Financial (In)Stability Zones

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Introduction

- Macropru as a policy framework is severely hampered by the lack of a quantifiable objective
- This was not a problem in the immediate aftermath of the GFC as the direction of policy was clear (Barwell, 2021)
- But a decade+ on, the countercyclical component of the macroprudential framework is rudderless
- Some have argued that GDP-at-Risk has potential as a quantitative indicator and perhaps even policy target (Suarez, 2021, Cecchetti and Schoenholtz, 2017)
  - Eg You could think about macropru policymakers being given a mandate to ensure that GDP-at-Risk is no greater than $|-2\%|$

This Paper

- We analyse the impact of key thresholds or non-linearities in the financial system in the context of a model of GDP-at-Risk
  - We follow the approach of Greenwood et al. [2022], who find that a simple metric of credit overheating in the household and business sectors has large predictive power for the pr(crisis)
- We extent this approach to include thresholds associated with weak bank capital and rapid credit growth in the non-bank system and we analyse the impact of crossing these thresholds in an empirical GDP-at-Risk context
- We also show how this framework can be used as a risk monitoring tool and as a device to inform policy

Greenwood et al. [2022]

	Household Sector Pr(Crisis within 3-y)				Business Sector Pr(Crisis within 3-y)			
	(1.1)	(1.2)	(1.3)	(1.4)	(2.1)	(2.2)	(2.3)	(2.4)
High Debt Growth (β^h)	20.5***		9.1**		16.8***		11.5**	
	(3.3)		(2.3)		(3.3)		(2.7)	
High Price Growth (δ^h)		8.1	0.0			10.5	7.4	
		(1.5)	(0.001)			(1.4)	(1.1)	
R-Zone (γ^h)			20.9***	28.6***			19.4**	33.7***
			(3.2)	(3.4)			(2.8)	(3.3)
R^2 (within)	5.6	1.4	7.6	7.0	3.8	2.4	7.8	6.1
N	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258

Greenwood et al. [2022] Table IV. Note: Coefficients are shown in the top row of each cell, with t-stats (in parentheses) below. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

This Paper

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- We extent this approach to include thresholds associated with weak bank capital and rapid credit growth in the non-bank system and we analyse the impact of crossing these thresholds in an empirical GDP-at-Risk context
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What We Find

- Overheating household and business credit markets shift the entire growth distribution leftward i,.e., not solely a "risk" story
- Erosion of bank equity capital leads to pronounced left-tail risk in the near term
- Vulnerabilities in non-bank financial institutions do not generate this effect [in progress]
- Negative growth effects are materially amplified when bank capital erosion follows a period of overheating household credit markets
- Forecasts of the probabilities of these "FI-zones" being activated can help guide pre-emptive macropru policy

Related Literature

- Following Adrian et al. [2019], a large literature has emerged on GDP-at-Risk:
  - Alternative RHS variables: Adrian et al. [2022], Lloyd et al. [2024], Lang et al. [2019], Adams et al. [2021], Aikman et al. [2019], Szabo (2020)
  - Techniques beyond quantile regression: Chavleishvili and Manganelli [2024], Busetti et al. [2021], Szendrei and Varga [2023], Kipriyanov [2022], Chronopoulos et al. [2024]
  - Macropru: Duprey and Ueberfeldt [2018], Brandao-Marques et al. [2020], Galán [2020]
- Our analysis also relates to the long literature on early warning models:
  - Kaminsky et al. [1998],Lowe and Borio [2002], Demirgüç-Kunt and Detragiache [1998], Schularick and Taylor [2012],Mian et al. [2017], Greenwood et al. [2022]
- Importance of financial non-linearities:
  - Banking: He and Krishnamurthy [2013], Holden et al. [2020], Brunnermeier and Sannikov [2014]
  - Housing:Eggertsson and Krugman [2012], Hall [2011], Korinek and Simsek [2016], Mian and Sufi [2009]
  - Aikman et al. [2024] analyses the impact of these thresholds jointly in a semi-structural macro model

Plan for the rest of the talk

- Defining financial instability zones
- The effects of financial instability zones in a GDP-at-Risk setting
- Using this framework for policy analysis

Defining financial instability zones

Financial instability zones

- The theory of financial stability emphasises the importance of non-linearities and threshold effects
  - The impact of an erosion of bank equity capital on lending depends on the how close banks are to the minimum requirement
  - The impact of an increase in interest rates on debt deleveraging depends on the prevailing burden of debt
- Financial stability policies are often implemented as thresholds
  - New borrowers are not permitted to borrow more than X times their income

Financial instability zones

- We posit that non-linearities in the macro-financial system are likely to be informative about GDP-at-Risk
- Building on the approach of Greenwood et al. [2022], we focus on 4 non-linearities:
  - Overheating housing markets
  - Overheating business markets
  - Erosion in banking system capital
  - Overheating non-bank credit markets (in progress)
- These mechanisms have been central to global economic developments in the past decade and have featured prominently in macro research

Macro-financial indicators

- To capture these potential effects, we focus on six macro-financial indicators:
  - Change in the ratio of mortgage credit to GDP
  - Change in the ratio of business credit to GDP
  - Growth rate in real housing prices
  - Growth rate in real equity prices
  - The market-based leverage ratio of the banking system
  - Change in the ratio of non-bank credit to GDP
- We focus on 9 advanced economies: Australia, Canada, Germany, Spain, France, Italy, Sweden, United Kingdom, United States from 1984Q1-2023Q4

Thresholds selection

- Methods for selecting thresholds:
  - Greenwood et al. [2022]: Thresholds are set at fixed percentiles of the sample distribution
  - Sarlin [2013]: Thresholds are chosen based on their effectiveness in predicting financial crises
  - GDP-at-risk approach: Thresholds are selected for their ability to capture shifts in the location and/or shape of the predicted GDP distribution *(In progress...)*

Threshold selection – Greenwood et al. [2022]

- We define three indicator variables:

$$\text{High-Debt-Growth}_{i,t} = \mathbf{1}\Big\{\Delta_{12}\Big(\frac{\text{Debt}}{\text{GDP}}\Big)_{i,t} > 80^{\text{th}} \text{ pct}\Big\}$$

$$\text{High-Price-Growth}_{i,t} = \mathbf{1}\Big\{\frac{\Delta_{12}(\text{Price}_{i,t})}{\text{Price}_{i,t-12}} > 66.7^{\text{th}} \text{ pct}\Big\}$$

$$\text{Low-Banking-Capital}_{i,t} = \mathbf{1}\Big\{\text{Mrkt TCE ratio}_{i,t} < 10^{\text{th}} \text{ pct}\Big\}$$

Financial instability zones

- We combine credit and price variables for the household and business sectors into a single FI-zone:

$$\text{FI-zone}^{J}_{i,t} = \text{High-Debt-Growth}^{J}_{i,t} \times \text{High-Price-Growth}^{J}_{i,t}$$

  where $J =$ (Household, Business)

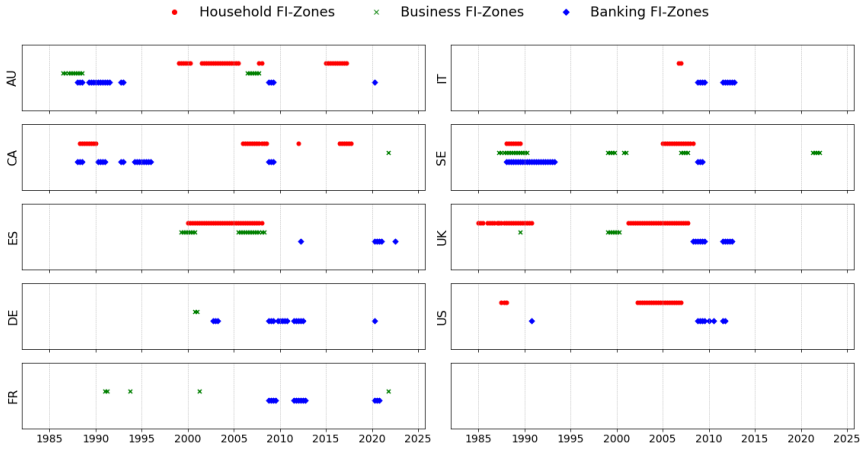
- We define Banking FI-Zone using the indicator for low market TCE ratio and the Non-Bank FI-Zone with the indicator for high non-bank credit growth

FI - Zones Summary

	Household	Business	Banking
Household	190 (13.19%)	-	-
Business	28 (1.94%)	76 (5.28%)	-
Banking	9 (0.69%)	13 (1.00%)	130 (10.00%)

Note: the table displays the number of times each FI-zone activates. The main diagonal represents the number of times each individual FI-zone activates independently, while the lower triangular section of the matrix shows the counts when two FI-zones are activated together. Sample details are as follows: for household and business and Non-Bank FI-zones, there are 1,440 quarterly observations covering the period from 1984Q1 to 2023Q4. For banking FI-zones, there are 1,296 quarterly observations from 1988Q1 to 2023Q4.

FI - Zones by Country



Note: The chart shows the periods when the household, the business and banking FI-zone are activated in each country in the analysis.

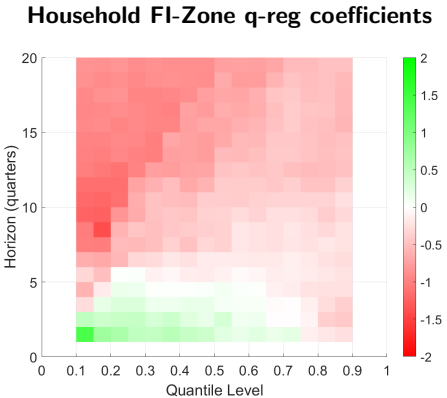
The effects of FI-zones in a GDP-at-Risk framework

FI-zones and GDP-at-Risk

Household FI-zone

- Model specification

$$y_{i,t+h} = \alpha^h_\tau + \beta^h_{\tau,1}\,\text{FI zone}^{HH}_{i,t} + \beta^h_{\tau,2}\,x_{i,t} + \epsilon_{i,t+h}$$

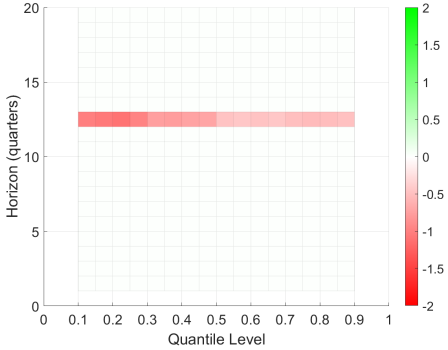


Notes: Colors represent the value of the quantile regression coefficient. Higher positive values are associated with green, and lower negative values are associated with red.

FI-zones and GDP-at-Risk

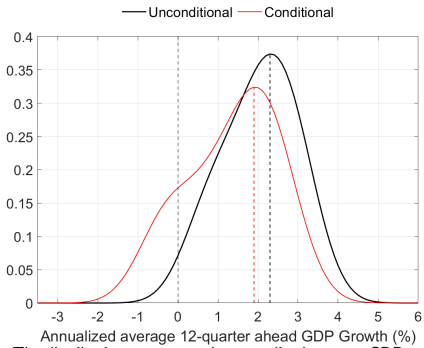
Household FI-zone

q-reg coefficients (h = 12)



Notes: Colour represent the value of the quantile regression coefficient. Higher positive values are associated with green and lower negative values are associated with red. Coloured row represent 12 quarter ahead quantile regressions coefficients.

Predicted distribution (h = 12)

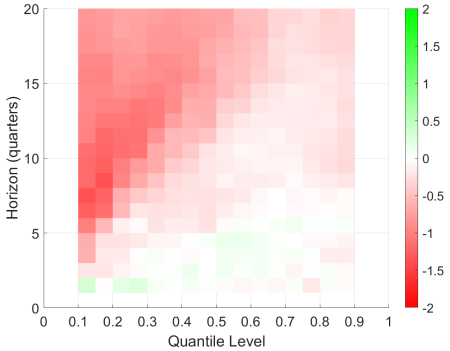


Notes: The distributions represent the annualized average GDP growth 12 quarters ahead for the countries included in the analysis. Black line shows the unconditional distribution, while the red line represents the distribution conditioned on the activation of the FI-zone for the household sector.

FI-zones and GDP-at-Risk

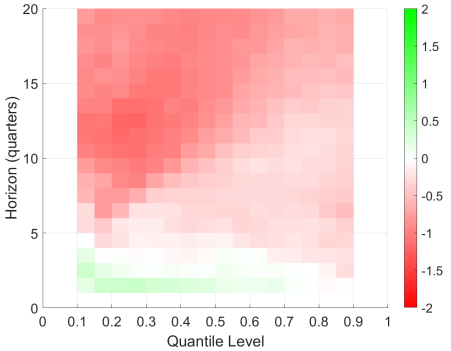
Household FI-zone - individual components

Household Credit



Notes: The chart illustrates the effect of the high-credit-growth dummy variable on the predicted distribution of GDP growth. Colors represent the value of the quantile regression coefficient. Higher positive values are associated with green, and lower negative values are associated with red.

House Prices



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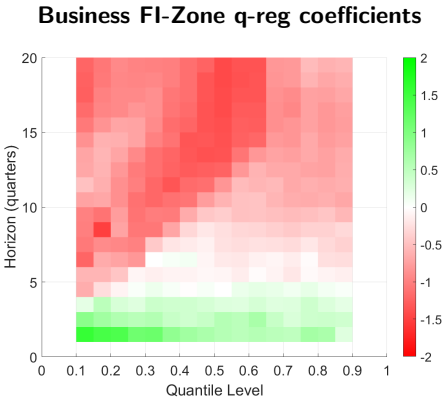
FI-zones and GDP-at-Risk

Business FI-zone

- Model specification

$$y_{i,t+h} = \alpha^h_\tau + \beta^h_{\tau,1}\ \text{FI zone}^{BUS}_{i,t} + \beta^h_{\tau,2}\, x_{i,t} + \epsilon_{i,t+h}$$

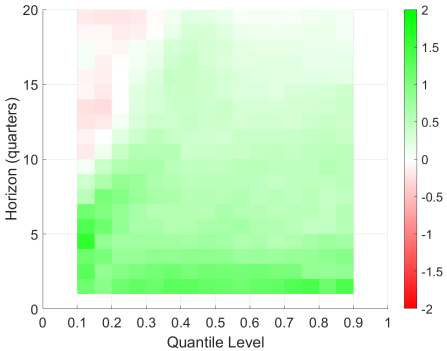


Notes: Colors represent the value of the quantile regression coefficient. Higher positive values are associated with green, and lower negative values are associated with red.

FI-zones and GDP-at-Risk

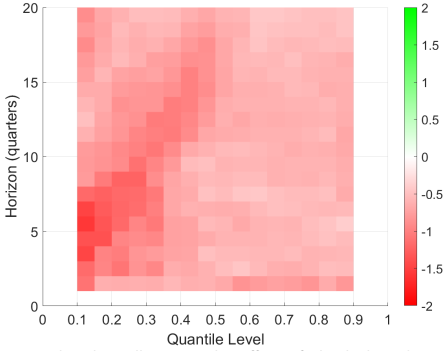
Business FI-zone - individual components

Equity Prices



Notes: The chart illustrates the effect of the high-price-growth dummy variable on the predicted distribution of GDP growth. Colors represent the value of the quantile regression coefficient. Higher positive values are associated with green, and lower negative values are associated with red.

Business Credit



Notes: The chart illustrates the effect of the high-credit-growth dummy variable on the predicted distribution of GDP growth. Colors represent the value of the quantile regression coefficient. Higher positive values are associated with green, and lower negative values are associated with red.

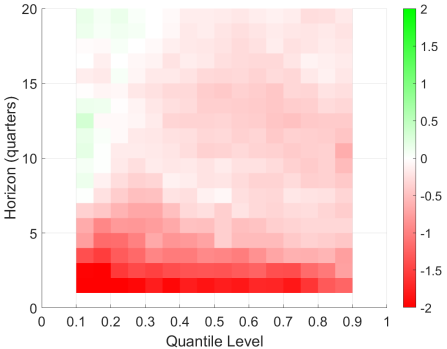
FI-zones and GDP-at-Risk

Banking FI-zone

- Model specification

$$y_{i,t+h} = \alpha^h_\tau + \beta^h_{\tau,1}\ \text{FI zone}^{BANK}_{i,t} + \beta^h_{\tau,2}\, x_{i,t} + \epsilon_{i,t+h}$$

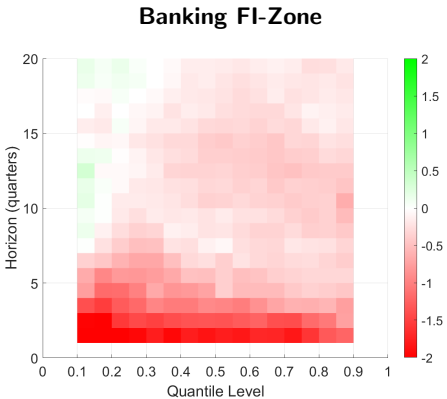
Banking FI-Zone q-reg coefficients



Notes: Colors represent the value of the quantile regression coefficient. Higher positive values are associated with green, and lower negative values are associated with red.

FI-zones and GDP-at-Risk

Banking FI-zone - non linearities



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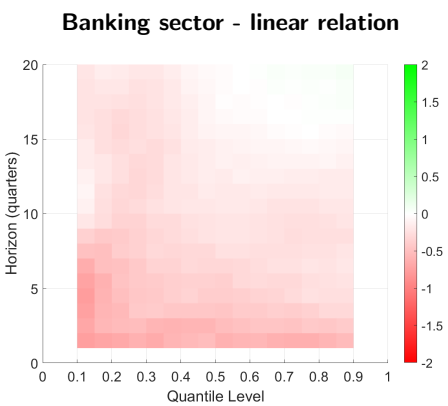


Note: We regress the individual component of the banking FI-zone. Values for market TCE ratio are standardized by country.

Financial instability zones interactions

FI-zone interactions

Household and banking FI-zones combined

- The model specification is:

$$y_{i,t+h} = \alpha^h_\tau + \beta^h_{\tau,1} Z_{i,t} + \beta^h_{\tau,2} \text{FI zone}^{\text{HH}}_{i,t} + \beta^h_{\tau,3} \text{FI zone}^{\text{BANK}}_{i,t} + \beta^h_{\tau,4} y_{i,t} + \epsilon_{i,t+h}$$

Where:

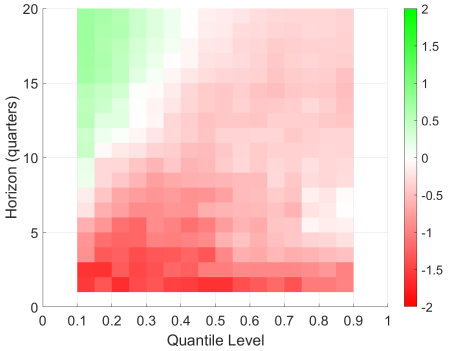
$$Z_{i,t} = \max\left(\text{FI zone}^{\text{HH}}_{i,t} \times \text{FI zone}^{\text{BANK}}_{i,t} \;\; ; \;\; \text{FI zone}^{\text{HH}}_{i,t-4} \times \text{FI zone}^{\text{BANK}}_{i,t}\right)$$

FI-zones interactions

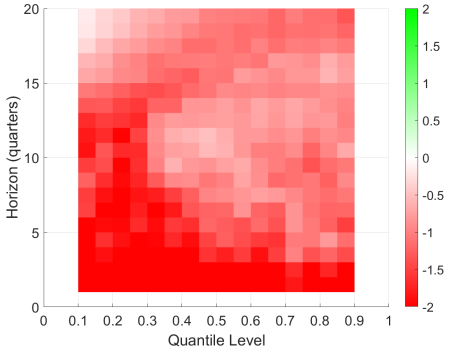
Household and banking FI-zones combined

This is the effect of switching on the banking FI-Zone if the household FI-Zone is also overheated

Banking FI-Zone | Household FI-Zone = 0



Banking FI-Zone | Household FI-Zone = 1



Notes: Chart on the lhs exhibits $\beta^h_{\tau,3}$; chart on the rhs exhibits the sum of $\beta^h_{\tau,1}$ and $\beta^h_{\tau,3}$. Colour represents the value of the quantile regression coefficient. Higher positive values are associated with green and lower negative values are associated with red.

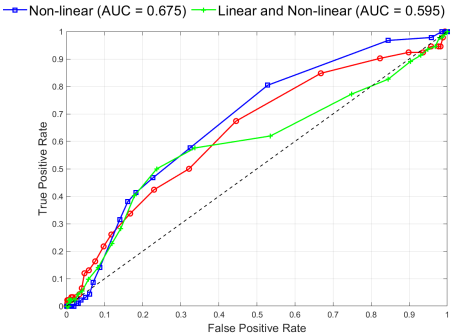
How well does the non-linear model perform?

Linear vs Non-Linear model

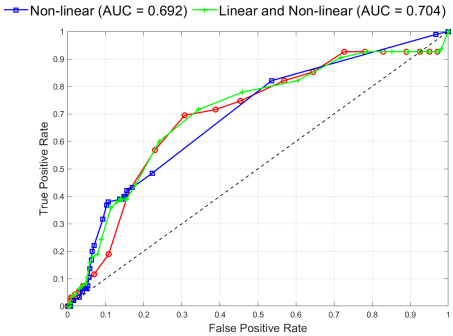
- We assess a model's ability to predict the left-tail of the GDP distribution by assessing the probability it assigns to GDP outcomes of a given severity at a given horizon
- If this probability exceeds a given signal-threshold, we classify the model as predicting the severe outcome
- We then vary this signal-threshold to generate a ROC curve

The ROC curves for non-linear vs linear models

Horizon = 8; Severity = 10^{th} pct



Horizon = 12; Severity = 10^{th} pct



Notes: The figure shows Receiver Operating Characteristic (ROC) curves for both the linear and nonlinear models at a severity level set to the 10^{th} percentile. In the left-hand panel, the prediction horizon is 8 quarters; in the right-hand panel, it's 12 quarters. The true positive rate (TPR) is computed as the ratio between true positive and the sum of true positive and false negative; the false positive rate (FPR) is computed as the ratio between false positive and the sum of false positive and true negative. Results are based on pooled data from all countries in the analysis.

Policy application

Turning this framework into a risk monitoring tool

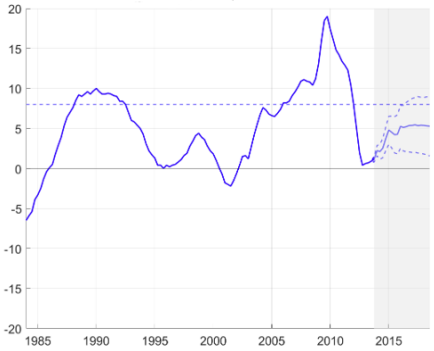
- Some natural questions that might arise when using this model in a policy setting:
  - How proximate are these nonlinear constraints?
  - What is the probability of one or more constraint binding over the next 3 years?
  - What types of scenarios might push us over each threshold?
  - What can/should macro policy do to reduce these risks?

BVAR

- Countries: Australia, Canada, Germany, United Kingdom and United States
- Variables included:
  - 5 macro-financial indicators + (ln) GDP, inflation, policy rate and unemployment
- Recursive estimation starts with data from 1981Q1 to 1995Q4, updated quarterly until 2023Q4
- We simulate the model forward 20 quarters, taking draws from the posterior
- Prior:
  - Pre-pandemic: Giannone Lenza, and Primiceri (GLP) prior (Giannone et al. [2015])
  - Post-pandemic: GLP pandemic prior (Cascaldi-Garcia [2022])

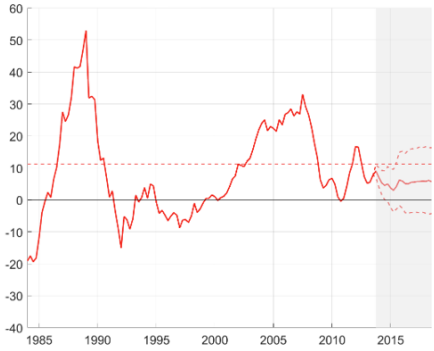
Canada - household sector (2013Q4)

3-year growth in household credit



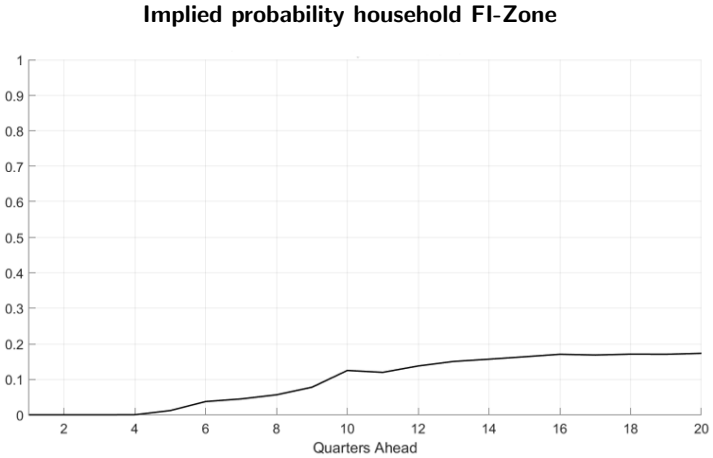
Notes: The horizontal line marks the threshold for credit variables, calculated as the 66th percentile of the "actual" series. The shaded area highlights the forecast period. Dotted lines represent the 25th and 75th percentile forecast bands.

3-year growth in house price



Note: The horizontal line marks the threshold for price variables, calculated as the 62th percentile of the "actual" series. The shaded area highlights the forecast period. Dotted lines represent the 25th and 75th percentile forecast bands.

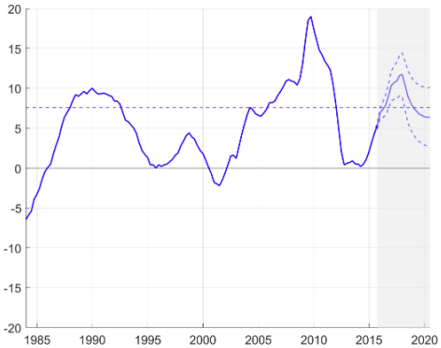
Canada – household sector (2013Q4)



Note: the implied probability is calculated as the ratio of simulations where the household FI-zone activates to the total simulations (3,000). The forecast period begins in 2013Q4 and spans 20 quarters.

Canada - household sector (2015Q4)

3-year growth in household credit



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3-year growth in house price

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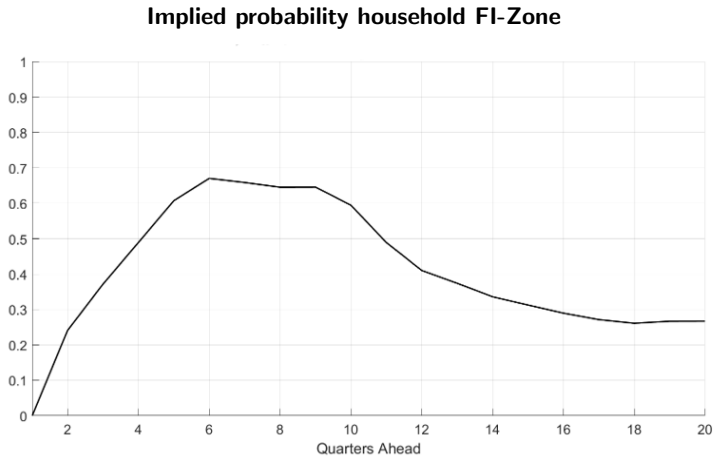
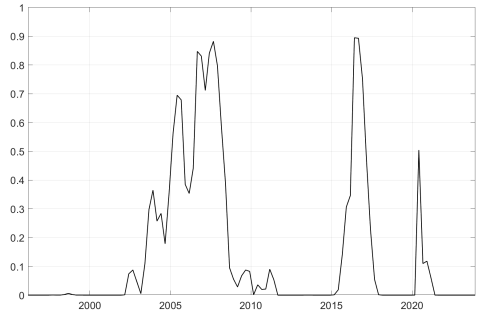
Canada – household sector (2015Q4)



Note: the implied probability is calculated as the ratio of simulations where the household FI-zone activates to the total simulations (3,000). The forecast period begins in 2015Q4 and spans 20 quarters.

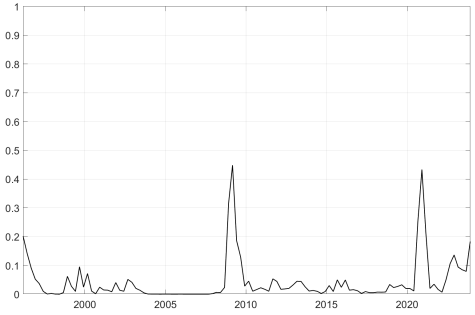
Canada – probabilities of FI-zones activating (h = 4)

Household FI-Zone



Notes: The charts start from 1996Q1, marking the beginning of the forecasted period generated by the BVAR model.

Banking FI-Zone



Notes: The charts start from 1996Q1, marking the beginning of the forecasted period generated by the BVAR model.

Conclusions and policy implications

- There seem to be important thresholds in the financial system, which, when crossed, trigger large changes in the predicted distribution of GDP growth:
  - Thresholds associated with overheating household and business markets, and with weaknesses in bank capital
  - In a state where household and business credit markets are overheating, the predominant impact is a shift in the full growth distribution, i.e., not a GaR story
  - The interactions between these constraints are also significant, e.g. the impacts of an erosion in bank capital depend importantly on whether the household sector is overstretched or not

Conclusions and policy implications

- These findings suggest the need to develop risk monitoring tools designed to track how close the financial system is to these critical thresholds:
  - What scenario might drive us uncomfortably close to these thresholds?
  - What policy interventions are available to steer us away from such an outcome?
- What are the policy implications of this?
  - Treat the cause: Can macropru policies be used to reverse the FI-zones?
  - Treat the symptoms: Should monetary or fiscal policy be eased to cushion the impact that is in train?

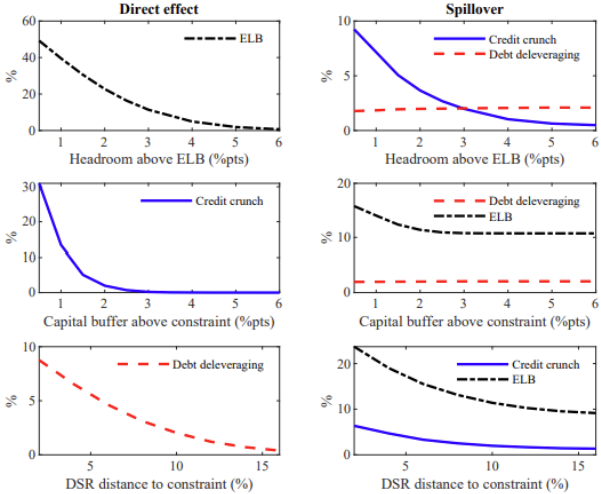
THANK YOU

Conceptual drivers of GDP-at-Risk

- In a previous paper (Aikman et al. [2024]), we analysed the drivers of GDP-at-Risk in a semi-structural NK setting with 3 occasionally-binding constraints:
  - A bank capital requirement that implies credit supply is highly sensitive to loan losses when capital buffers are depleted
  - A debt service ratio constraint such that the private sector reduces spending sharply when the interest burden of debt becomes too high
  - An effective lower bound on interest rates

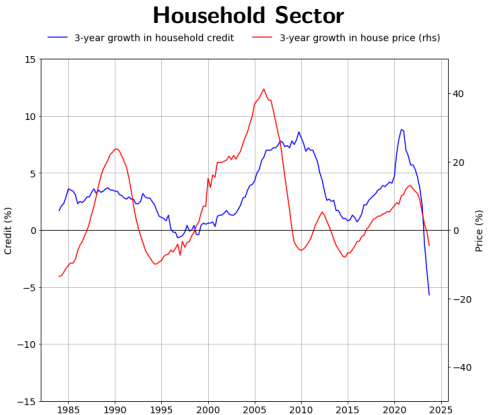
Conceptual drivers of GDP-at-Risk

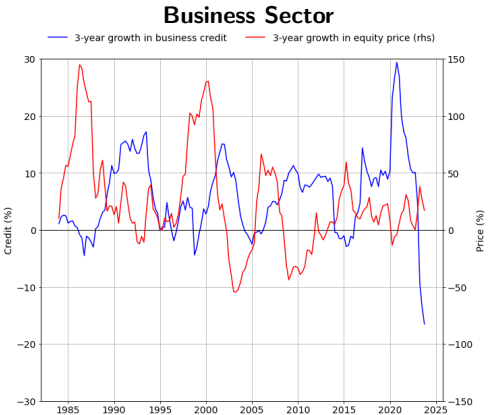
- Key insights from this model:
  - The link between macro-financial developments and risk is highly non-linear
  - As the economy gets closer to one constraint, the likelihood that others will bind increases



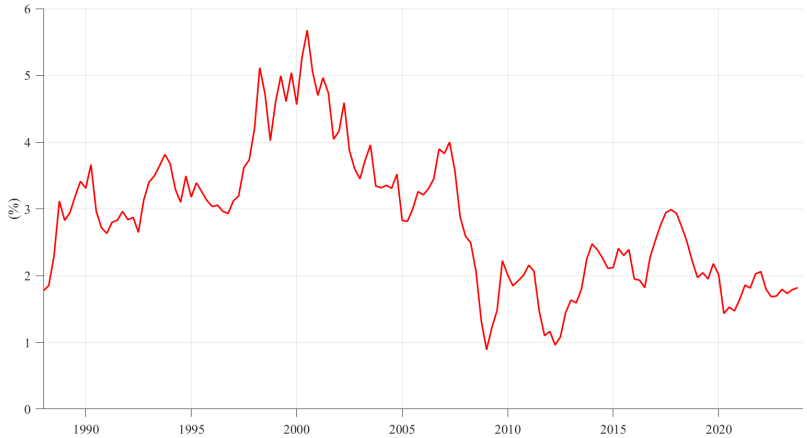
Notes:The figure plots the frequencies with which constraints bind as a function of their proximity. We simulate the model for 440 quarters, discarding the first 40 and repeating the process 1000 times. The y-axis is the average % of simulated quarters for which each constraint binds. The x-axis is the degree of headroom assumed in the steady state. The first column ('Direct effect') shows the impact of making each constraint more proximate on the frequency with which it binds. The second column ('Spillover') shows the impact on the frequency with which other constraints bind.

Price and Credit Series - France



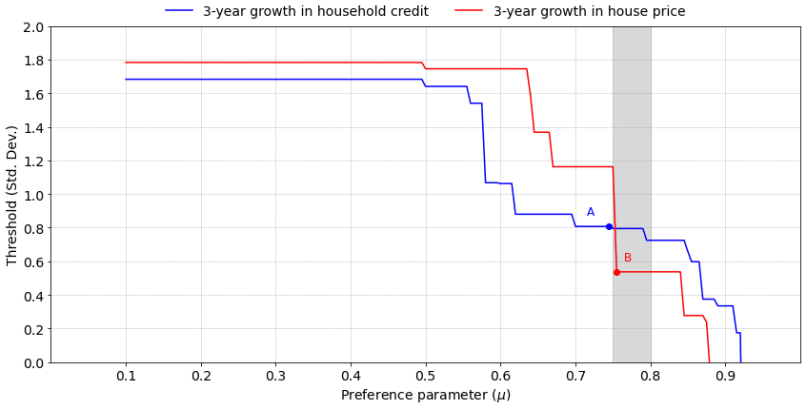


Banking system market-based leverage ratio - France



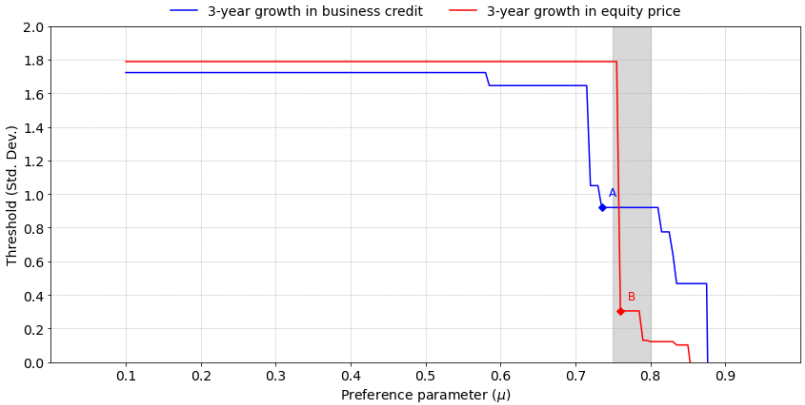
Source: Refinitiv Datastream and authors' own computations. Notes: The data are presented at quarterly frequency. Selected banks included in this analysis are: BNP Paribas, Societe Generale, Credit Agricole, Natix, Dexia.

Thresholds selection – household sector



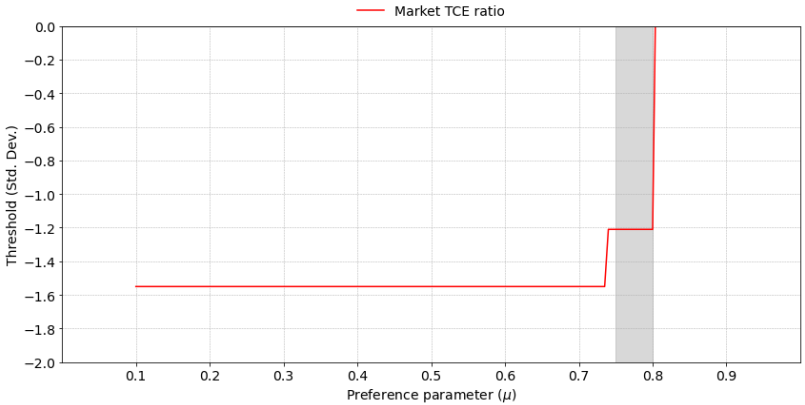
Note: The chart illustrates the optimal thresholds for the price and credit variables related to the household sector that maximize the policymaker's utility function across different levels of the preference parameter (μ). Thresholds computed as in Greenwood et al. [2022] are indicated with labelled dots: 'A' for credit and 'B' for price. The dot labelled 'A' represents the 5th quintile of the credit variable, and the dot labelled 'B' represents the 3rd tercile of the price variable. The shaded grey area corresponds to preference parameters that range between 0.75 and 0.8. The grid search performed to obtain the optimal threshold is bounded above by the 95th pct. of the variable and below by the 5th pct., with grid searches executed at increments of 0.01 standard deviations.

Thresholds selection – business sector



Note: The chart illustrates the optimal thresholds for the price and credit variables related to the business sector that maximize the policymaker's utility function across different levels of the preference parameter (μ). Thresholds computed as in Greenwood et al. [2022] are indicated with labelled dots: 'A' for credit and 'B' for price. The dot labelled 'A' represents the 5th quintile of the credit variable, and the dot labelled 'B' represents the 3rd tercile of the price variable. The shaded grey area corresponds to preference parameters that range between 0.75 and 0.8. The grid search performed to obtain the optimal threshold is bounded above by the 95th pct. of the variable and below by the 5th pct., with grid searches executed at increments of 0.01 standard deviations.

Thresholds selection – banking sector



Note: The chart illustrates the optimal thresholds for the market tangible common equity ratio related to the banking sector that maximize the policy-maker's utility function across different levels of the preference parameter (μ). The shaded grey area corresponds to preference parameters that range between 0.75 and 0.8. The grid search performed to obtain the optimal threshold is bounded above by the 95th pct. of the variable and below by the 5th pct., with grid searches executed at increments of 0.01 standard deviations.