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# GDP-at-Risk as a Tool for Macroprudential Policy

CCBS Course for Central Bank of Egypt

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# Plan for this session

## 1. A Framework and Toolkit for Risk Assessment

- Triggers, vulnerabilities and resilience
- Heat maps, indicator swathes and GDP-at-Risk

## 2. What is GDP-at-Risk?

- How is it relevant for financial stability policy?

## 3. A Model of GDP-at-Risk

- What can we capture in a model for GDP-at-Risk?
- Which transmission channels can be proxied?

## 4. Applying Tools to Policy

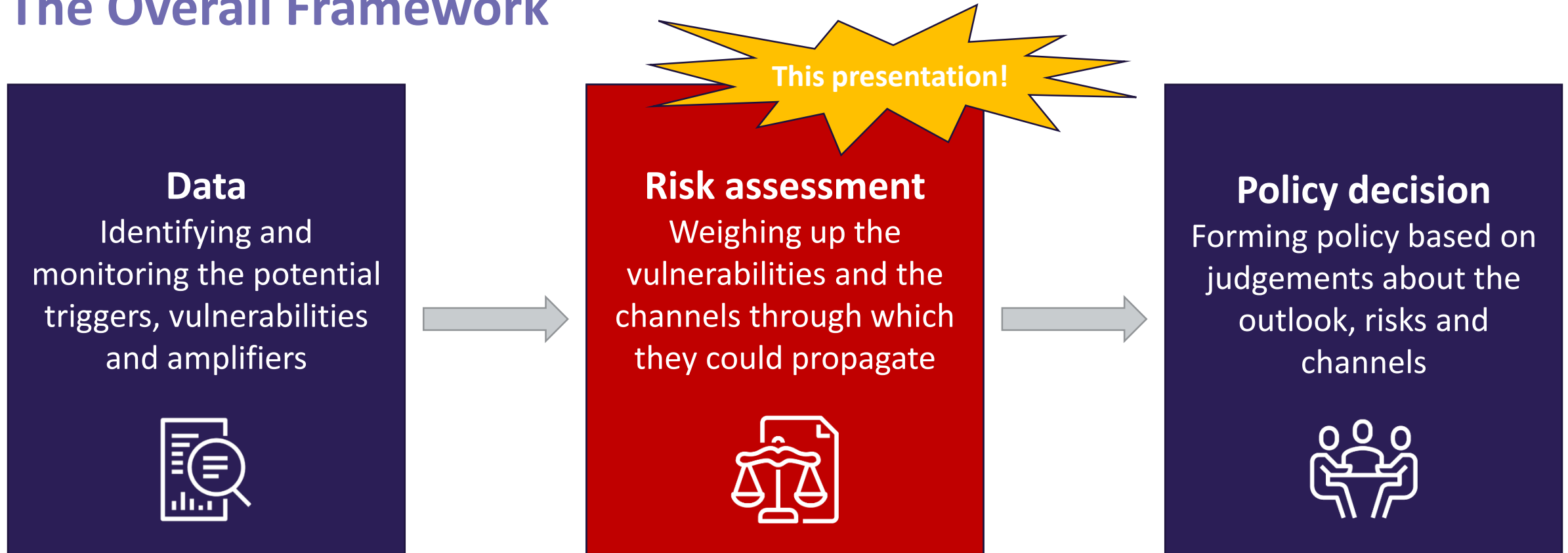
- Forming judgements



# A Framework and Toolkit for Risk Assessment

## PART 1

# The Overall Framework



No simple mapping between any of these. So **judgement needed.**

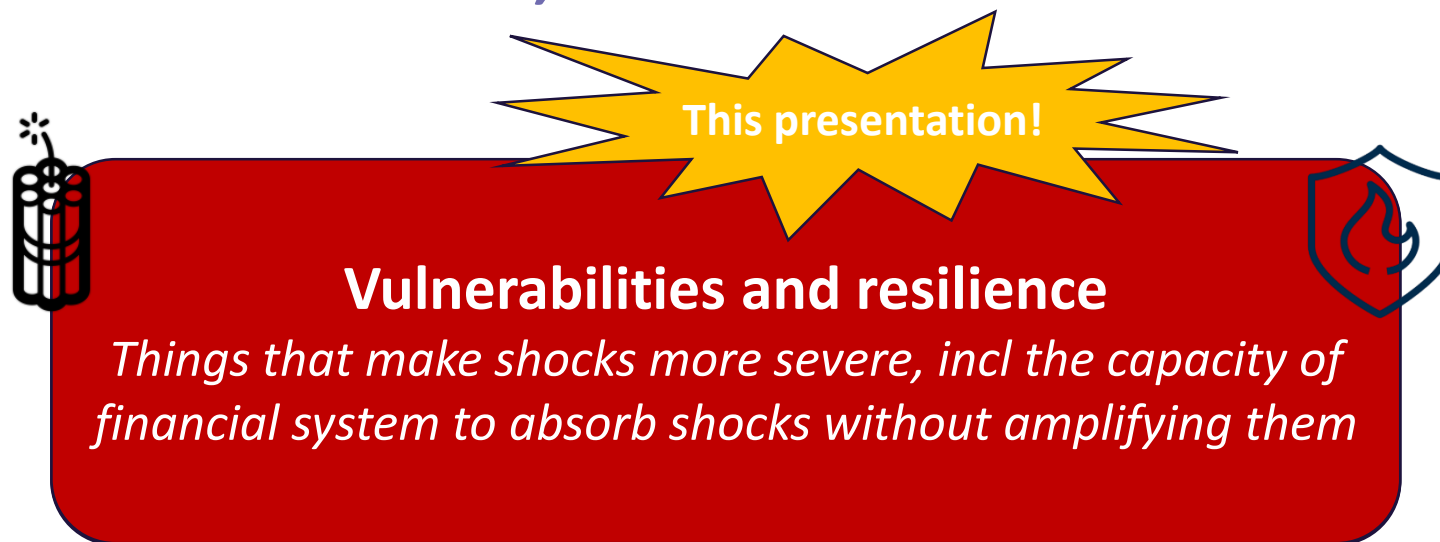
## An Example: The Bank of England's CCyB Policy Statement

**Set a UK CCyB rate in the region of 2% when risks are standard (neither elevated nor subdued)**

# Classifying Risks: Triggers, Vulnerabilities, Resilience



If risks are crystallising, release buffers



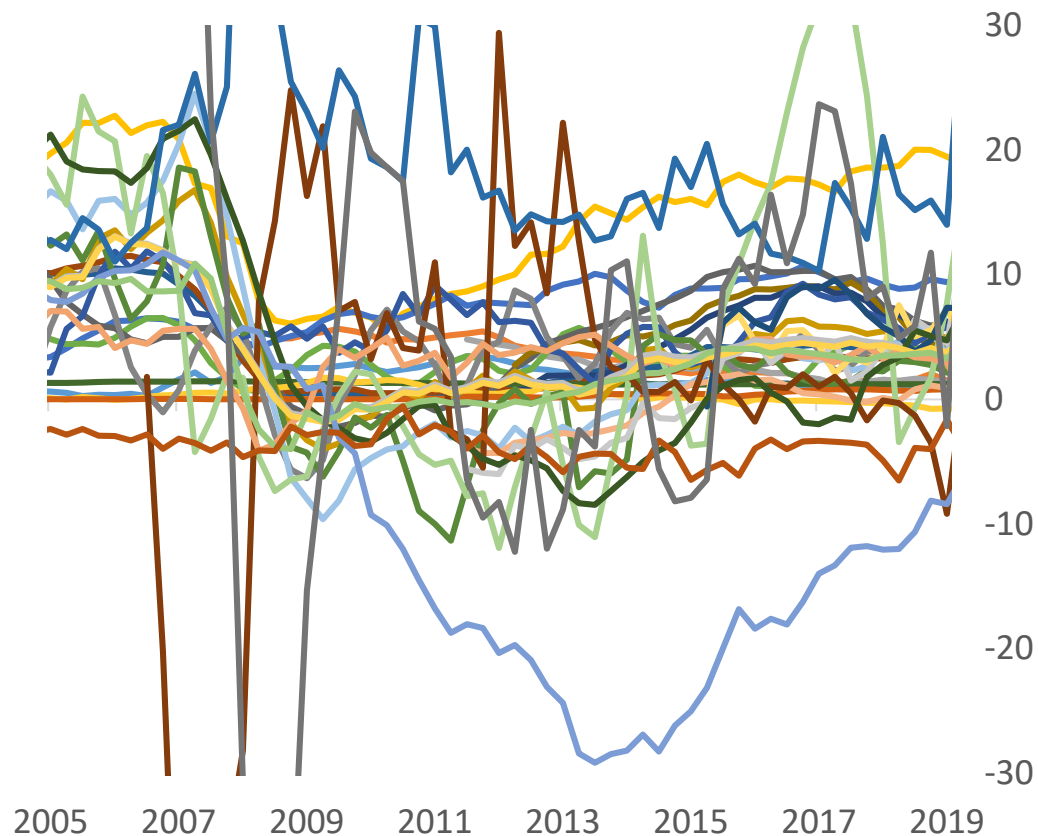
If vulnerabilities increasing, build up buffers

**How can we assess the evolution of the risk environment over time?**



## ...and simple time series plots aren't very informative!

Time Series plot of “Risk and Resilience” Indicators

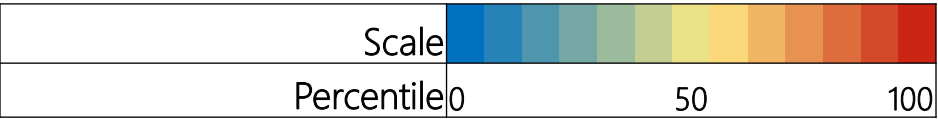
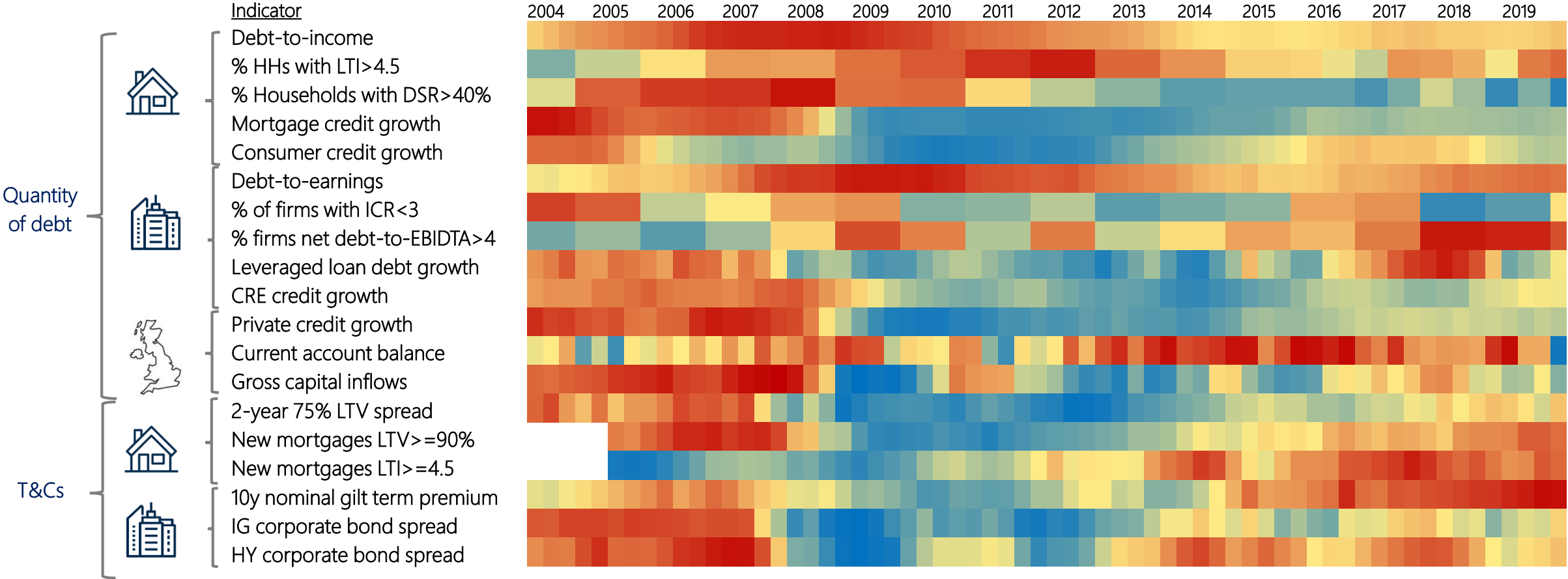


**We need a range of tools to help draw out an overall picture:**

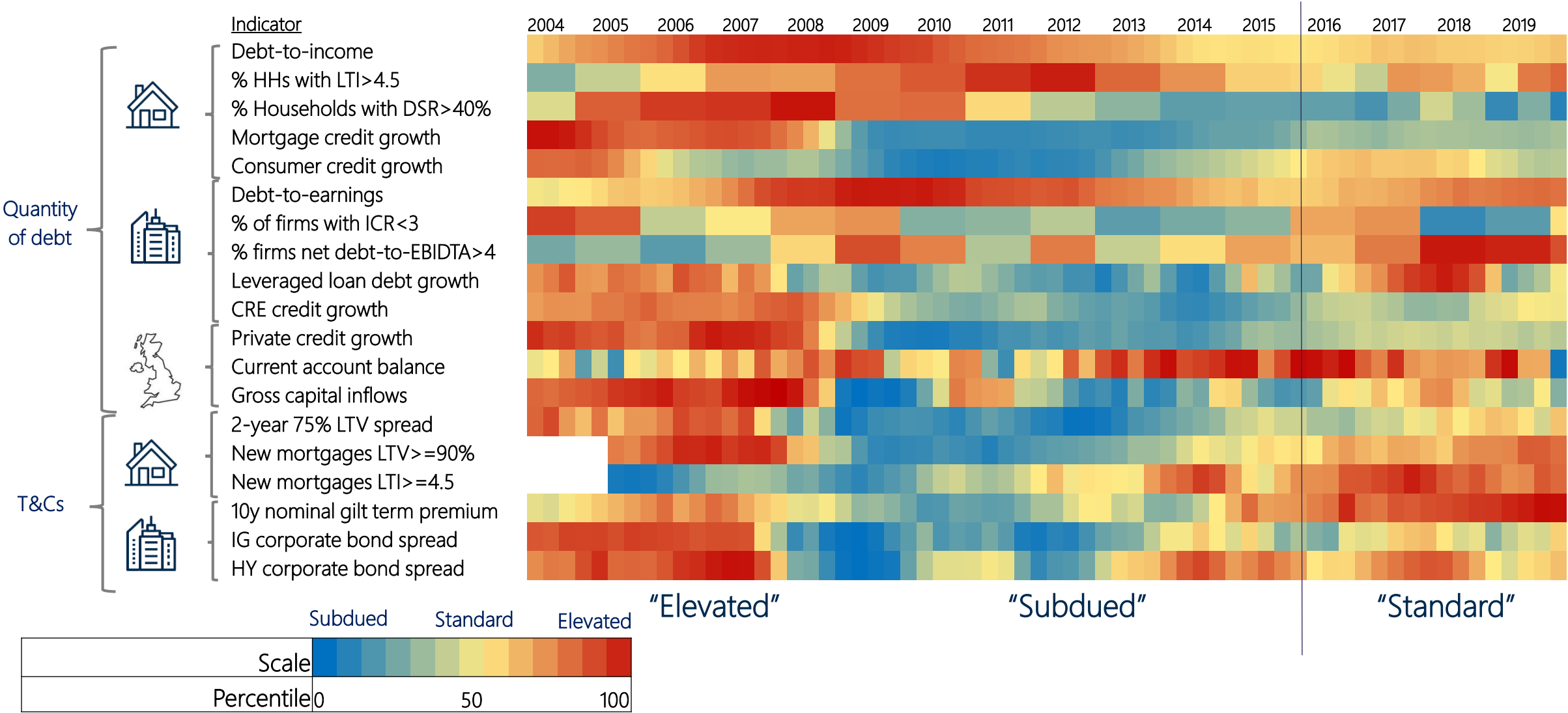
- Heat maps
- Indicator swathes
- GDP-at-Risk



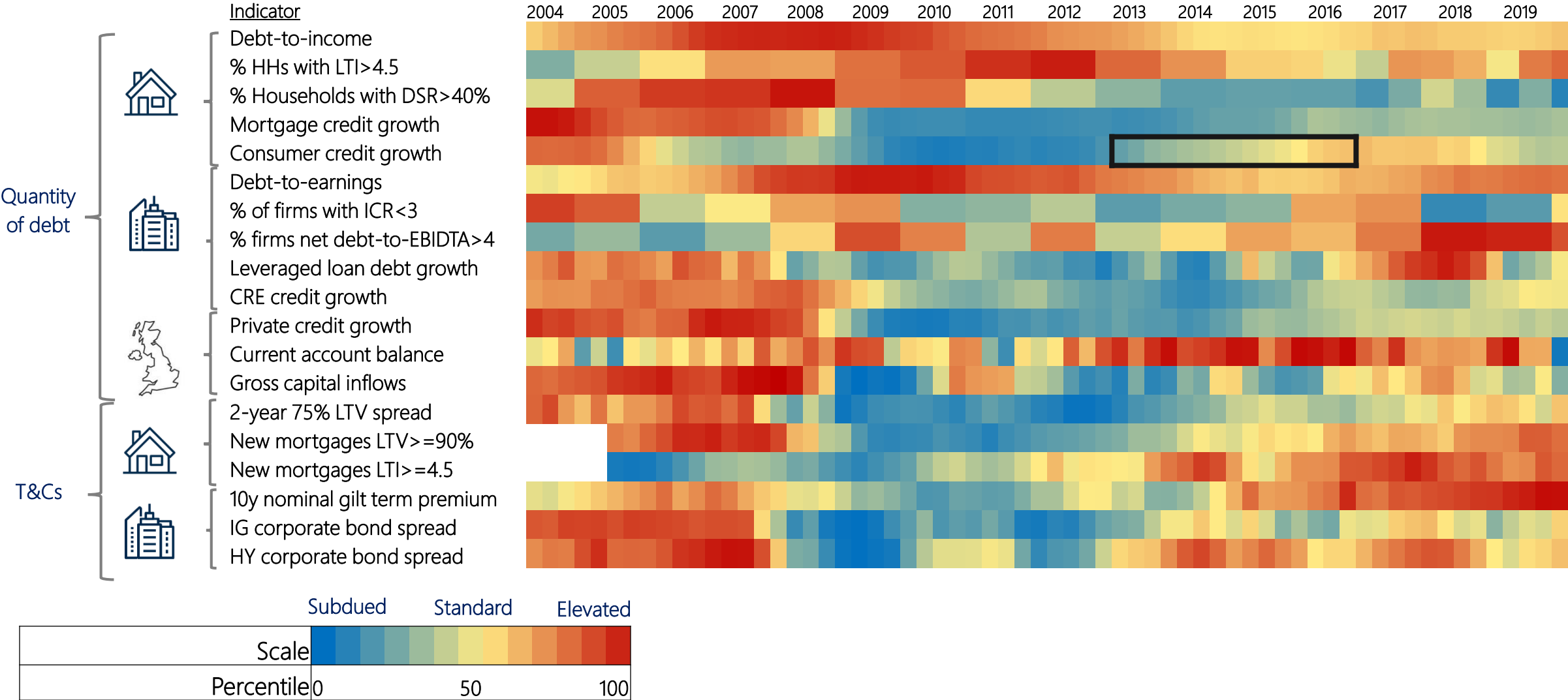
# Heat maps visualise the raw data and put it into historical context



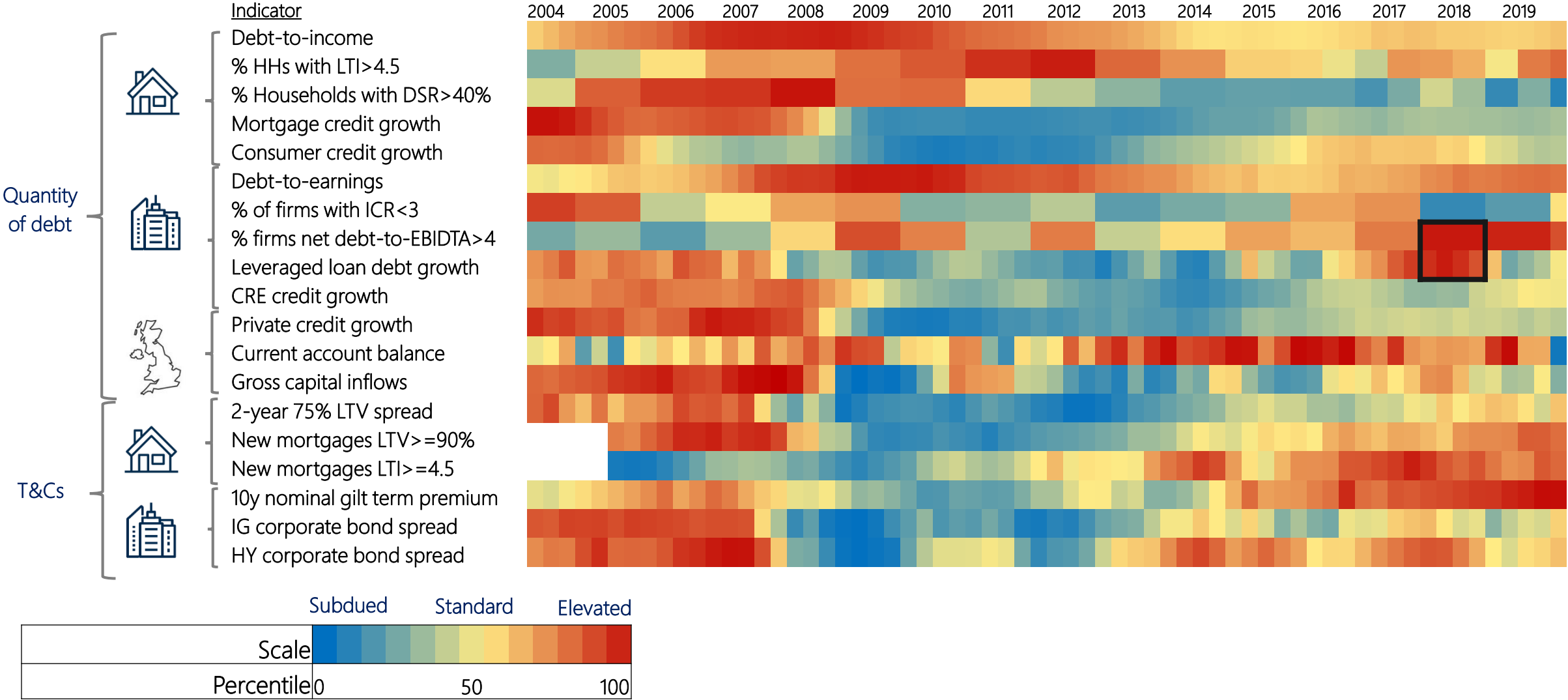
# Heat maps can be linked to judgements about risk environment



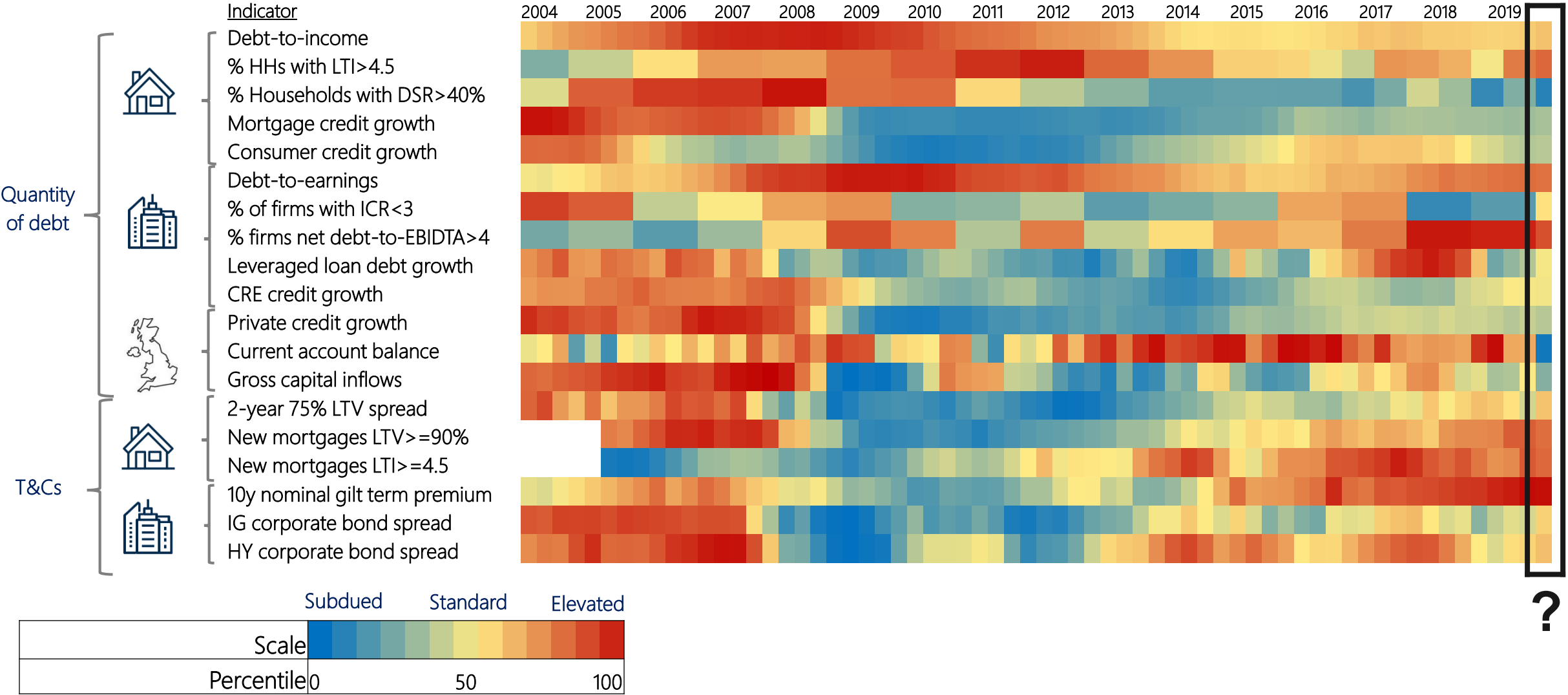
# Heat maps can identify building risks...



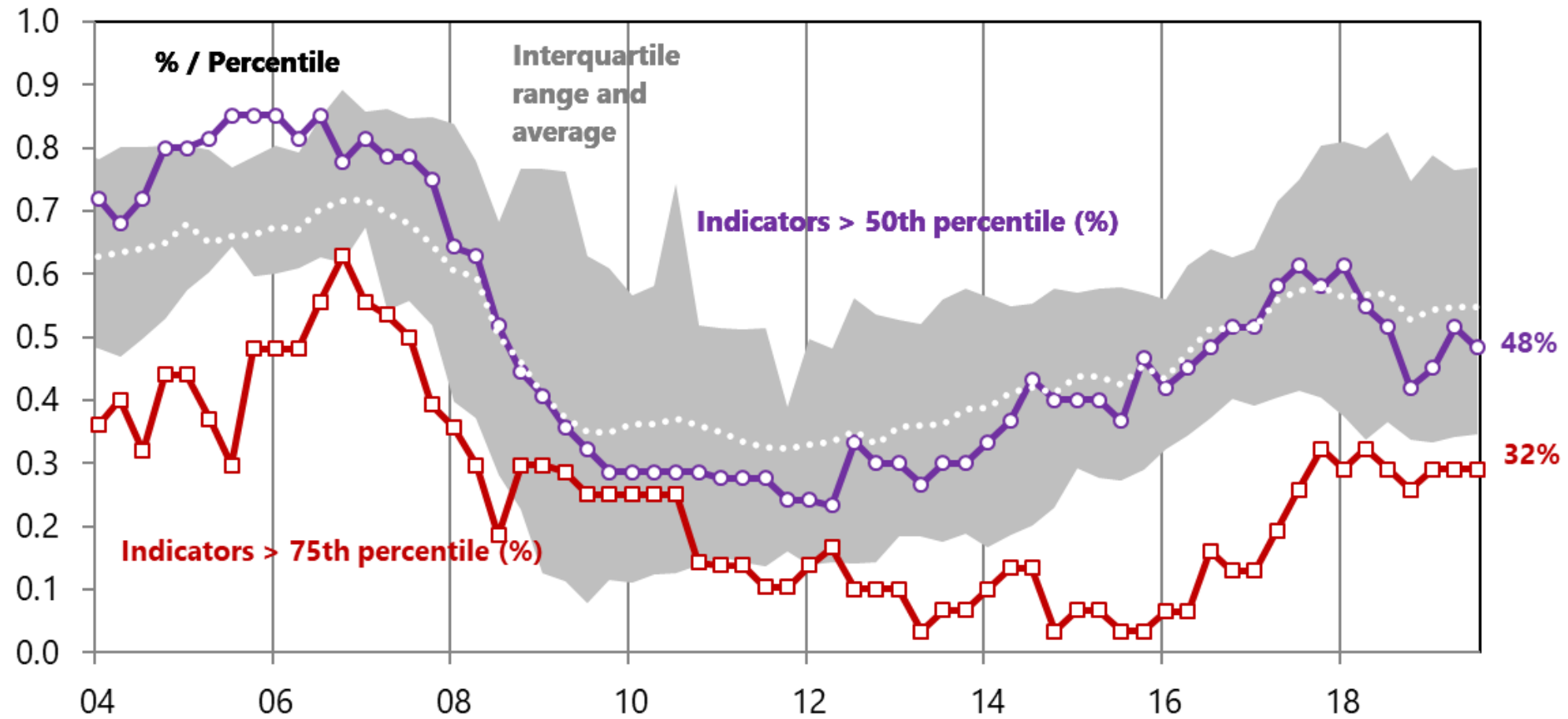
# ...and pockets of risk



# But it can be hard to weigh up risks overall

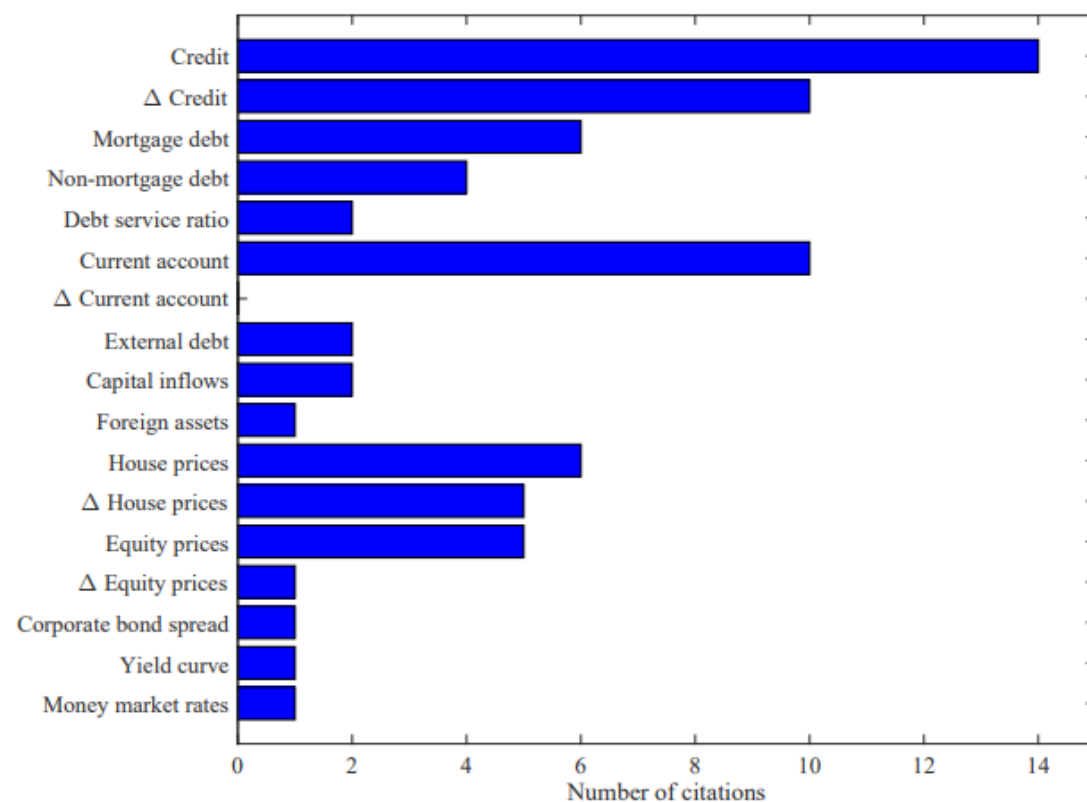


# Indicator swathe gives sense of overall changes in environment



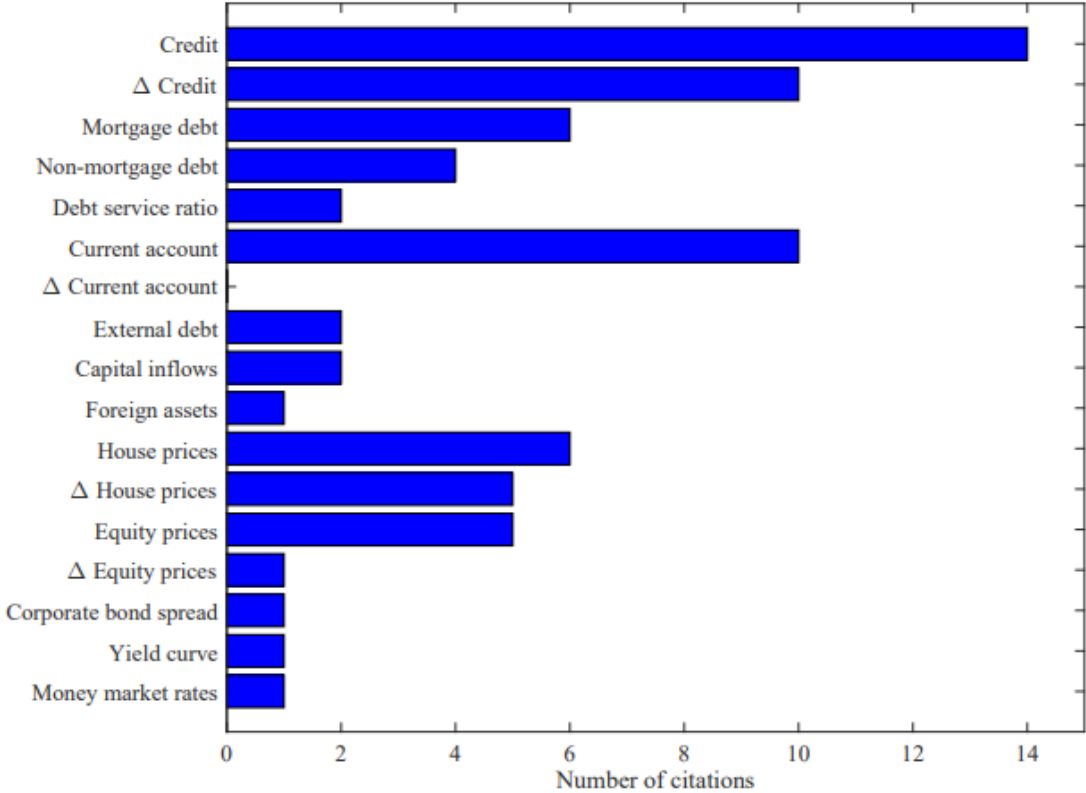
# But what variables matter, and by how much?

Number of citations for each indicator (Aikman et al. (2018))

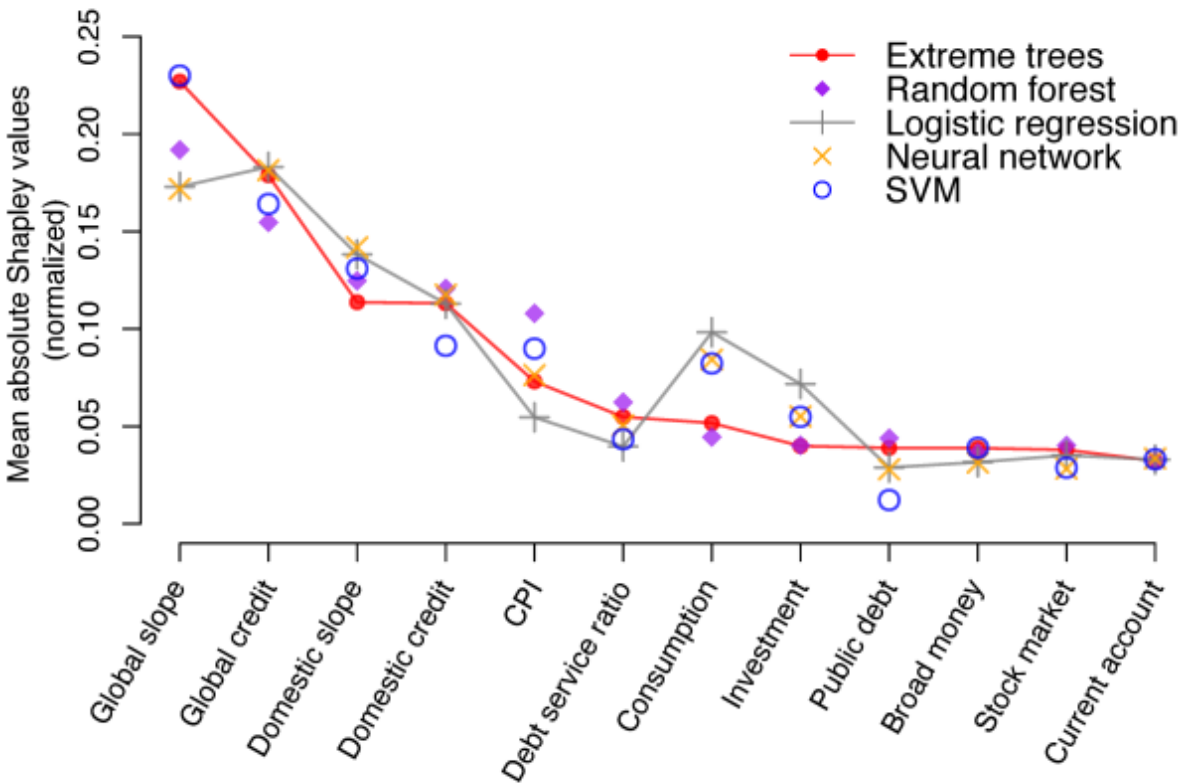


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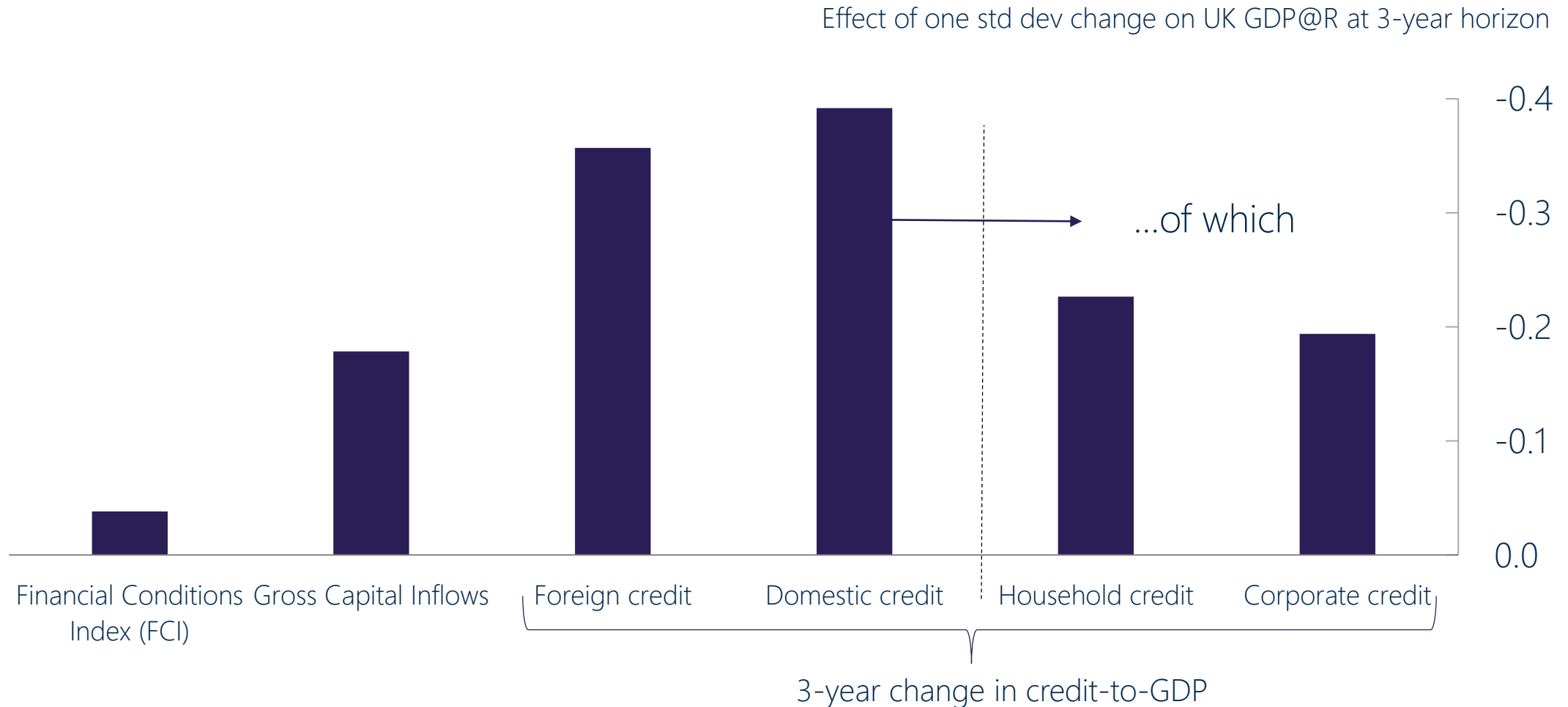
Indicator predictive power in machine learning model (Bluwstein et al. (2020))



Greater predictive power



# GDP-at-Risk models can also 'weight' different variables

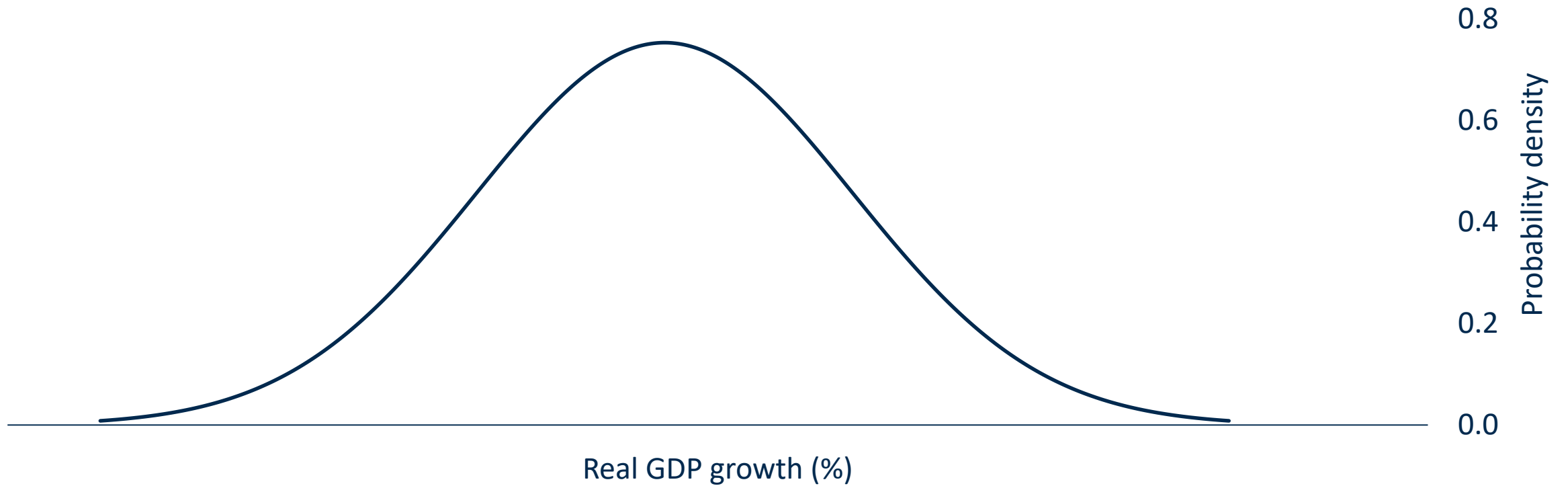




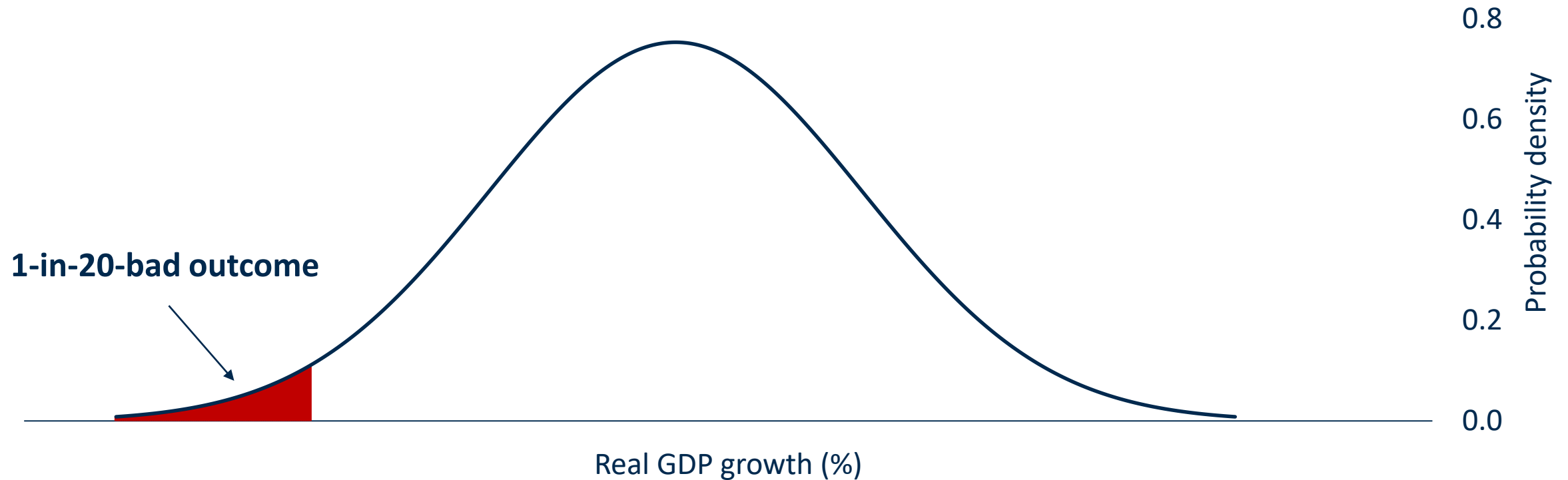
# What is GDP-at-Risk?

## PART 2

# What is GDP-at-Risk?

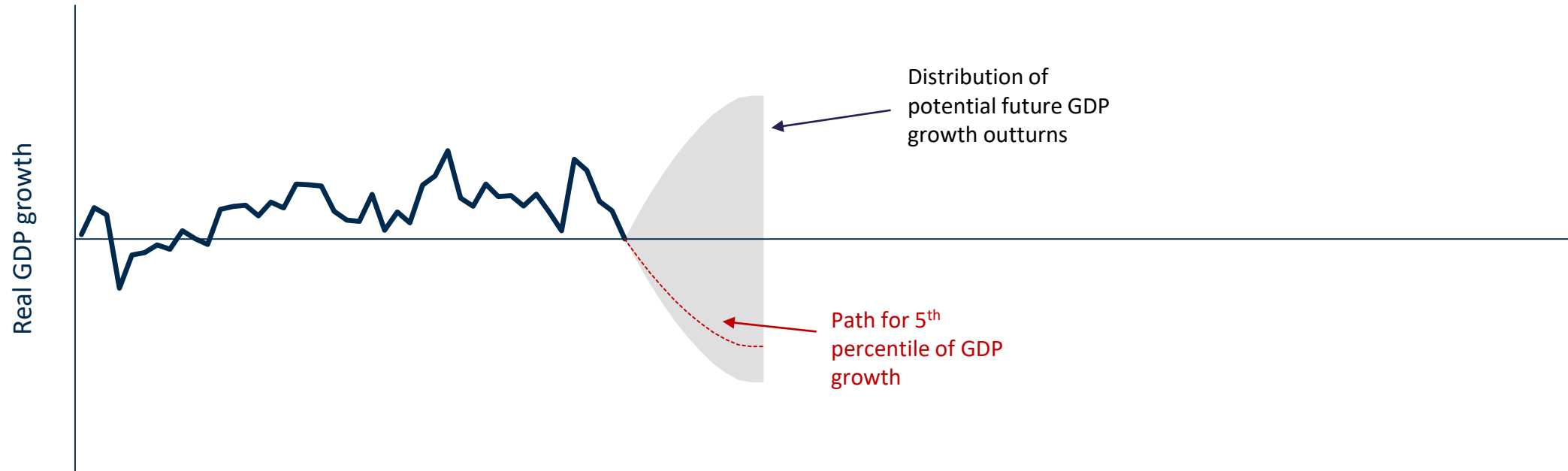


# What is GDP-at-Risk?



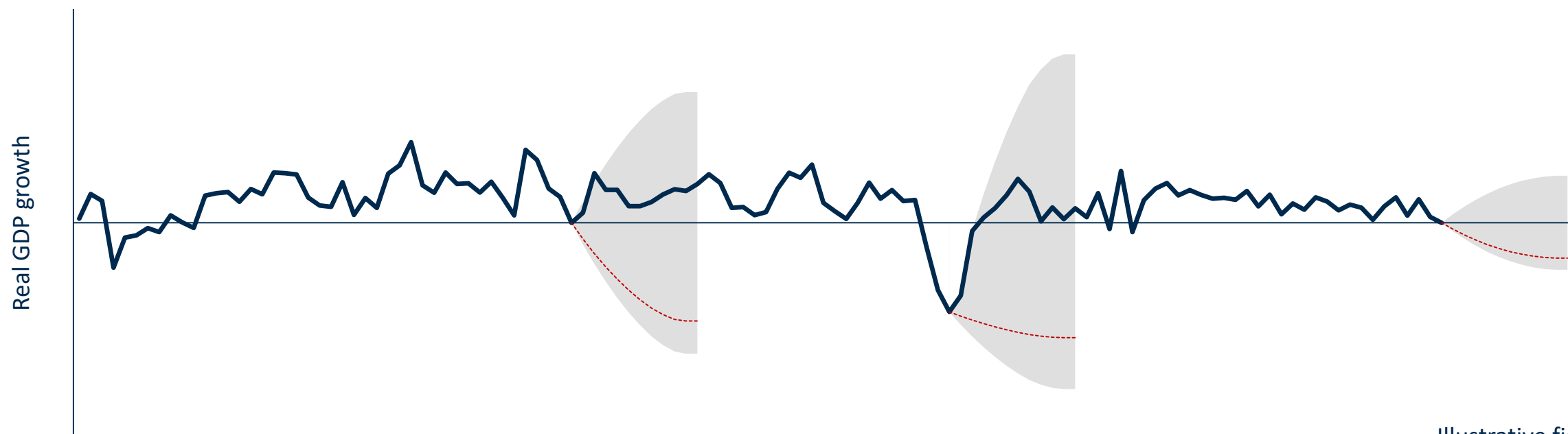
- **Summary statistic** for the overall level of macroeconomic tail risk
- An estimate of what a **1-in-20 bad outcome** (i.e. 5<sup>th</sup> percentile) for GDP growth could be

# GDP-at-Risk is not directly observable



Illustrative figure

# GDP-at-Risk is not directly observable



Illustrative figure

- Level of GDP-at-Risk over time
- Growth-at-risk over different horizons in the future (i.e. 1 vs. 3-years ahead)
- Different drivers of GDP-at-Risk (e.g. financial conditions, credit growth)

# What *could* estimates of GDP-at-Risk be used for?

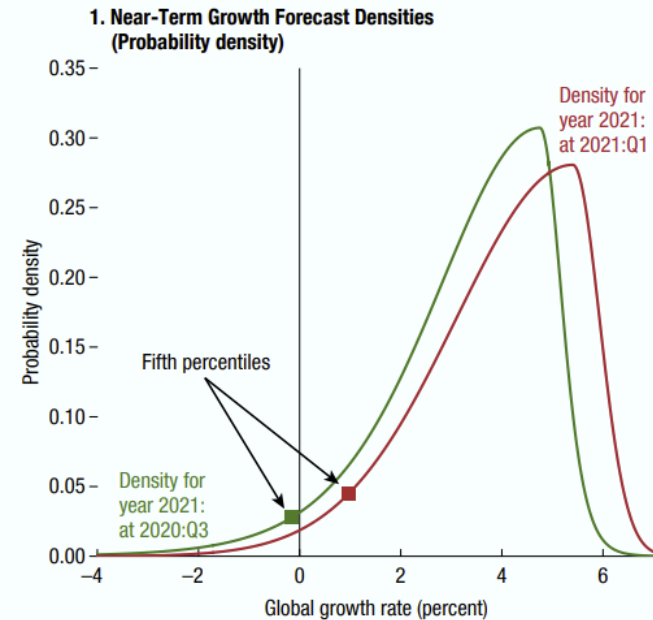


# Practical uses of GDP-at-Risk

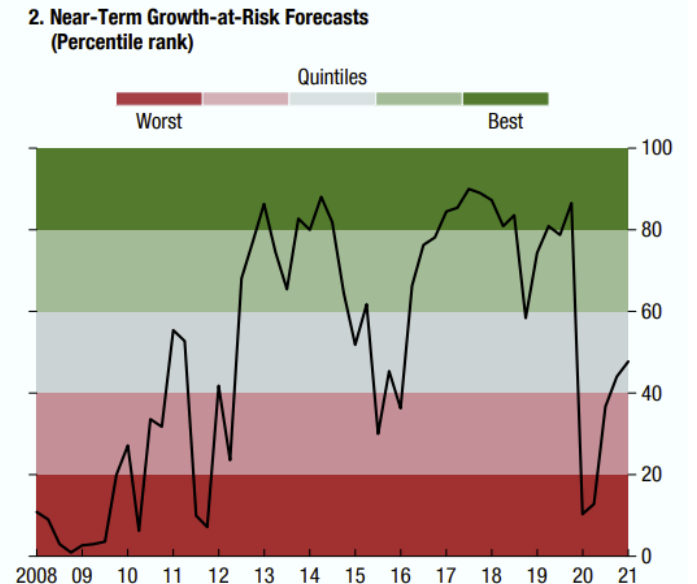
## Estimating the level of tail risk

Adrian, Boyarchenko and Giannone (2019),  
“Vulnerable Growth”, *American Economic Review*, 109(4).

The upward revision in global growth forecast for 2021 is accompanied by a slight improvement in ...



... the downside risk to growth, although it still remains meaningful relative to historical norms.



Source: IMF staff calculations.

Note: Forecast density estimates are centered around *World Economic Outlook* forecasts for 2021. In panel 2, the black line traces the evolution of the 5th percentile threshold (the growth-at-risk metric) of near-term growth forecast densities. The color of the shading depicts the quintiles for the growth-at-risk metric calculated since 1991. See the April 2018 *Global Financial Stability Report* for details.

Source: IMF *Global Financial Stability Report*, April 2021, Figure 1.1



# Practical uses of GDP-at-Risk

## Decomposing drivers of tail risk

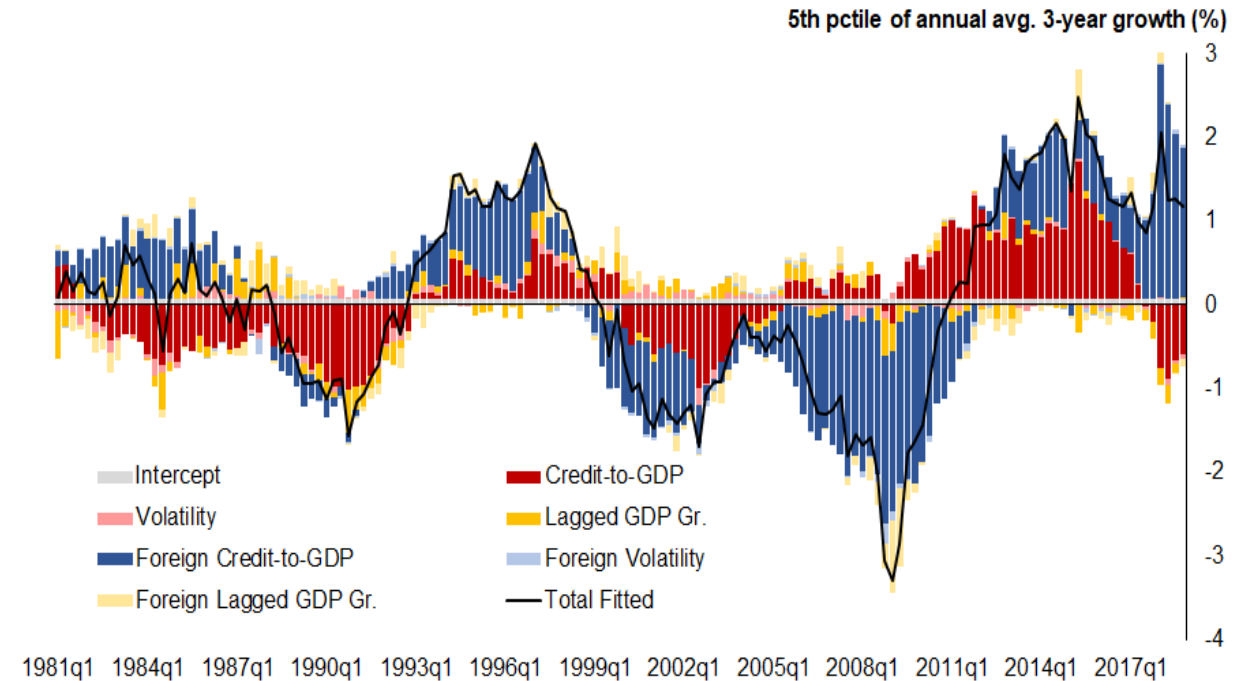
Aikman, Bridges, Bruggess, Galletly, Levina, O'Neill and Varadi (2018), "Measuring risks to UK financial stability", Bank of England Staff Working Paper No. 738

Aikman, Bridges, Hacıoglu Hoke, O'Neill and Raja (2019), "Credit, capital and crises, a GDP-at-Risk approach", Bank of England Staff Working Paper No. 824.

Adrian, Grinberg, Liang, Malik and Yu (2021), "The Term Structure of Growth-at-Risk", *AEJ: Macroeconomics*, forthcoming.

Lloyd, Manuel and Panchev (2021), "Foreign vulnerabilities, domestic risks: the global drivers of GDP-at-Risk", Bank of England Staff Working Paper No. 940.

Cesa-Bianchi, Dickinson, Kösem, Lloyd and Manuel (2021), "No economy is an island: how foreign shocks affect UK macrofinancial stability", *Bank of England Quarterly Bulletin 2021 Q3*.



Source: Lloyd, Manuel and Panchev (2021)

# Practical uses of GDP-at-Risk

## Links between **GDP-at-Risk** and macroprudential policy framework

Carney (2020), “The grand unifying theory (and practice) of macroprudential policy”, Speech at UCL, 5 March.

Aikman, Bluwstein and Karmakar (2021), “A tail of three occasionally-binding constraints: a modelling approach to GDP-at-Risk”, Bank of England Staff Working Paper No. 931.

$$\min_{\rho_t} \mathcal{L} \equiv E_t \left\{ \sum_{i=0}^T \beta^i [f(G@R_{t+i}) - \phi y_{t+i}] \right\}$$

Source: Carney (2020)



# A Model of GDP-at-Risk?

## PART 3

# Introduction to the model



- **First-best aim:** To develop a model to estimate the levels and drivers of tail-risk to UK GDP.



- **Challenges:** Variable selection, computational cost, time-varying relationships between variables.



- **Realistic outcome:** To develop a model that estimates the levels of the main drivers of tail-risk, leaving scope to overlay judgement about additional variables or changing dynamics.

## How do we get at the relationships?

$$GDP\ growth_{i,t+h} = \underbrace{\alpha_i}_{\text{Country fixed effects}} + \underbrace{\beta_1 X_{i,t}}_{\text{Risk indicators}} + \underbrace{\beta_2 Y_{i,t}}_{\text{Resilience indicators}} + \underbrace{\beta_3 Z_{i,t}}_{\text{Controls}}$$

- **We estimate the relationships at the tail via quantile regression, using a panel dataset.** The quantile regression framework is broadly similar to OLS but it calculates a specified percentile, rather than the mean.
- **Indicators are standardised** such that they are expressed relative to their historical mean.
- **Foreign variables are weighted** using the average of a) bilateral trade linkages and b) bilateral financial linkages, based on bank's exposures across regions.

# What's in the model?

<u>Variable</u>	<u>Impact on UK GDP-at-Risk</u>
<b>Vulnerabilities:</b> associated with worsening in tail risk	
Credit-to-GDP growth	Increase in leverage is associated with increased severity of downturns <b>(medium-term)</b>
Financial Conditions Index	Tightening of financial conditions associated with a worsening in GDP@R <b>(near-term)</b>
Gross capital inflows	Sharper capital inflows associated with worsening in domestic GDP@R <b>(medium-term)</b>

Our approach is similar to that in [Aikman et al \(2019\)](#)

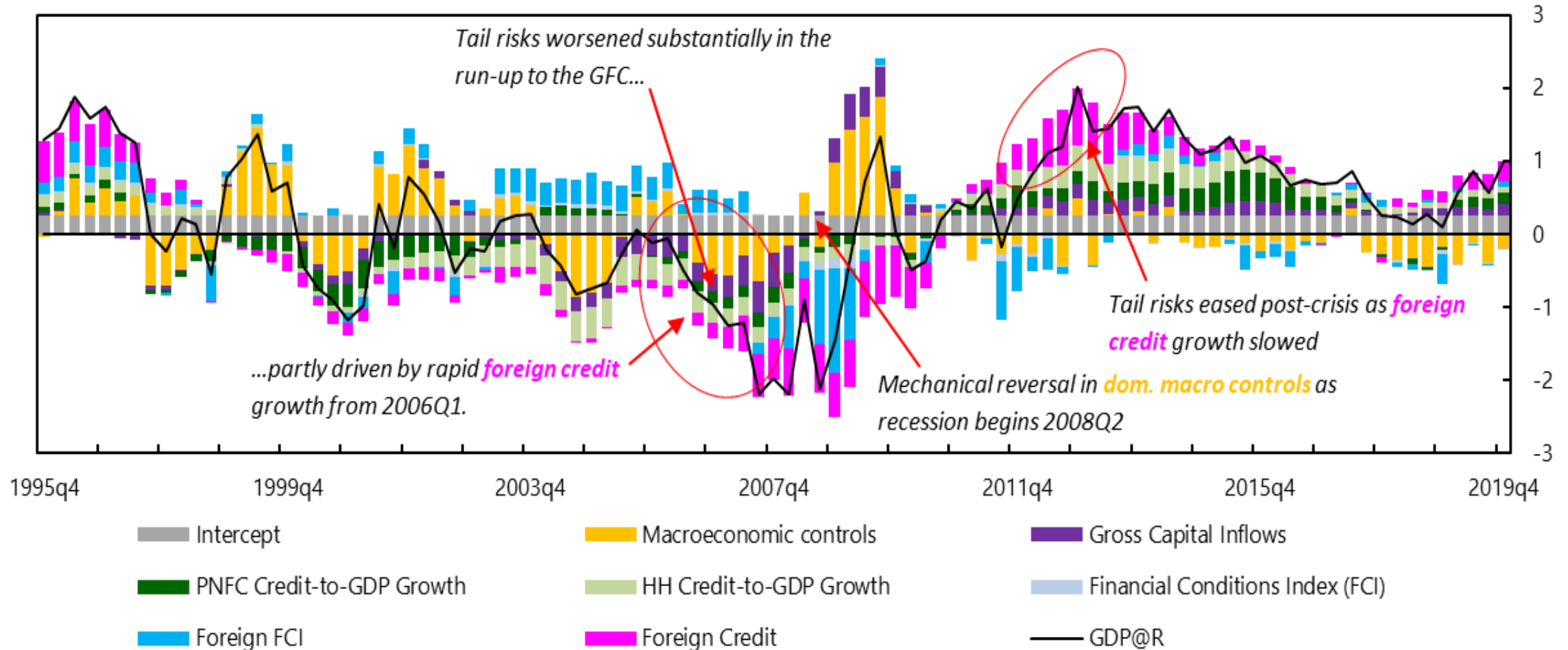
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Financial Conditions Index	Tightening of financial conditions associated with a worsening in GDP@R <b>(near-term)</b>
Gross capital inflows to the UK	Sharper capital inflows associated with worsening in domestic GDP@R <b>(medium-term)</b>
<b>Resilience:</b> associated with improvement in tail risk	
UK banking system capital ratio	Higher capital ratios associated with improvement in GDP@R <b>(medium-term)</b>
<b>Controls:</b> intended to capture prevailing state of macroeconomy	

Our approach is similar to that in [Aikman et al \(2019\)](#)

# Adding it all up...

UK GDP-at-Risk (Estimated 5th percentile of 3-year-ahead annual average GDP growth at each point in time, %)





# GDP-at-Risk model is just one input into overall risk assessment

## Three key reasons why we may want to “aim off”:

1. The model includes the *key* indicators we think matter for assessing risks – but **other indicators** may also be informative
2. GDP@R model assumes mapping between indicators in the model and risk environment is **constant** over time
3. GDP@R provides **top-down** assessment – bottom-up approaches may paint a different picture



# Applying Tools to Policy

## PART 4

# What *could* estimates of GDP-at-Risk be used for?



# What *could* estimates of GDP-at-Risk be used for?



- In practice, no simple mapping between GDP-at-Risk and policy!

# To see the full story, judgement is needed

Three key reasons why you still need judgement:

## 1. Practical pros and cons to different tools

- Challenges to aggregation and limits to indicators we capture
- *Toolkit unlikely to provide complete picture*

## 2. Fighting the last war

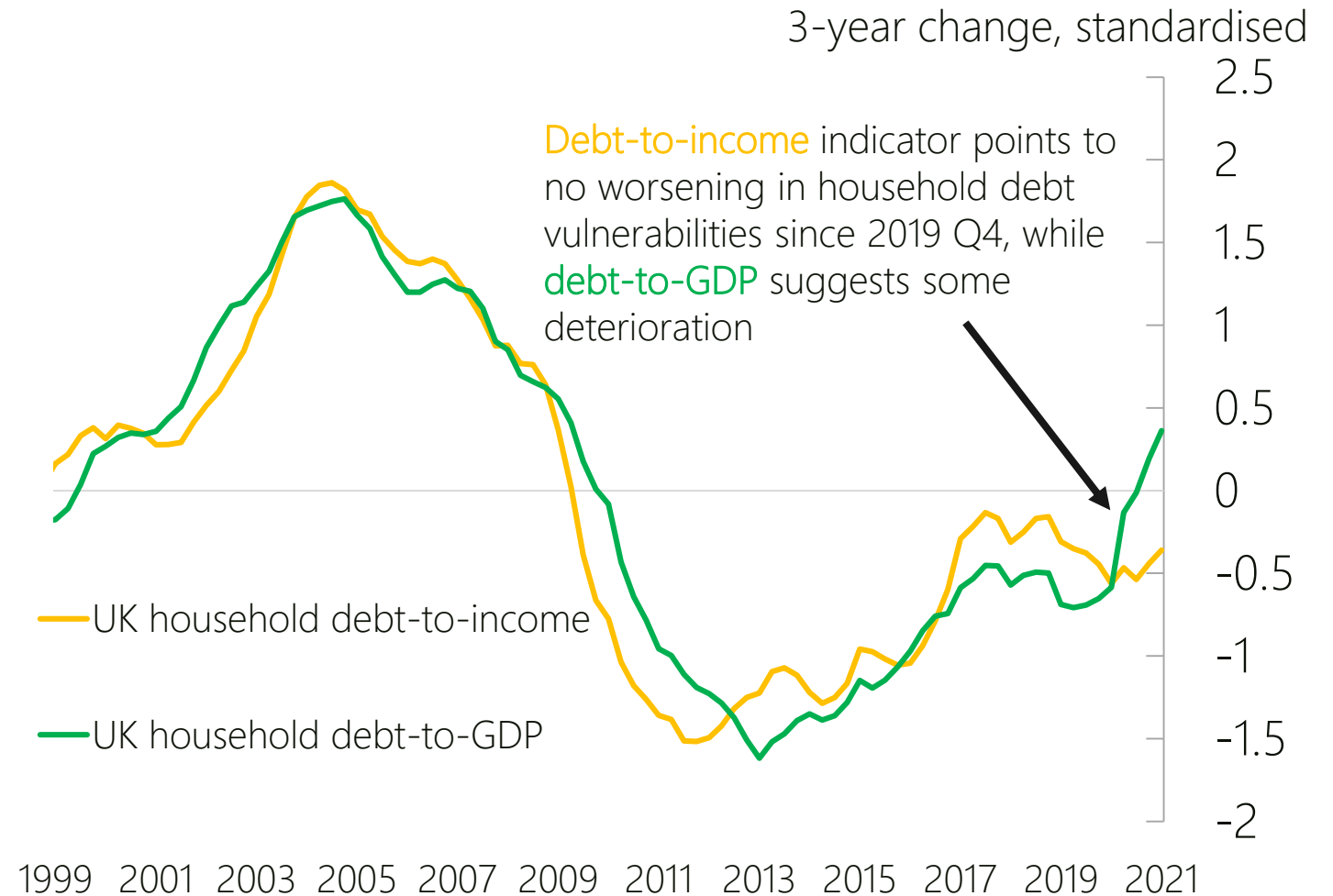
- Toolkit guided by historical data, so may not always capture idiosyncratic features of present day
- *Risks need to be assessed in the context of the current conjuncture*

## 3. Aggregate measures could mask nuances relevant for overall assessment

- Tools over 'top-down' view of risks, but 'bottom-up' assessment could paint different picture
- *Need to think about the channels of transmission*

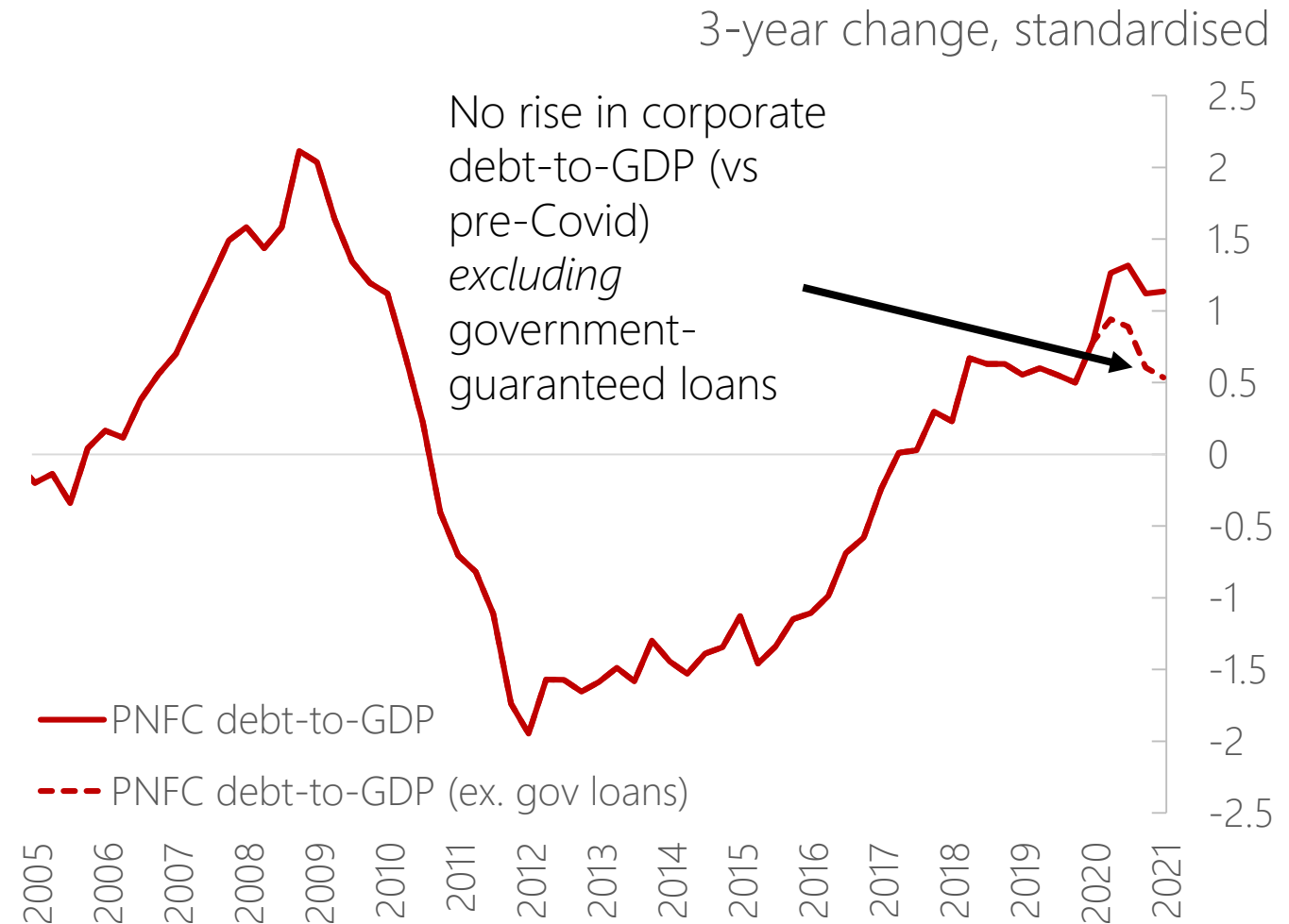
# 1. Other indicators may paint different story

- Data on household **debt-to-income**, and **debt servicing costs** may provide a different (and, at times, more accurate) steer on household debt vulnerabilities than debt-to-GDP metrics
- But they are **less readily available** (shorter time series and fewer countries), so we do not include them in the model

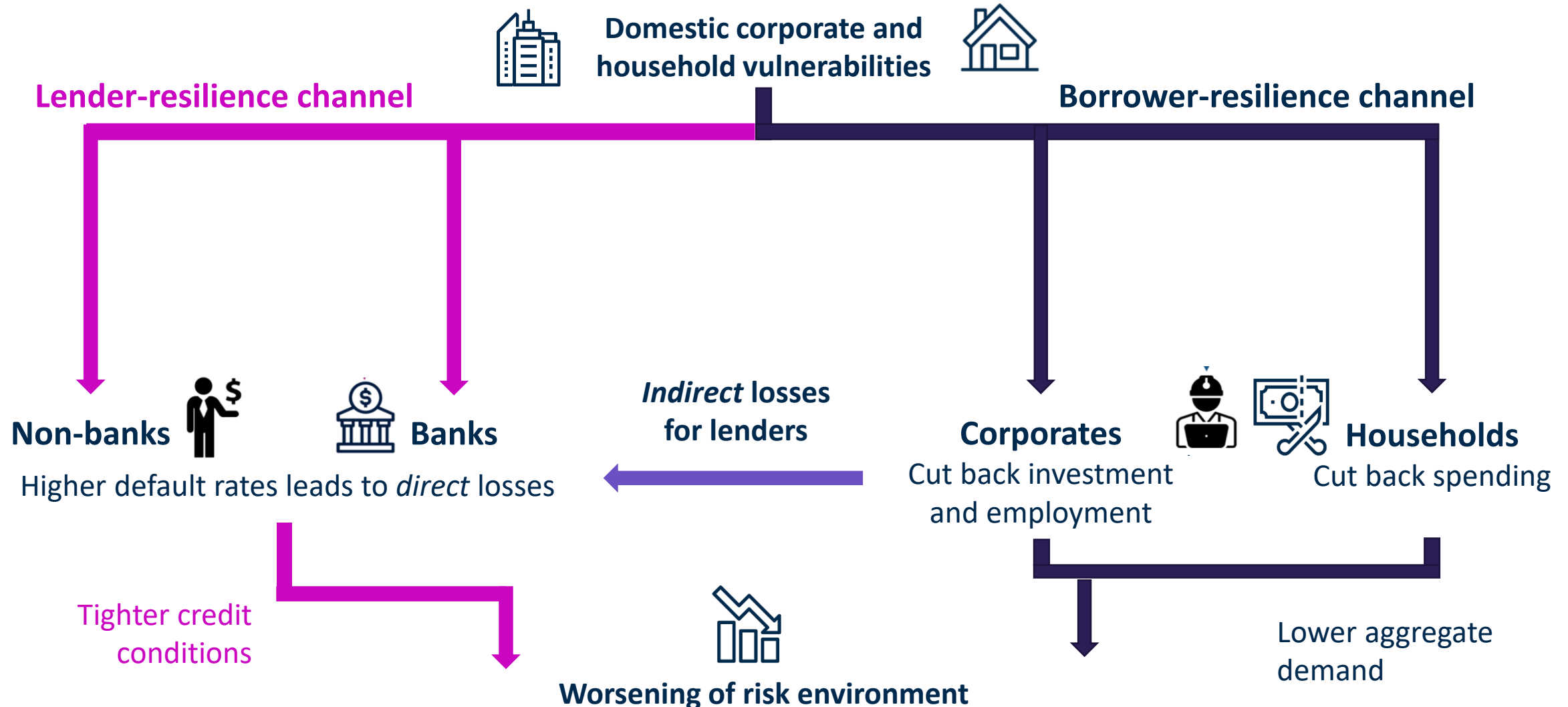


## 2. Government guarantees may affect “typical” relationship between debt and GDP-at-Risk

- Government guarantees limit direct risks to **lender** resilience...
- ...but higher debt may still pose risks to **borrower** resilience.



### 3. Transmission mechanisms can be important





## More granular bottom-up analysis can also be informative about the channels (and overall level) of risk

- May have access to more granular data sets e.g. Experian dataset for corporates (see [Hurley et al., 2021](#)) and various household surveys (see [Franklin et al., 2021](#))
- This can be informative about e.g.:
  - Which sectors / income groups are driving the rise in debt
  - Extent to which UK banks have direct exposures to these groups

## Conclusion



Risk assessment toolkit (incl. GDP-at-Risk model) is useful when assessing the **level and drivers of risk over time**



The GDP-at-Risk toolkit includes a range of (domestic and foreign) **risk and resilience indicators**



But it has a **number of limitations**: in practice, there's no simple mapping between model outputs and policy decisions

- Lots of risk assessment tools, but no single model gives us all the answers
- Judgement needed to inform policy

## References (\* recommended)

Aikman, D., Bridges, J., Hacıoglu Hoke, S., O'Neill, C., Raja, A., 2019. "Credit, capital and crises: a GDP-at-Risk approach." Bank of England, Staff Working Paper, No. 824.

\*Bank of England, 2016. "The Financial Policy Committee's approach to setting the countercyclical capital buffer." Policy statement, April.

\*Bluwstein, K., Buckmann, M., Joseph, A., Kang, M., Kapadia, S., Simsek, Ö., 2020. "Credit growth, the yield curve and financial crisis prediction: evidence from a machine learning approach." Bank of England, Staff Working Paper, No. 848.

Franklin, J., Green, G., Rice-Jones, L., Venables, S., Wukovits-Votzi, T., 2021. "Household debt and Covid." *Bank of England Quarterly Bulletin*, 2021 Q2.

Hurley, J., Karmakar, S., Markoska, E., Walczak, E., Walker, D., 2021. "Impacts of the Covid-19 crisis: evidence from 2 million UK SMEs." Bank of England, Staff Working Paper, No. 924.

\*Lloyd, S., Manuel, E., Panchev, K., 2021. "Foreign vulnerabilities, domestic Risks: the global drivers of GDP-at-Risk." Bank of England, Staff Working Paper, No. 940.