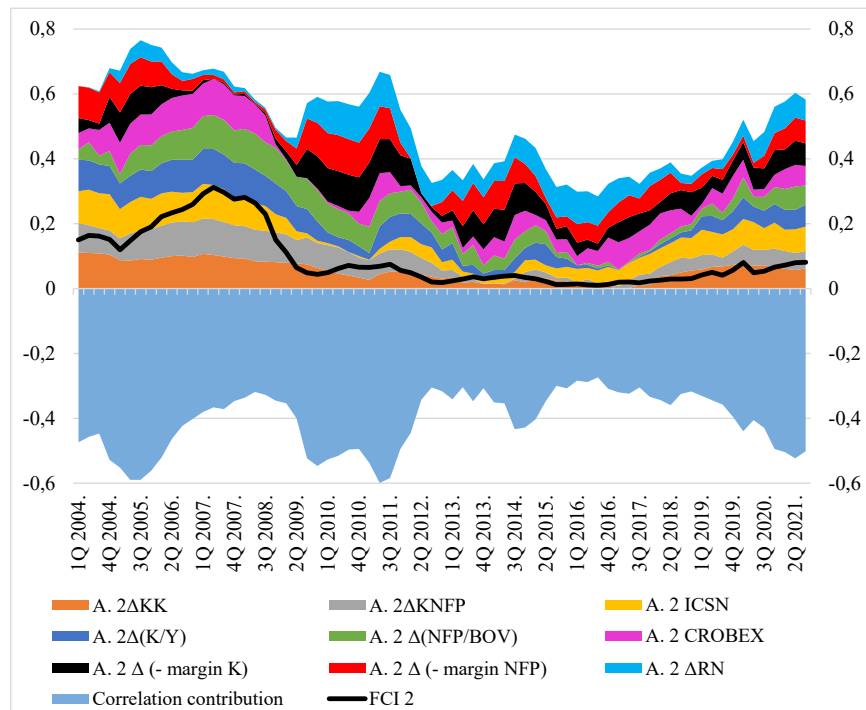
➤ Comments

- No criteria on which variables, how
- Equal weights ; tried to min RMSE in forecasting NPLs
- Correlation interpretation
- Nonlinearity
- Smoothing parameter
- No evaluation of results

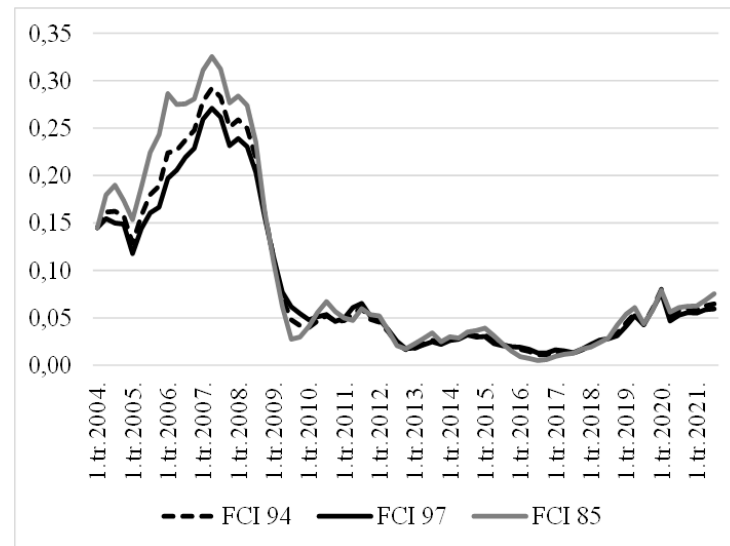
Solution

- EWM or most common ones
- EWM based
- no corrs (next indicator)
- (next indicator)
- DCC approach
- EWM or some forecasting

FCI for Croatia



Different smoothing parameters



KK – Household credit, KNFP – NFC credit, ICSN House price index, -LR – leverage ratio * (-1), LTD – credit to deposit ratio, K/Y – household debt to earnings ratio, NFP/BOV – NFC debt to gross operating surplus ratio, -margin K – excess return of HH credits to Euribor *(-1), -margin NFP – excess return of NFC credits to Euribor *(-1), RN – current account to GDP ratio* (-1)

2) Cyclogram - Rychtarik (2014, 2018)

➤ Linear aggregation, otherwise similar to FCI $CYCLOGRAM_t = \frac{\sum_{i=1}^N z_{i,t}}{N}$

➤ Transformation
$$z_{i,t} = \begin{cases} 1, & \text{if } ranking_{i,t} < x_{i,t}^{10\%} \\ 2, & \text{if } x_{i,t}^{10\%} \leq ranking_{i,t} < x_{i,t}^{20\%} \\ \dots \\ 9, & \text{if } ranking_{i,t} \geq x_{i,t}^{80\%} \end{cases}$$
 or max-min

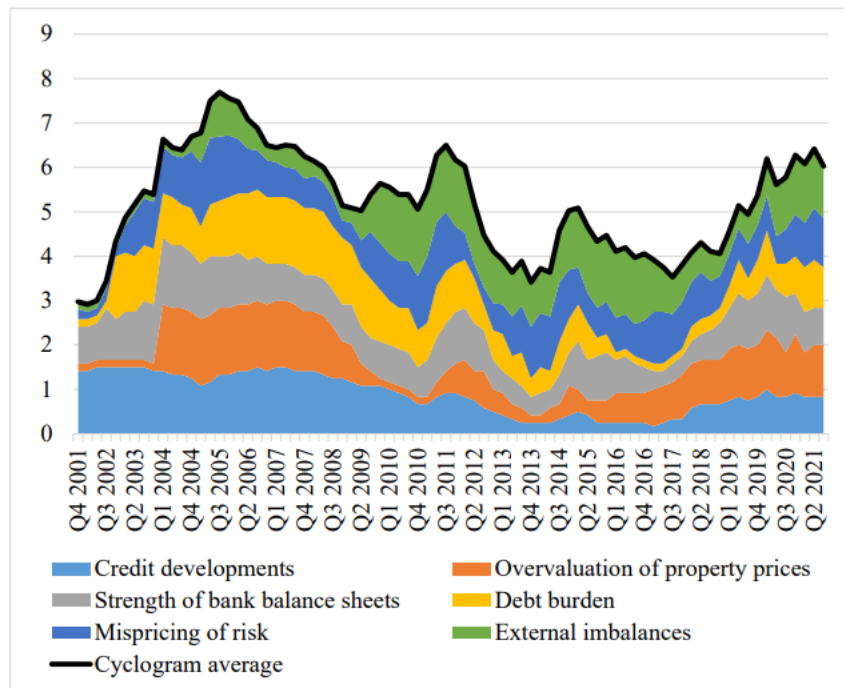
➤ Comments

- Macro variables – business cycle? Late response?
- No criteria on var selection
- Levels with diffs and growth rates?
- Simple
- No evaluation of results

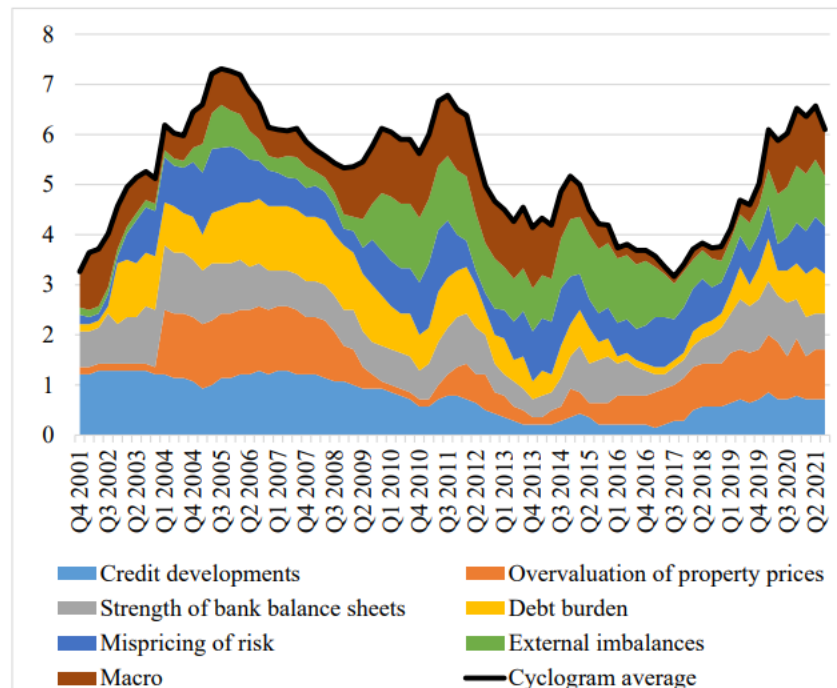
Solution

- track, but...
- as previous
- needs to reflect cycle
- as previous

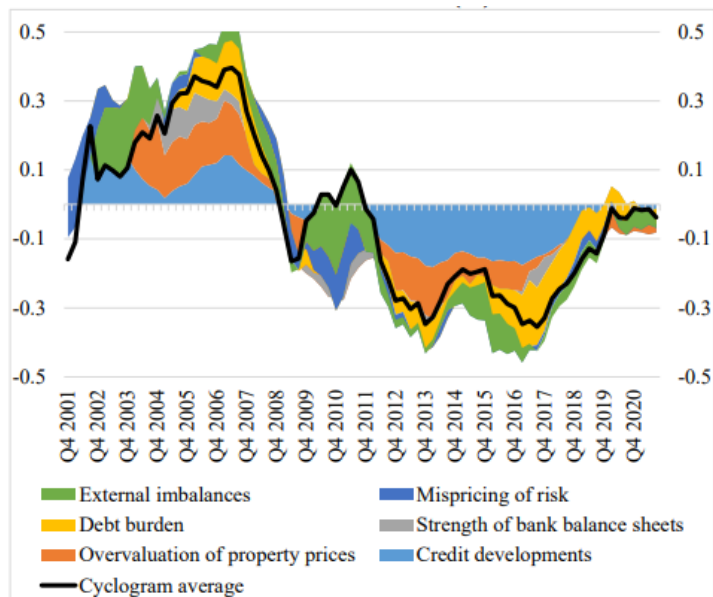
Cyclogram for Croatia 1



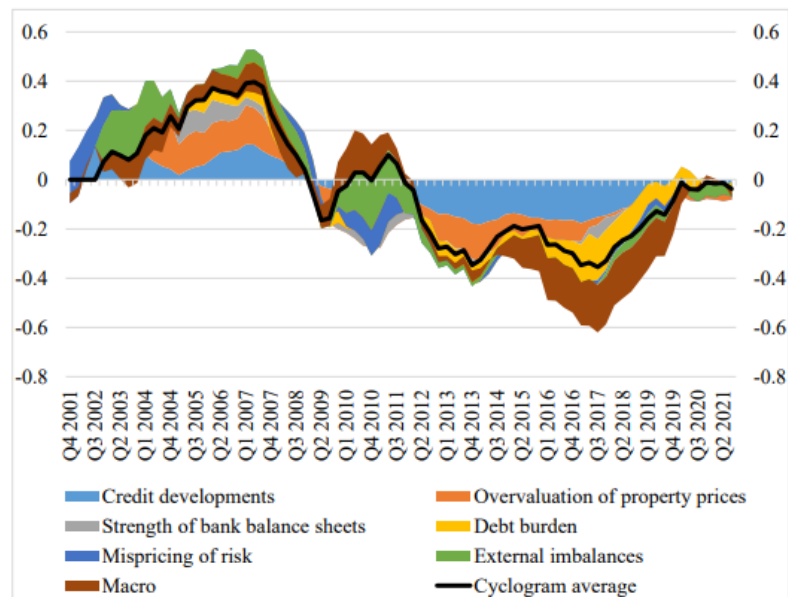
Cyclogram for Croatia 2



Cyclogram for Croatia 1



Cyclogram for Croatia 2



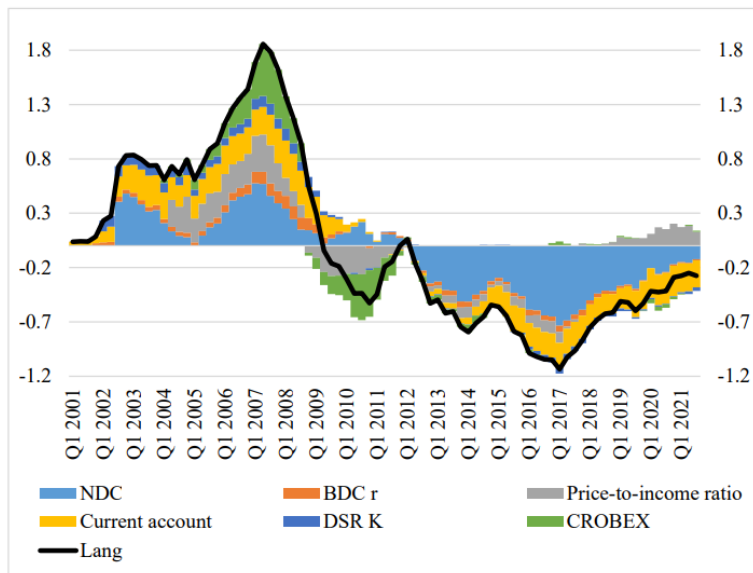
(max-min)

3) d-SRI (domestic systemic risk indicator) – Lang et al. (2019)

- Linear aggregation $d-SRI_t = \sum_{i=1}^N w_i z_{i,t}$
- Standardisation of variables, EWM based selection (panel dataset)

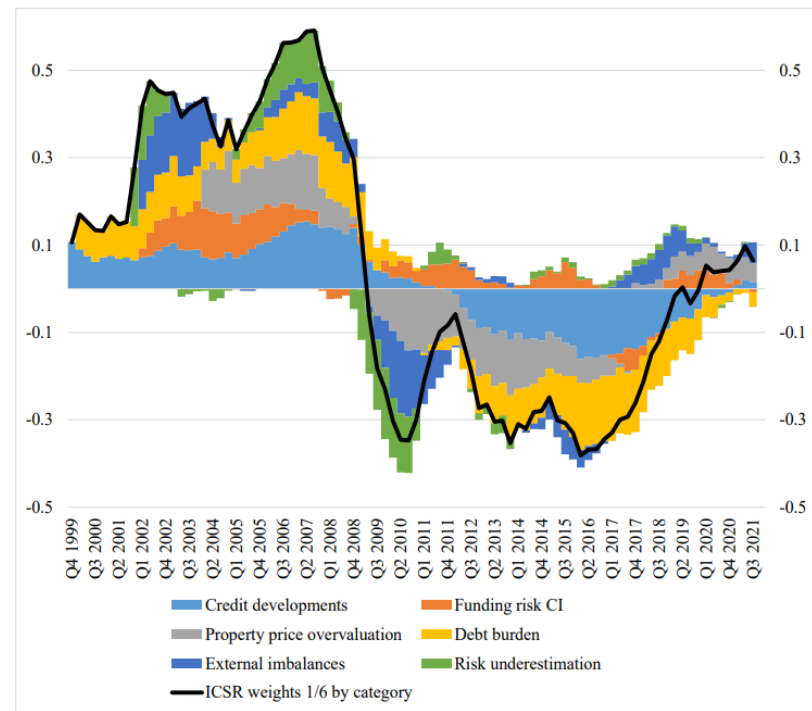
- | Comments | Solution |
|--------------------------------------|-----------------------------|
| ➤ Rationale on variable selection | |
| ➤ Transformation of variables | - max-min for data like HR |
| ➤ RH problem: bias due to one crisis | - look at other experiences |
| ➤ Simple interpretation | |
| ➤ Correlation? | |

d-SRI, Lang version



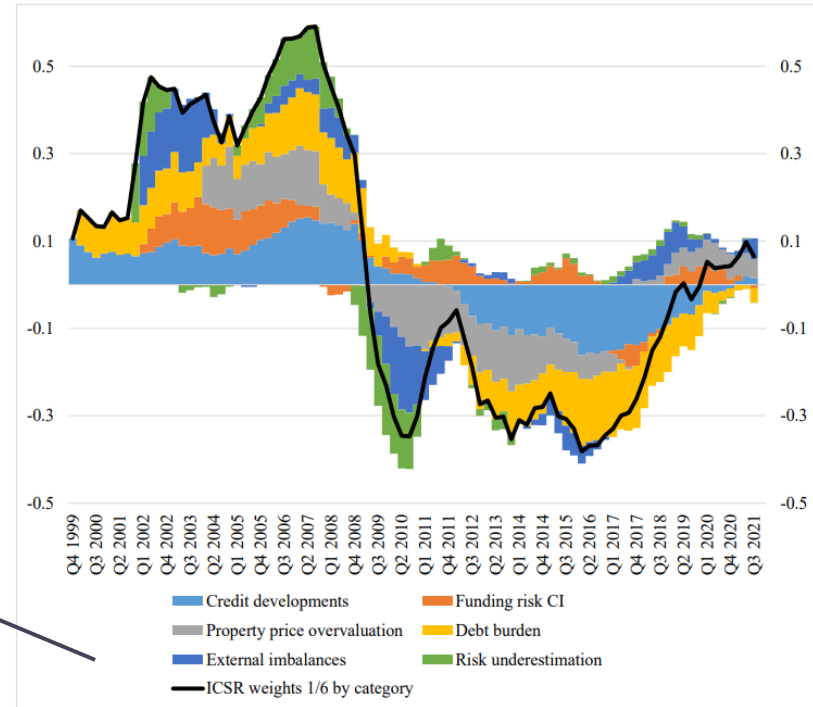
NDC - annualised 2-year change in credit-to-GDP ratio (36%); BDC r annualised 2-year real credit growth rate (5%); Price to income ratio - annualised 3-year change in real estate price-to-income ratio (17%); Current account - current account-to-GDP ratio (20%); DSR K - annualised 2-year change in debt service-to-income ratio (5%); CROBEX- annualised 3-year change in real stock market index (17%)

d-SRI, RH version



Risk categories	Indicator description
Credit dynamics measures	HP gap for the broad definition of credit to households, smoothing parameter of 125,000
	HP gap for the broad definition of credit to non-financial corporations, smoothing parameter of 125,000
	HP gap for the ratio of narrow definition of credit and the sum of GDP of the current quarter and the preceding three quarters, smoothing parameter of 125,000
Measures of credit institution financing risk	Annualized two-year change in the negative ratio between credit institutions' equity and assets
	Annualized two-year change in the negative ratio between private sector deposits and credit
	Annualized two-year growth rate in the residential real-estate price index
Measures of potential real estate price overvaluation	Annualized two-year growth rate in the residential real-estate price-to-disposable income ratio
	Annualized two-year growth rate in the volume index of construction works
	HP gap for the ratio between corporate debt and gross operating surplus, smoothing parameter of 125,000
Measures of private sector debt burden	HP gap for the ratio between household debt and disposable income, smoothing parameter of 125,000
	HP gap of debt service measures – households, smoothing parameter of 125,000
	HP gap of debt service measures – corporations, smoothing parameter of 125,000
	Annualized two-year change in the negative share of net exports of goods and services in GDP
Measures of external imbalances	Annualized two-year change in the negative share of current account balance in GDP
	Annualized two-year growth rate in CROBEX
Measures of potential mispricing of risk	Annualized two-year change in the negative interest margin on new loans to households relative to the 3-month EURIBOR
	Annualized two-year change in the negative interest margin on new corporate loans relative to the 3-month EURIBOR

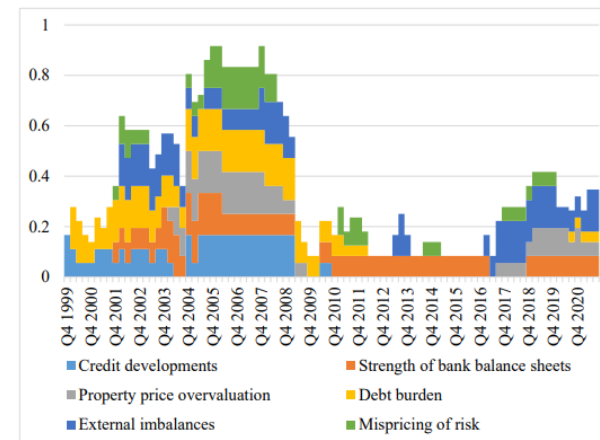
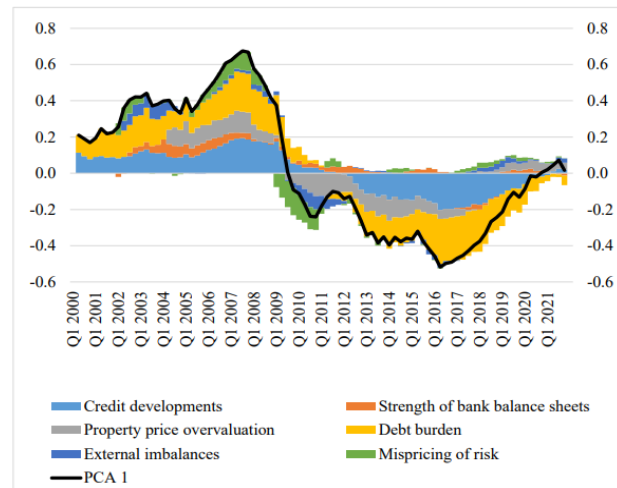
d-SRI, RH version



Other selected methodological things

- PCA for aggregation
 - Karamisheva et al. (2019)
 - Assumptions of PCA
 - HR: Almost equal weights and small variability explained

- Overheating index $OI_t = \sum_{i=1}^N w_i I_t^i$
 - Chen & Sviryzdenka (2021)
 - I is a binary variable, equal to 1 if the value exceeds threshold from EWM
 - HR: Biased results

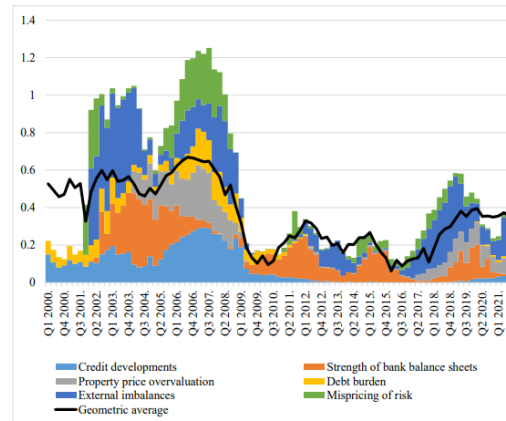


Other selected methodological things

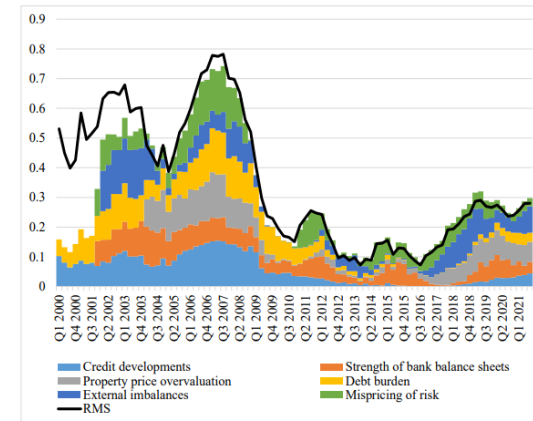
➤ FED paper

- Aikmann et al. (2015) $V_t = [\sum_{i=1}^N w_i (v_{i,t})^r]^{\frac{1}{r}}$
- A couple of variants based on r :
 - $r = 1$... simple average
 - geom average, RMS
- Problems for negative values
- Interpretation problems

Geometric average



RMS indicator



Discussion

- Different aspects are important:
 - Objective vs subjective variable selection, transformation
 - Way of aggregating data
 - Interpretation and communication
- Recommendations?
 - EWM, however
 - Max-min transformation for problematic data
 - Aggregation – simple, but still some corr missing
 - Use additional indicators as help

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Thank you