GDP-at-Risk:
Research and Policy Agenda

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Outline

- The concept of GDP-at-Risk and its potential use in macroprudential policy

- Two research papers:
  - "Credit, Capital and Crises: A GDP at Risk Approach" with Jonathan Bridges (BoE), Sinem Hacioglu-Hoke (BoE), Cian O'Neill (BoE) and Akash Raja (LSE)
  - "A Tale of 3 Occasionally-Binding Constraints", with Kristina Bluwstein (BoE) and Sudipto Karmakar (BoE)

- Concluding thoughts on where this literature is heading

GDP-at-Risk and macroprudential policy

- Macropru as a policy framework is severely hampered by the lack of a quantitative objective

- This was not a problem in the immediate aftermath of the Global Financial Crisis as the direction of policy was clearly to build resilience (Barwell, 2021)

- But a decade plus on from that episode, the countercyclical component of the macroprudential framework is rudderless

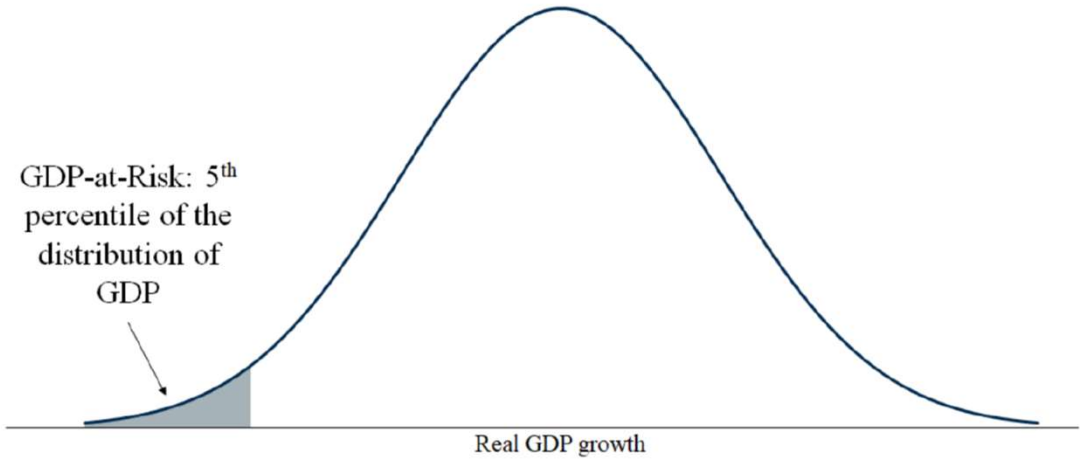
Problems this creates

- Accountability is impeded
- Decision making is poorer
  - —Ambiguity fosters the status quo bias
  - —The attention of policymakers may gravitate to more measurable goals like supporting competition and growth
- Imagine the task of Monetary Policy Committees right now if we didn’t have inflation targets in place!

What is GDP-at-Risk?

- GDP-at-Risk is the most promising idea we have developed so far for quantifying the objectives of macroprudential policy

- It's an estimate of the most severe recession we might reasonably expect to experience over a defined period ahead, eg the next 3 years



Attractive concept for several reasons:

- It provides a numeraire, ie it allows us to express financial stability risks in common units
- GDP is a well understood concept
- The focus on “tail risk” dovetails with the focus of monetary policy on the central outlook
  - A GDP-at-Risk forecast could play a role akin to that of the inflation forecast in monetary policy deliberations

But it also has drawbacks

- Understanding the relationship between financial sector developments and macro tail risk is a significant challenge – is it beyond our ability?

- As we're seeing, there are many other sources of risk for the real economy beyond financial crises – so a financial stability "target" for GDP-at-Risk doesn't make much sense

Some key contributions to the literature

- Early literature: Cecchetti (2006), Cecchetti and Li (2008), De Nicolo and Lucchetta (2012)
- Seminal paper: Adrian et al. (2019), "Vulnerable Growth", AER
- Voluminous literature following this contribution:
  - Adrian et al (2019): Term structure of Growth at Risk
  - Duprey and Ueberfeldt (2020): Managing GDP at Risk
  - Kiley (2019): Unemployment Risk
  - Chavleishvili and Manganelli (2020): Quantile VAR
  - Boyarchenko et al (2020)
  - Covi et al (2022)
  - Suarez (2021)
- Plagborg-Moller et al (2020): When is growth at risk? BPEA

Some of my work in this area

- "Credit, capital and crises: A GDP-at-Risk approach"

  with Jon Bridges (BoE), Sinem Hacioglu-Hoke (BoE), Cian O'Neill (BoE), Akash Raja (LSE)

- "A tale of three occasionally-binding constraints: a modelling approach to GDP-at-Risk"

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What this paper does

- This paper examines the relationship between a wide set of macroprudential indicators and GDP-at-Risk

- 2 novelties relative to existing literature:

  —We include measures of banking system resilience in the analysis, allowing us to account for the impact of Basel 3 on GDP-at-Risk

  —We focus on a horizon 3-5 years ahead, which is arguably the relevant policy horizon for considering prophylactic macroprudential policy actions

Data

- Cross-country panel dataset, 16 advanced economies, 1980Q4-2017Q4
- 5 macroprudential indicators:
  - 3-year change in private non-financial sector credit to GDP ratio
  - 3-year growth in real house prices
  - Current account deficit (% of GDP)
  - Realised volatility in equity prices
  - Banking system tangible common equity to total assets ratio
- Macroeconomic controls: policy rate, inflation, lagged GDP growth

Quantile regression approach

We follow Canay (2011) 2-step approach:

First step: Estimate the following linear pooled panel model by OLS

$$y_{i,t+h} = \alpha_i^h + \gamma^h X_{i,t} + \epsilon_{i,t},$$

where $y_{i,t+h} = \frac{(Y_{i,t+h} - Y_{i,t})}{h/4}$ and *X* are conditioning variables

The fixed effects can be estimated as: $\hat{\alpha}_i^h = \frac{1}{N} \sum_{i,t} (y_{i,t+h} - \hat{\gamma}^h X_{i,t})$

Quantile regression approach

Second step: We estimate the quantile regression coefficients:

$$\hat{\beta}_{\tau}^{h} = \underset{\beta^{h}}{\operatorname{argmin}} \sum_{i,t} \rho_{\tau}(y_{i,t+h}^{*} - X_{i,t}\beta_{\tau}^{h})$$

where $y_{i,t+h}^{*} = y_{i,t+h} - \hat{\alpha}_{i}^{h}$

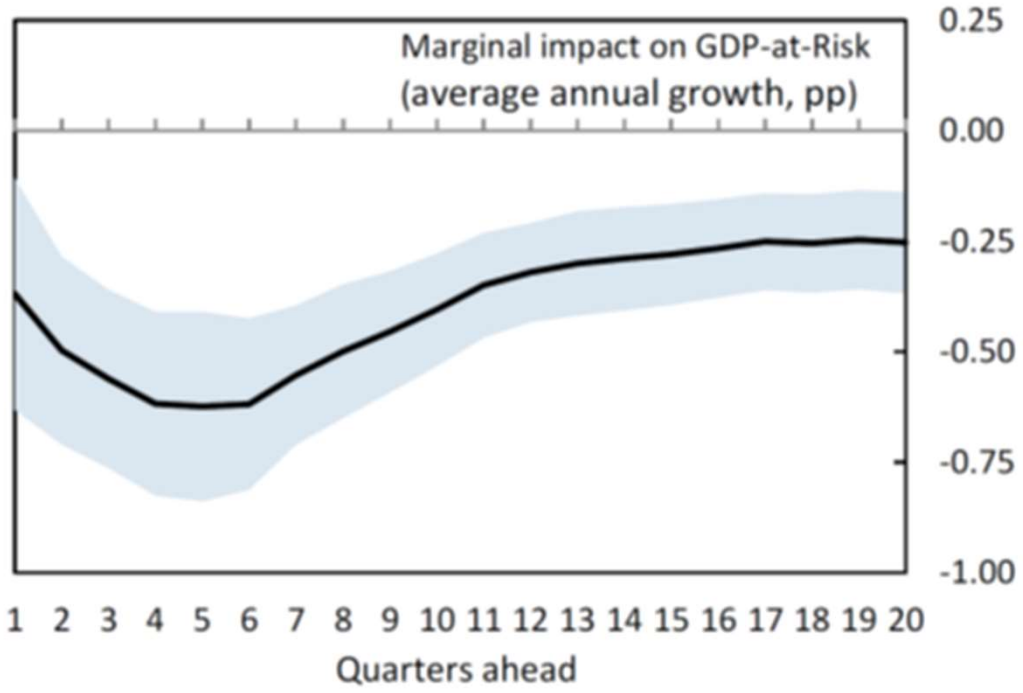
We estimate betas for 1-20 quarters ahead using local projections

Predicted 5th percentile of GDP growth = **"GDP-at-Risk"**

GDP-at-Risk response following 1 std increase in:

(A) Credit-to-GDP (3 year pp change)

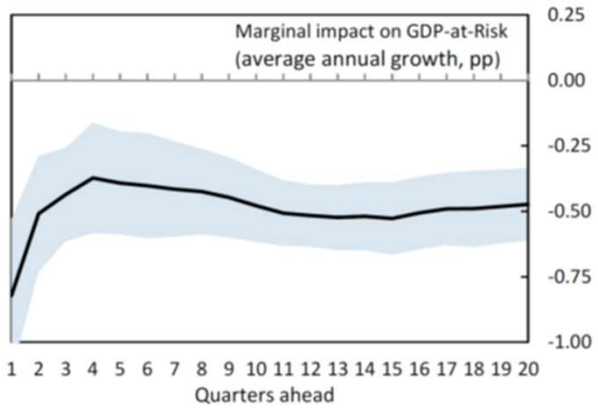
Note: +-1 standard error confidence intervals



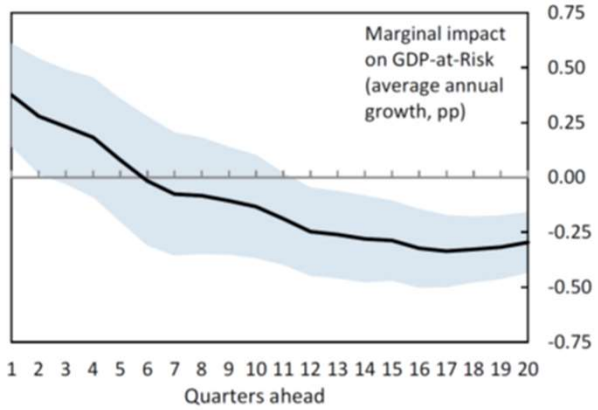
GDP-at-Risk response following 1 std increase in:

Note: +-1 standard error confidence intervals

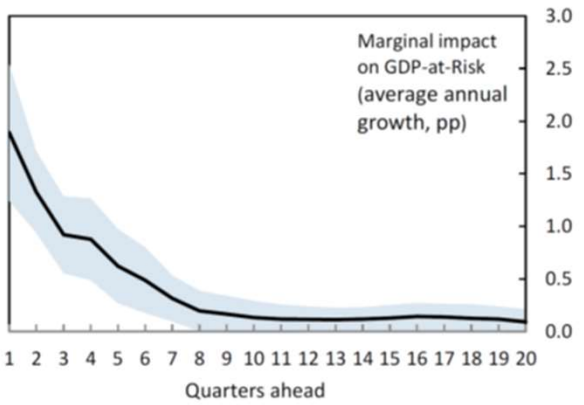
(B) Current account deficit



(C) Real house price growth (3 year)



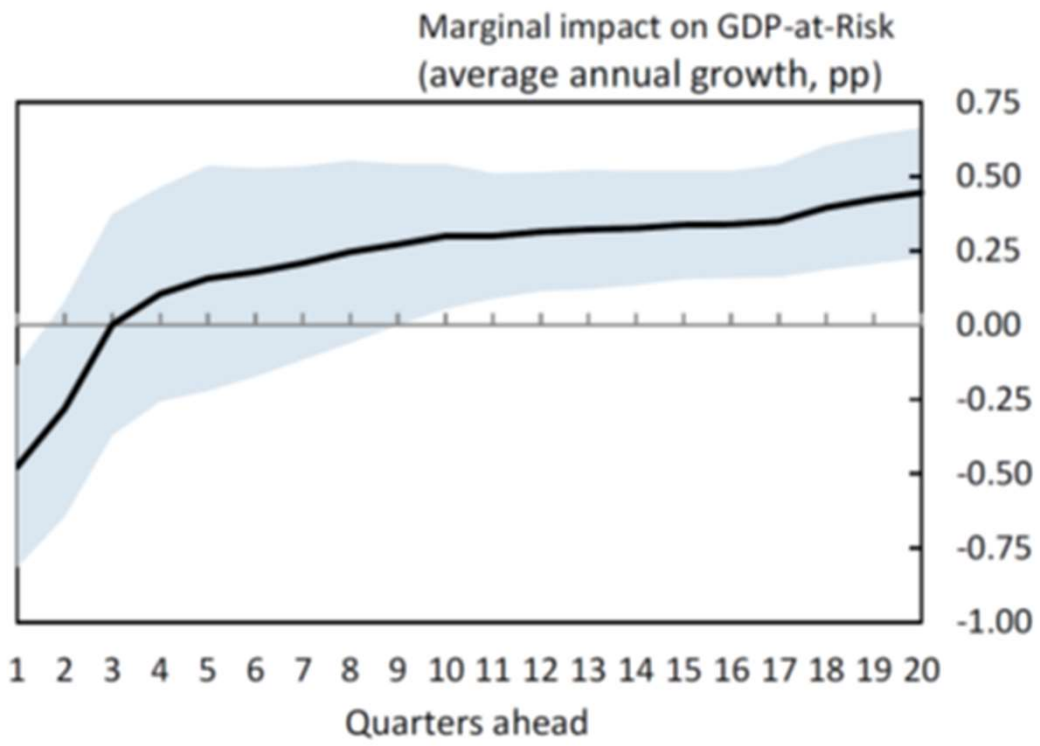
(D) Volatility



GDP-at-Risk response following 1 std increase in:

Note: +-1 standard error confidence intervals

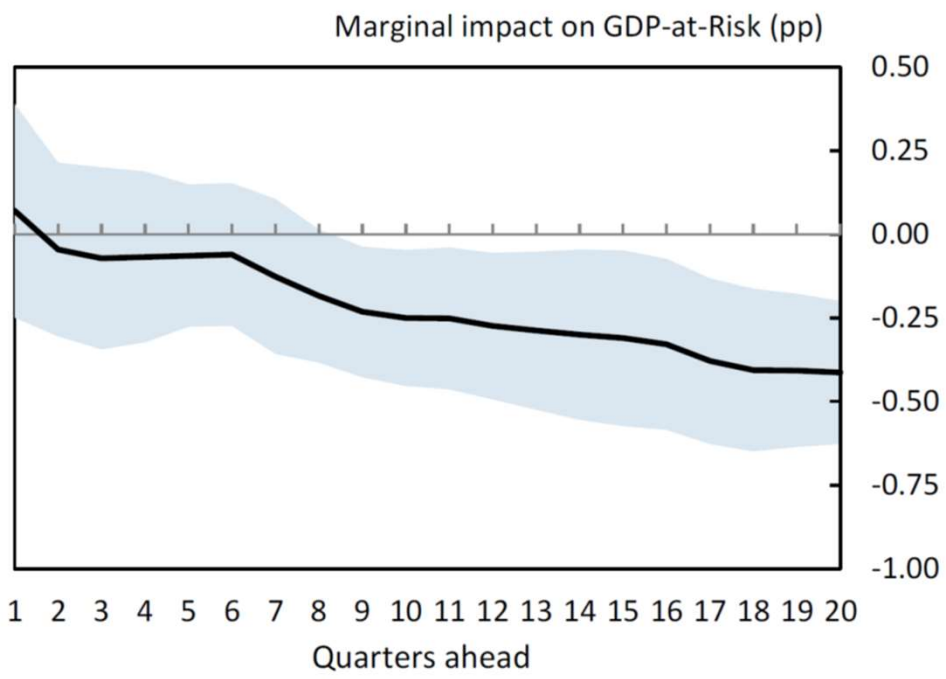
(E) Bank capital (TCE) ratio



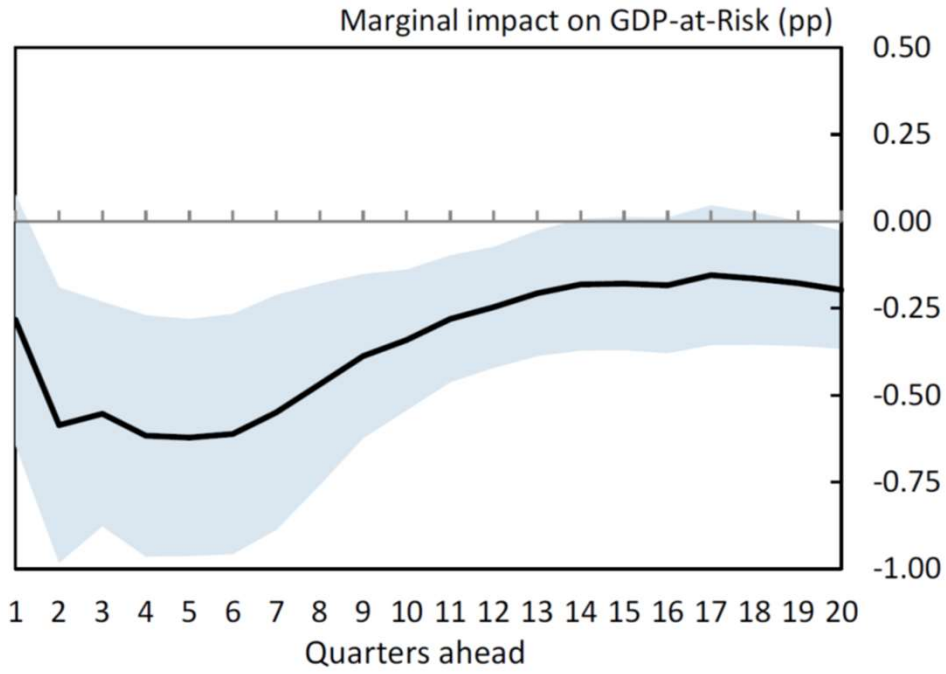
Summary of GDP-at-Risk impacts over 3-years

Household vs firm credit impact on GDP-at-Risk

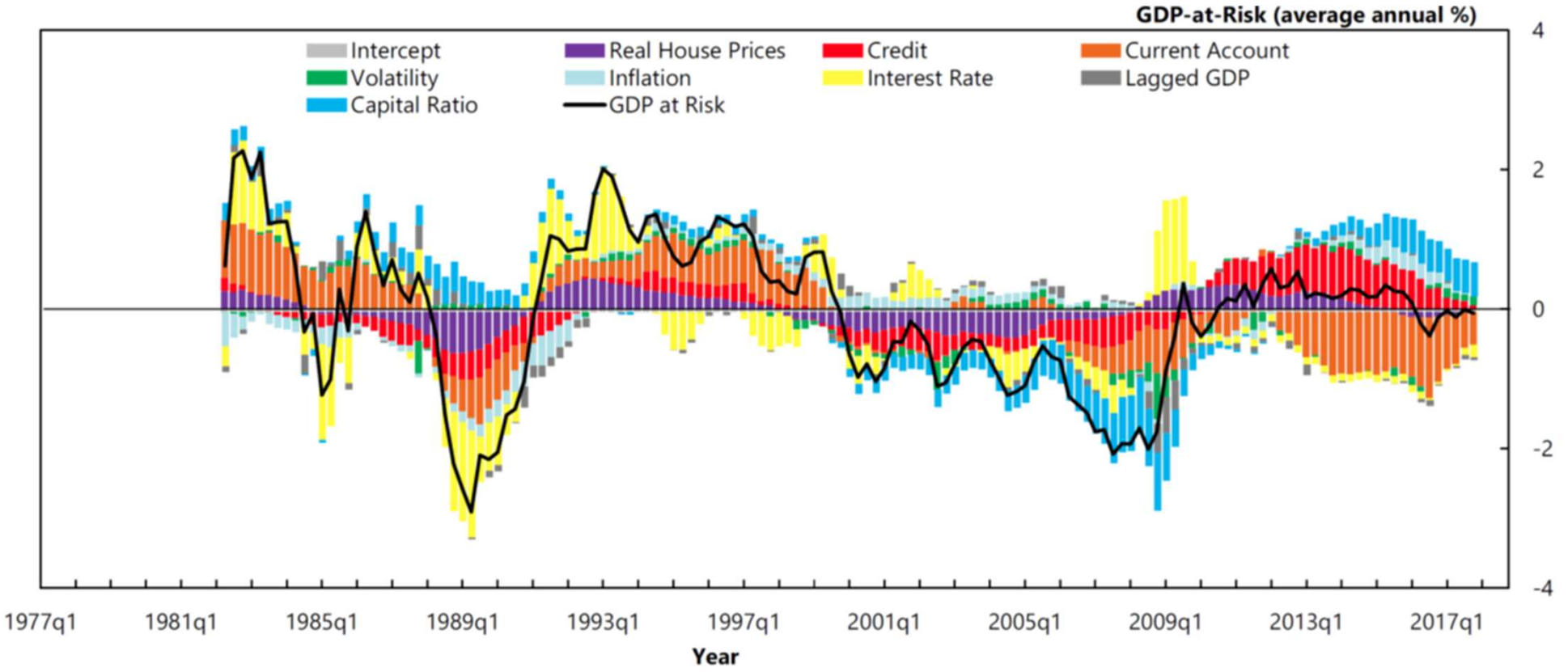
(A) Household credit-to-GDP (3 year pp change)



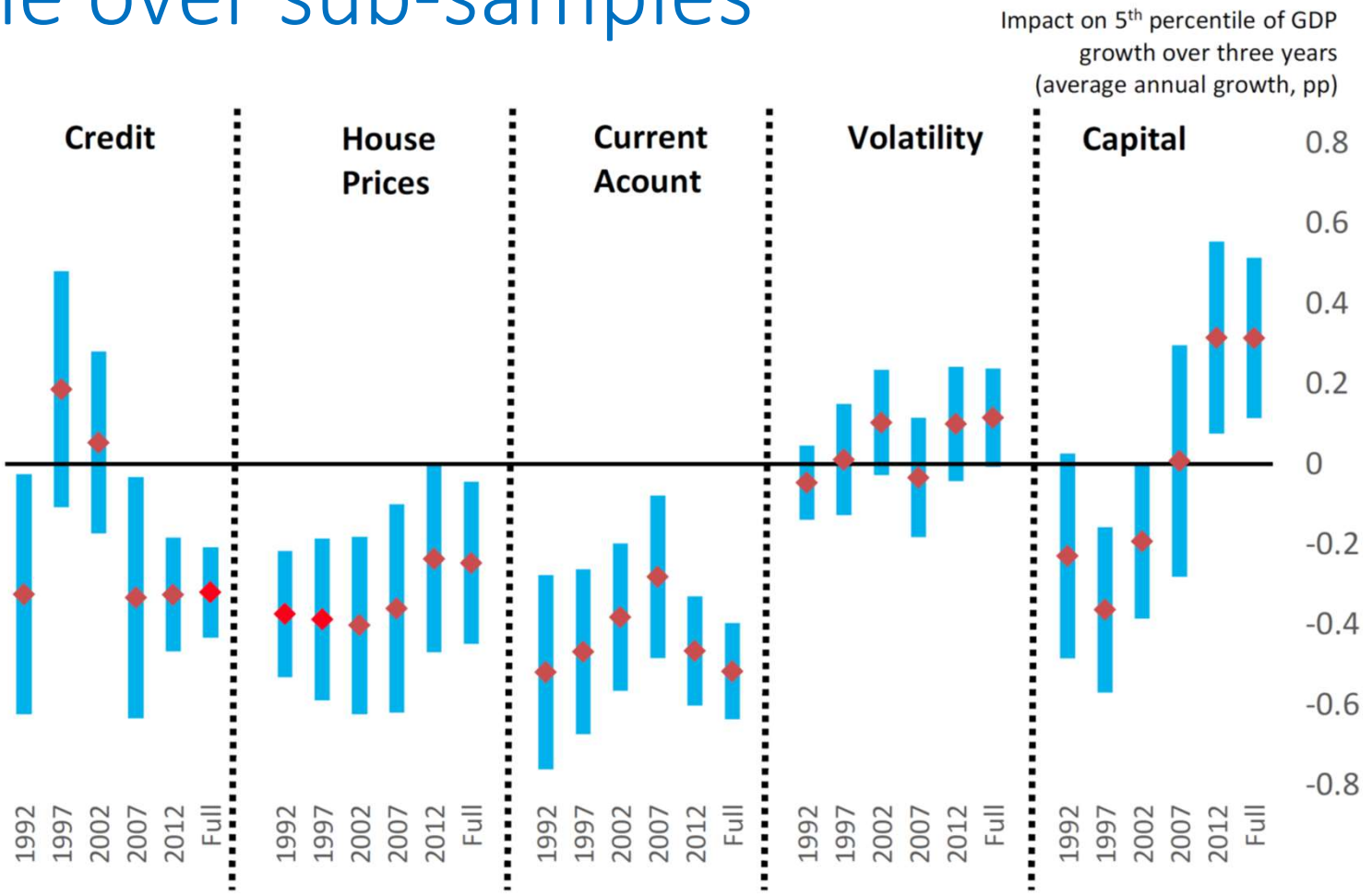
(B) Corporate credit-to-GDP (3 year pp change)



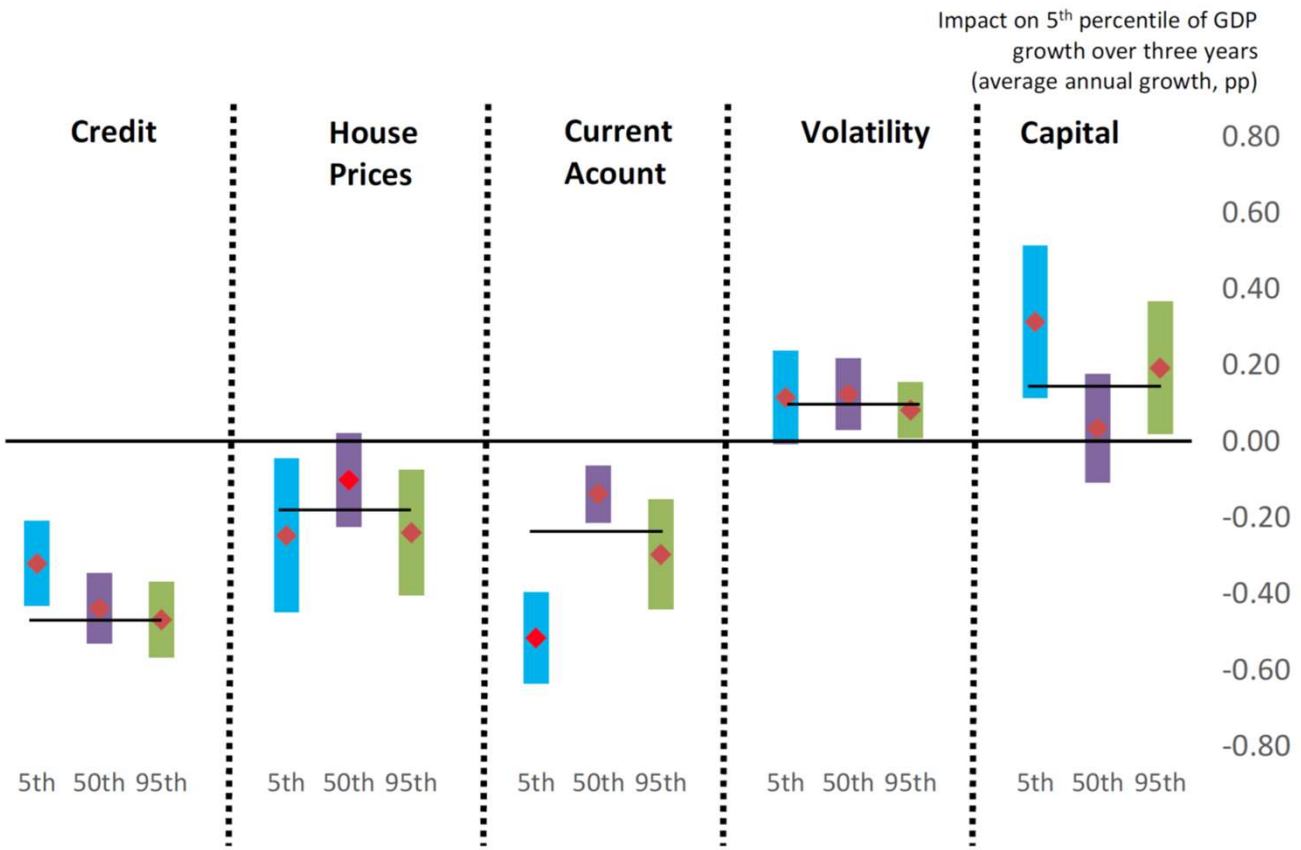
Decomposition of GDP-at-Risk 3-years ahead: UK



Some GDP-at-Risk coefficient estimates are unstable over sub-samples

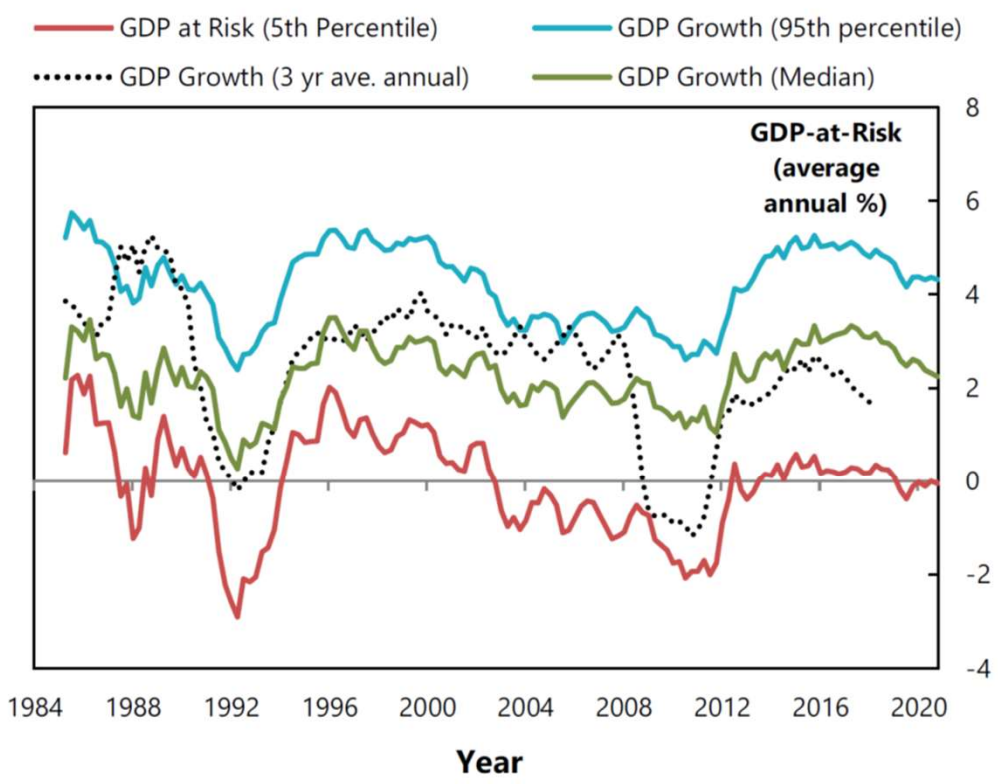


Some variables change the location rather than the shape of the growth distribution

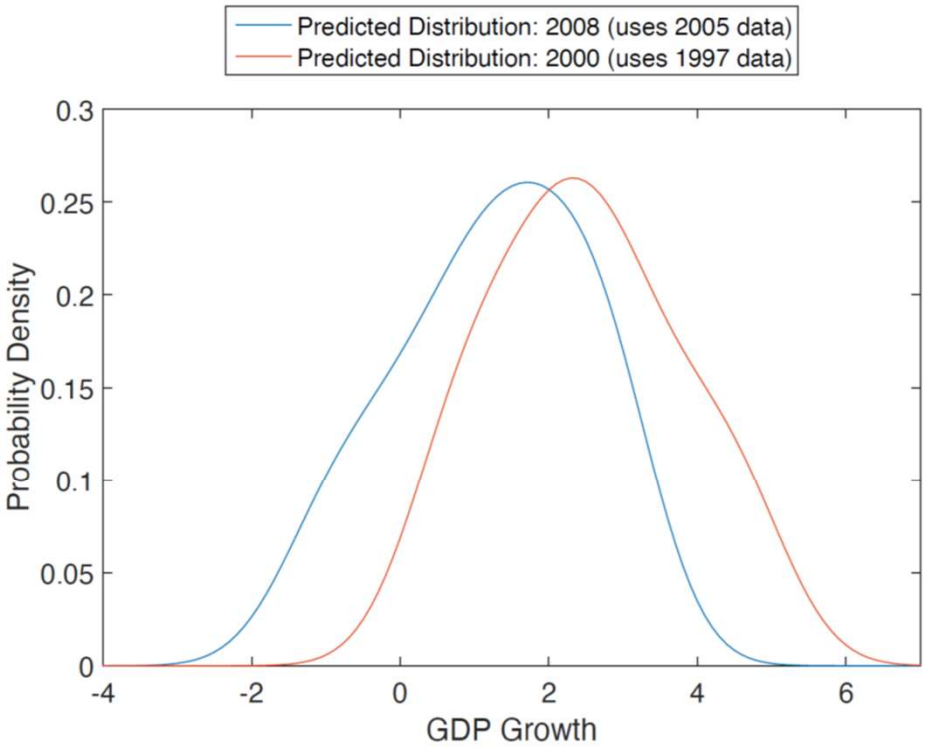


Predicted GDP growth density

(A) Forecast from 3 years previously vs. actual outturn



(B) Predicted density (3 years ahead)



Some of my work in this area

- "Credit, capital and crises: A GDP-at-Risk approach"

  with Jon Bridges (BoE), Sinem Hacioglu-Hoke (BoE), Cian O'Neill (BoE), Akash Raja (LSE)

- **"A tale of three occasionally-binding constraints: a modelling approach to GDP-at-Risk"**

  with Kristina Bluwstein (BoE) and Sudipto Karmakar (BoE)

A tale of 3 occasionally-binding constraints

- Hitherto, most studies of GDP-at-Risk have been purely empirical
- Few attempts to provide a more structural interpretation of the concept
- A model of GDP-at-Risk is useful for:
  - Running "what if" scenarios, eg what's the impact of a persistent inflation shock?
  - Understanding interaction effects, eg if the economy is further away from the ELB, what does that mean for the vulnerability of the banking system?
  - Analysing policy strategies

What this paper does

- We build a semi-structural New Keynesian model

- The model incorporates three non-linear constraints:
  - An effective lower bound on nominal interest rates
  - A credit crunch in credit supply when bank capital is depleted
  - Deleveraging by borrowers when debt service burdens become excessive

- We calibrate the model for the UK and use simulations to understand its properties

The model in words

- The macro block is pretty conventional: IS curve, Phillips curve, Taylor rule

- The financial block includes:
  - Credit demand, linking credit to output and the (spread adjusted) real interest rate
  - Credit supply, linking credit to the bank capital ratio
  - Bank capital dynamics, via which bank net worth varies autoregressively and depends on the level and change in nominal interest rates plus (procyclical) credit losses

Nonlinear constraints

1. **Effective lower bound on policy rate**

2. **Bank capital constraint**

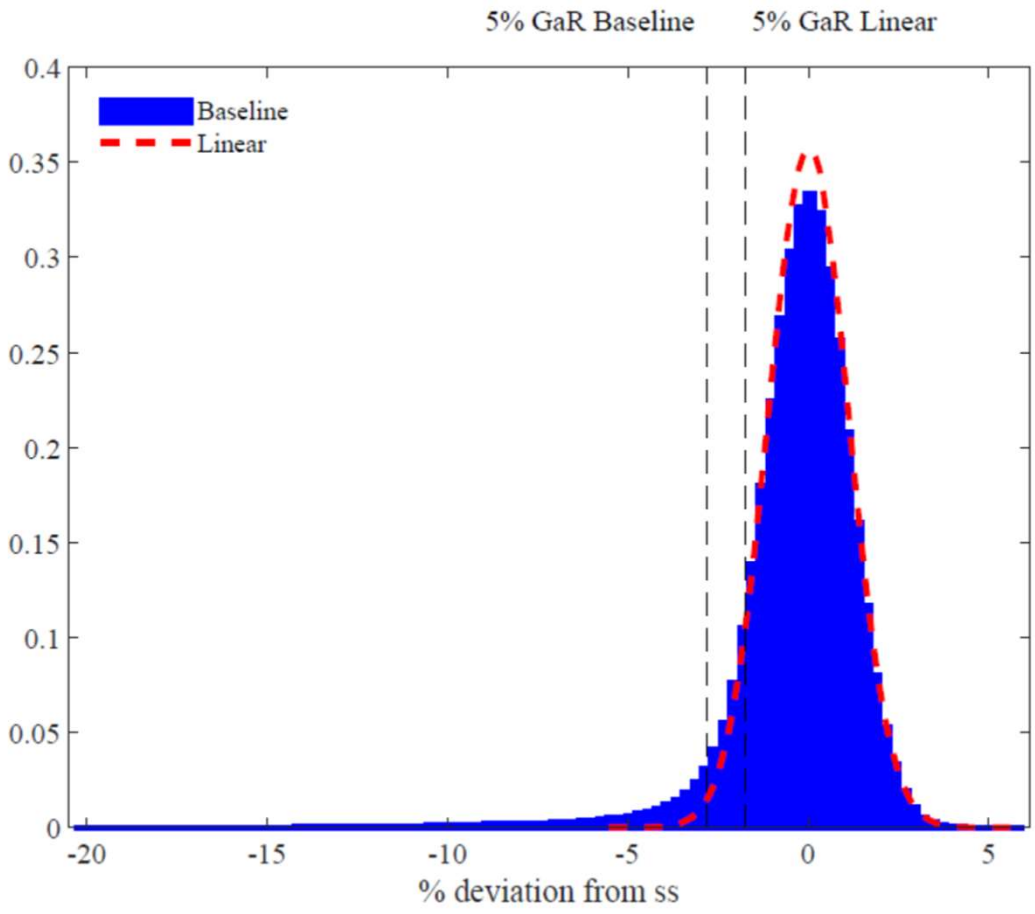
- In normal times, loan supply is insensitive to bank capital
- But when capital ratios drop below a threshold, loan supply falls abruptly and becomes highly sensitive to bank capital

3. **Debt deleveraging constraint**

- Borrowers begin deleveraging when their debt service ratios (DSRs) cross a boundary
- Deleveraging is a simultaneous shock to the IS and credit demand equations

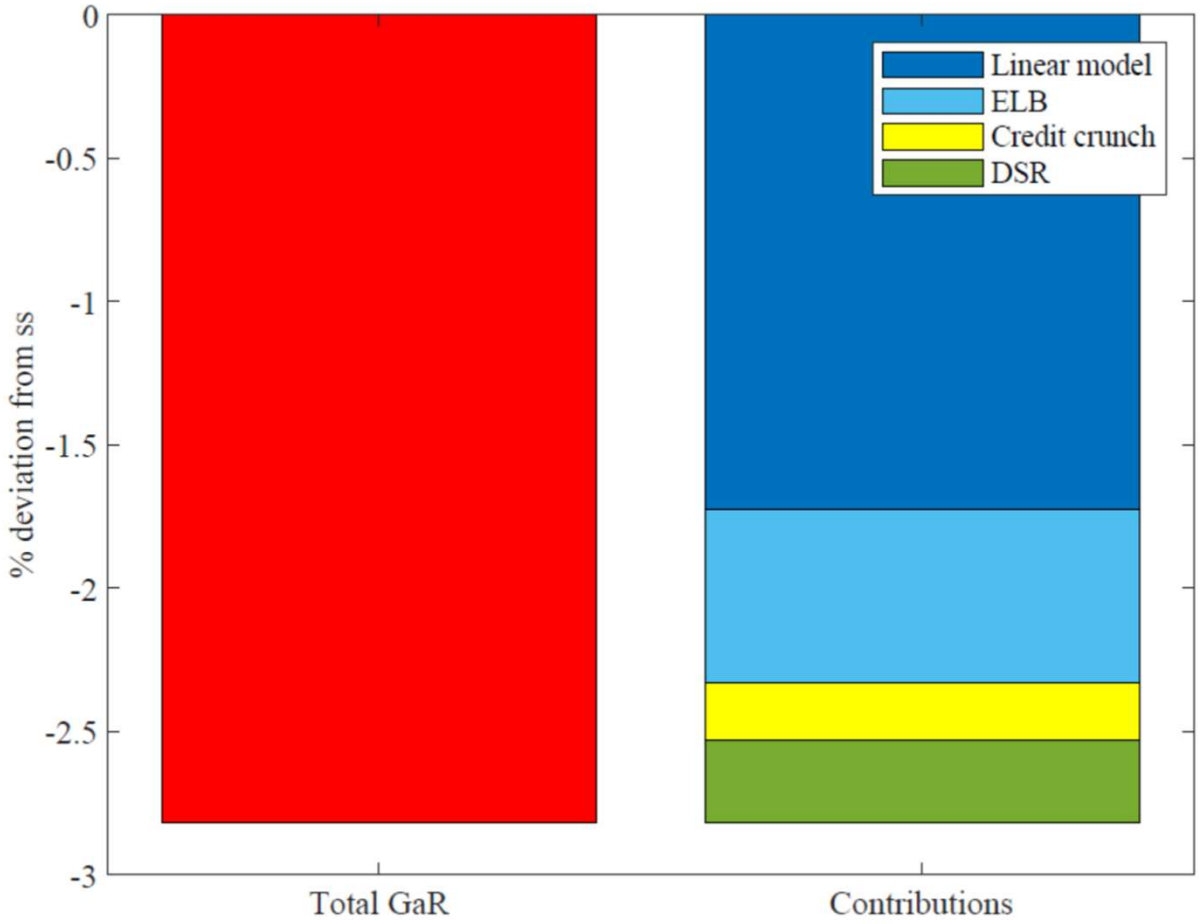
Unconditional distribution of (detrended) GDP

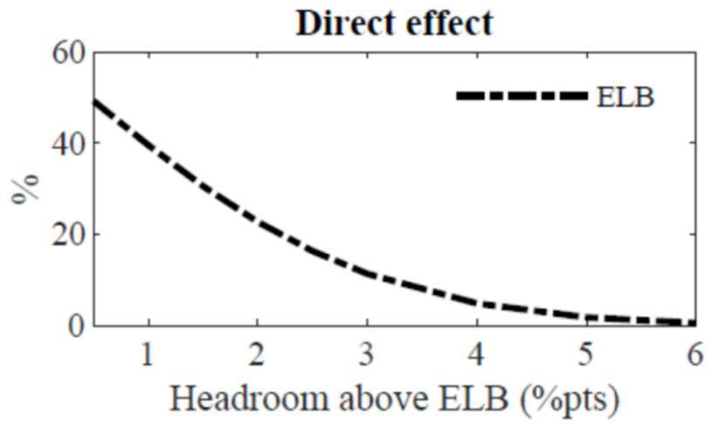
- 5000 simulations of 140 quarters (first 40 discarded)
- GDP-at-Risk: **-2.8%**
- NB: GDP-at-Risk is
  - **-1.7%** in the model without constraints
  - **-2.9%** in the data

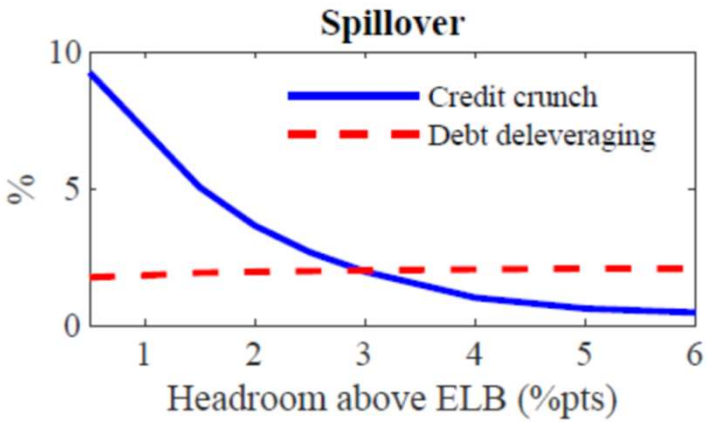


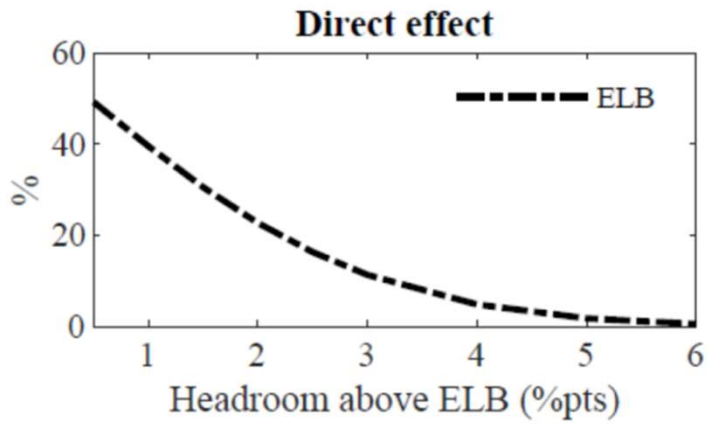
Shapley value contributions to GDP-at-Risk

- Frequency with which constraints bind:
  - ELB: 11.1%
  - Credit crunch: 1.8%
  - DSR: 1.9%




Direct effect
60
40
20
0
%
ELB
1
2
3
4
5
6
Headroom above ELB (%pts)


Spillover
10
5
0
%
Credit crunch
Debt deleveraging
1
2
3
4
5
6
Headroom above ELB (%pts)


Direct effect
60
40
20
0
%
ELB
1
2
3
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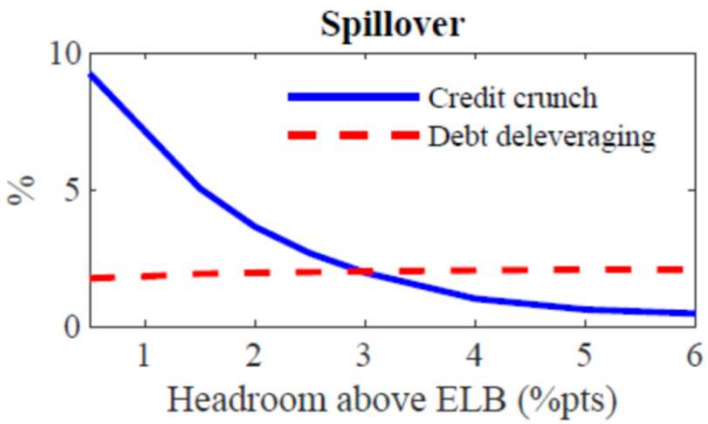
Headroom above ELB (%pts)


Spillover
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Credit crunch
Debt deleveraging
1
2
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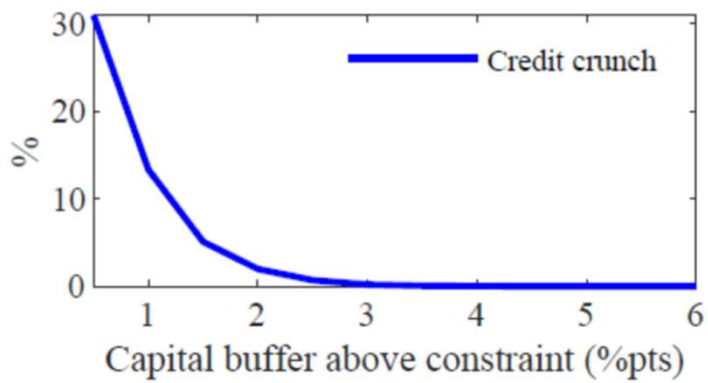
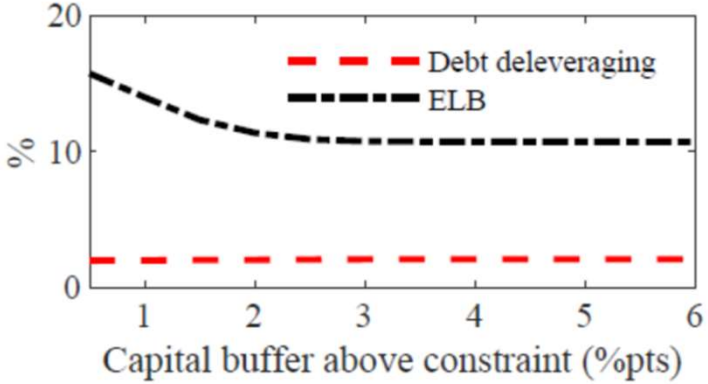
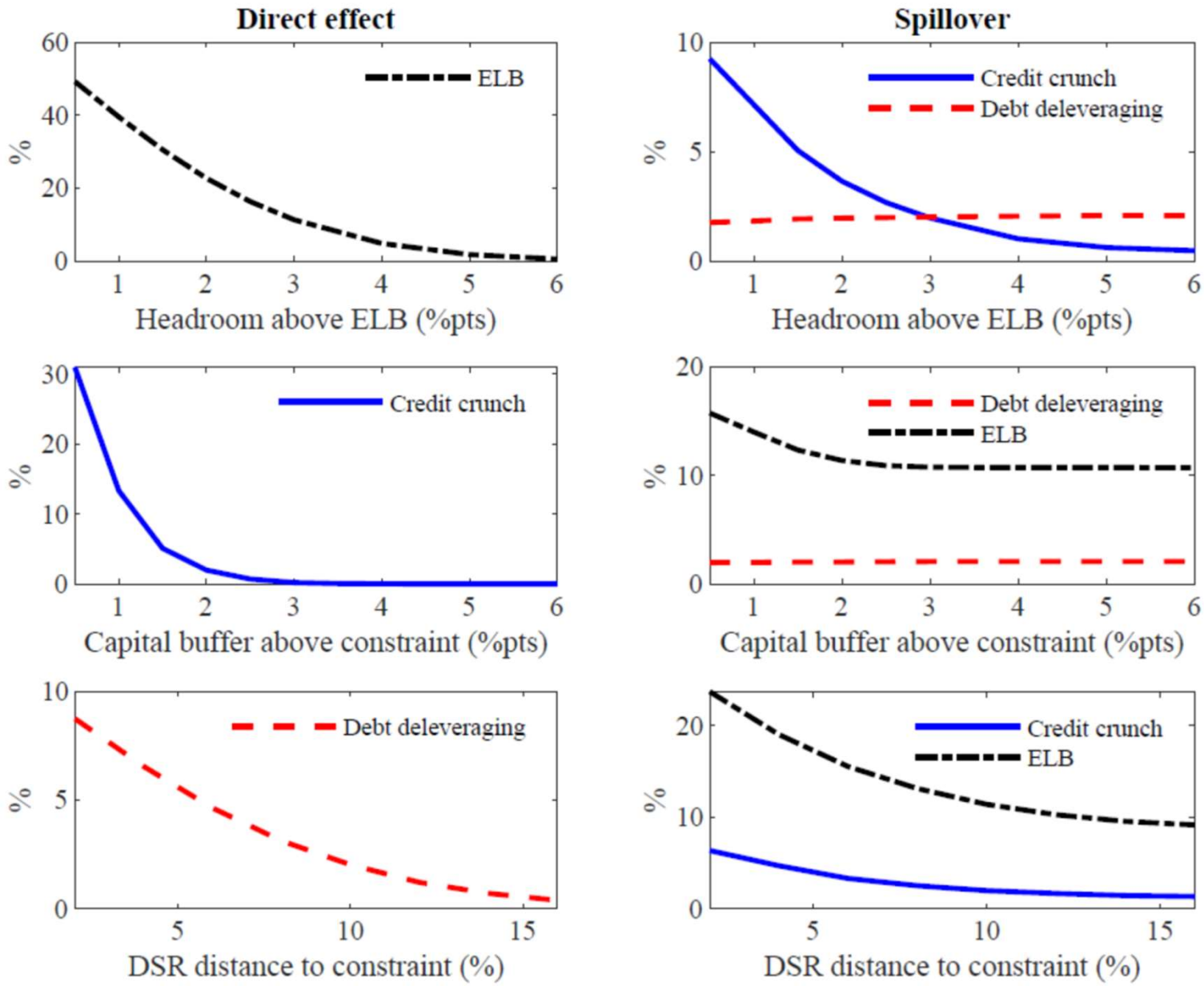
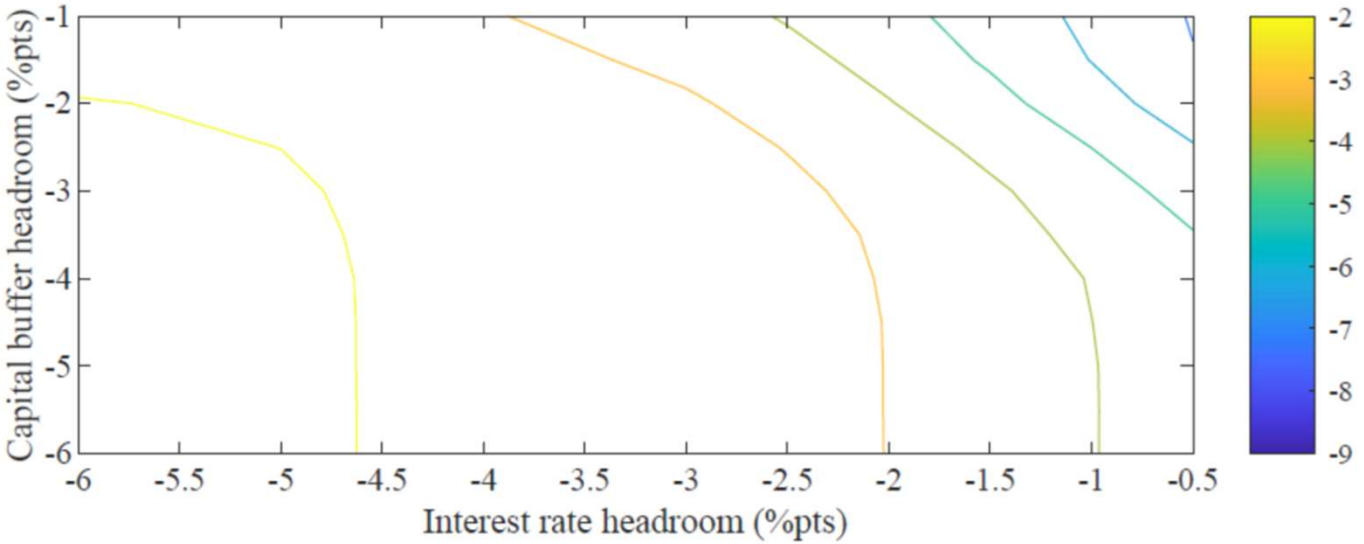
Headroom above ELB (%pts)


30
20
10
0
%
Credit crunch
1
2
3
4
5
6
Capital buffer above constraint (%pts)

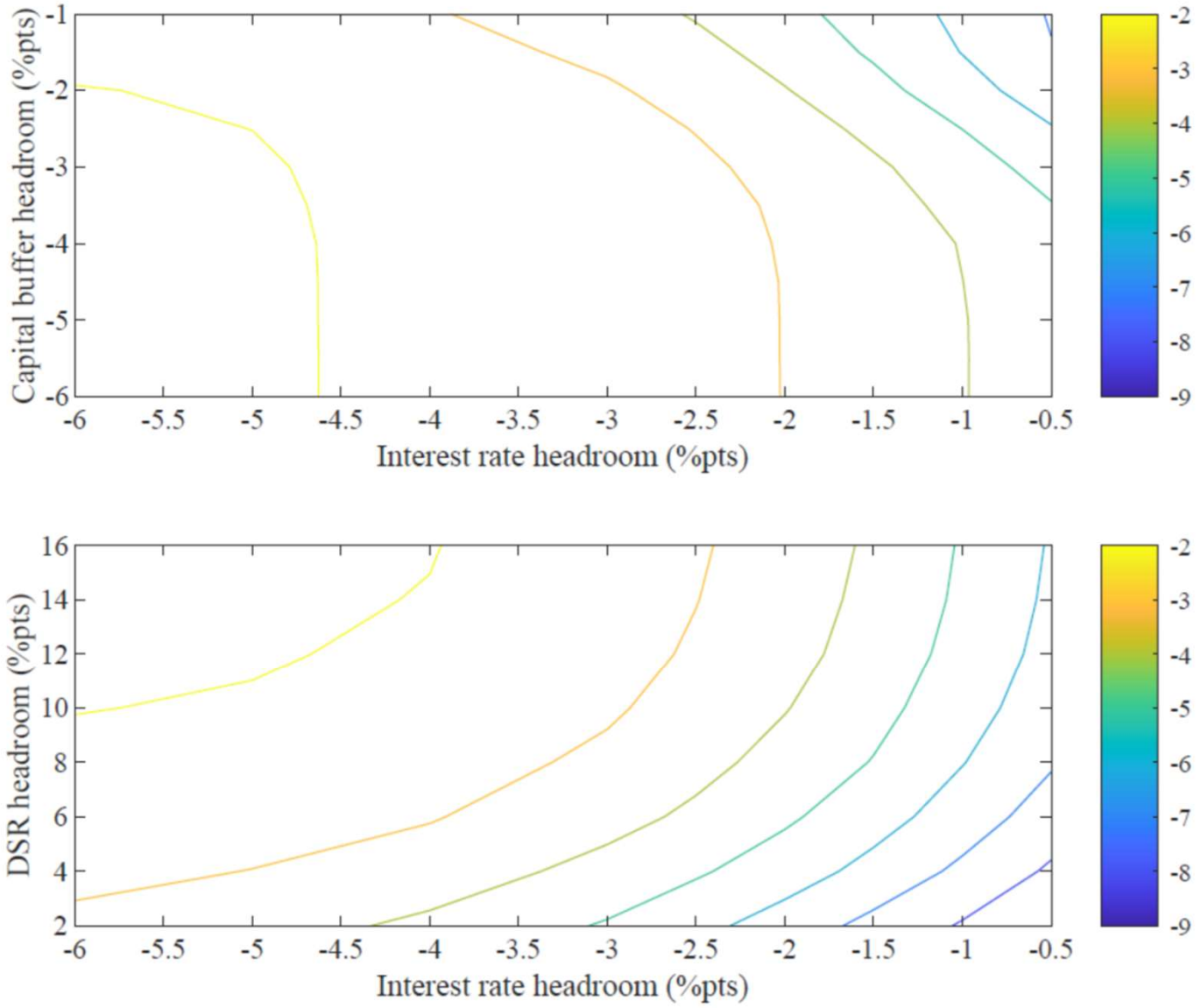

20
10
0
%
Debt deleveraging
ELB
1
2
3
4
5
6
Capital buffer above constraint (%pts)


Direct effect
Spillover
ELB
Credit crunch
Debt deleveraging
%
Headroom above ELB (%pts)
Capital buffer above constraint (%pts)
DSR distance to constraint (%)

Iso-risk curves



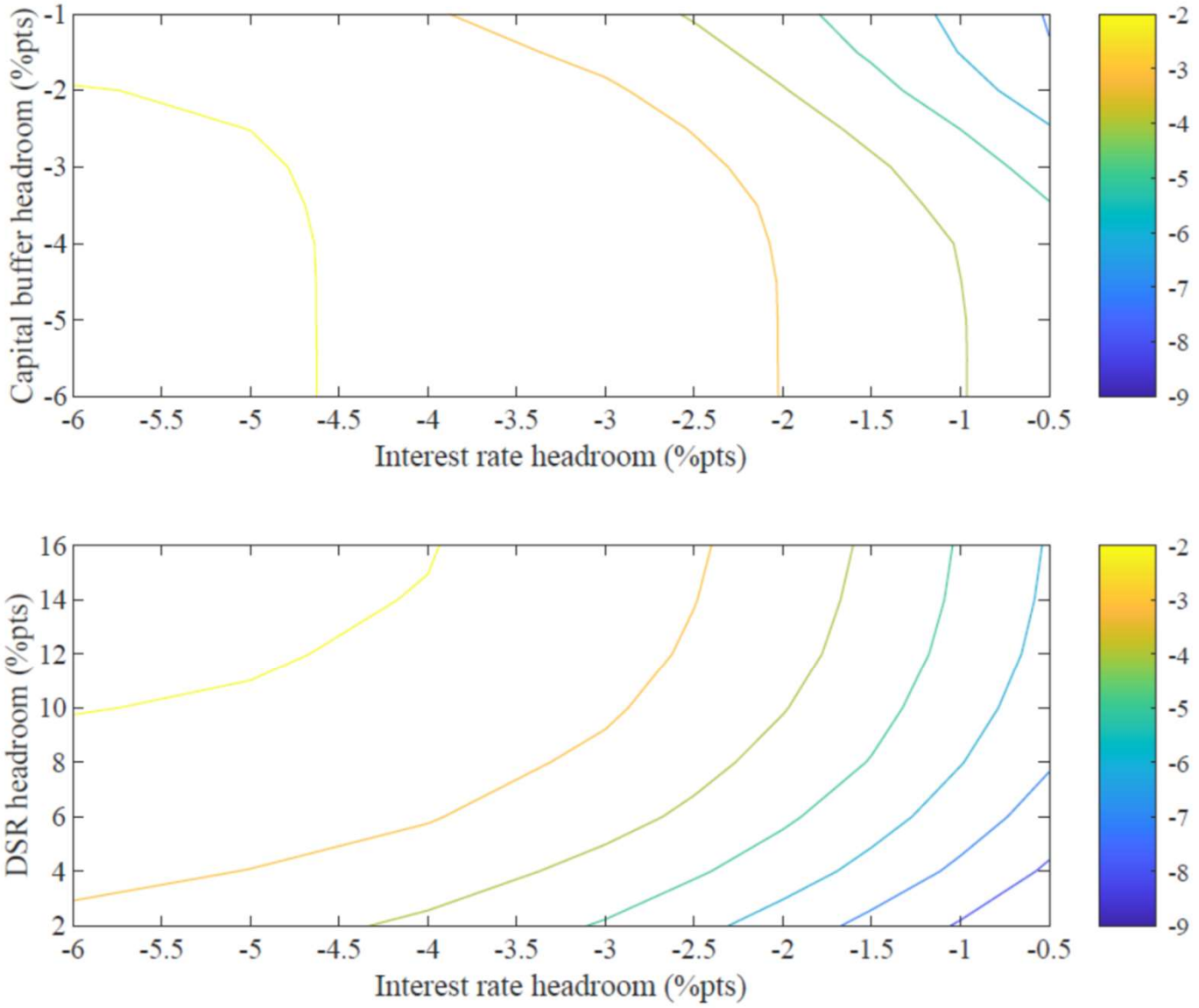
Iso-risk curves



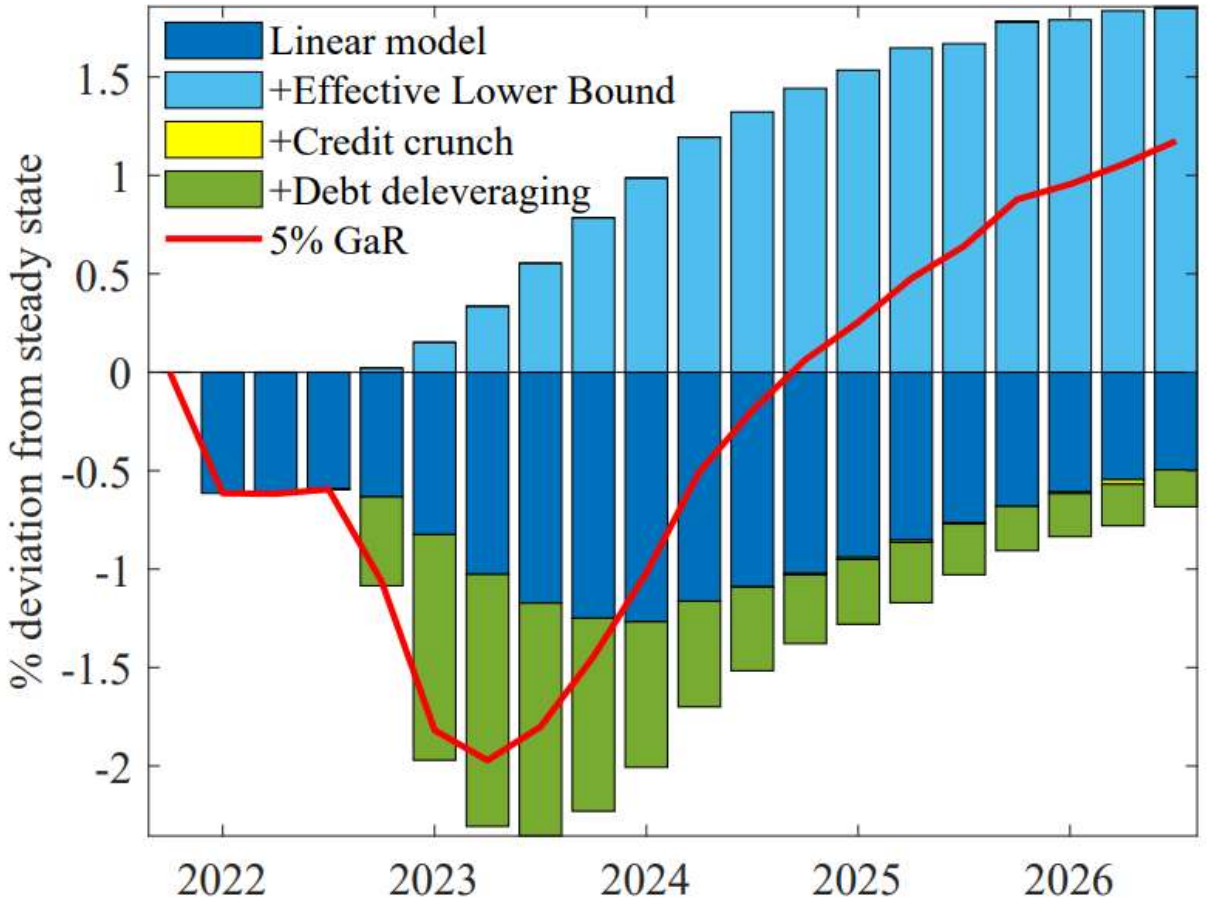
Iso-risk curves

50 basis point decline in monetary policy headroom requires:

- Additional capital buffers of 1% of assets
- Lower debt service burdens of 2-2.5% pts



Impact of a persistent inflation shock on GDP-at-Risk



Thoughts on what next for this literature

1. We need more empirical work on the reliability of GDP-at-Risk estimates at the policy horizon relevant for macropru: 2-3 years+

2. We need richer structural models of GDP-at-Risk, which incorporate a role for macropru policy tools such as the CCyB

3. Is this the right concept or should we focus on a metric of credit supply at risk?

4. Whether / how to integrate GDP-at-Risk with macro stress testing and in an integrated policy framework for macropru, ie with a loss function

Additional slides

Model: the macro block

- **IS equation** extended with spreads [Curdia & Woordford, 2010]:

$$\underbrace{y_t}_{Output} = \theta^y y_{t-1} - \theta^r \Big(\underbrace{r_t}_{interest} - \underbrace{\pi_{t-1}}_{inflation} + \underbrace{s_t}_{spread} \Big) + \varepsilon_t^y + \varepsilon_t^d$$

- **Phillips curve** extended with spreads:

$$\pi_t = \beta^\pi \pi_{t-1} + \beta^y y_{t-1} + \beta^s s_{t-1} + \varepsilon_t^\pi$$

- **Taylor rule** with effective lower bound:

$$r_t = \max[\bar{r}, (1-\phi^r)(\phi^\pi \pi_t + \phi^y y_t) + \phi^r r_{t-1} + \varepsilon_t^r]$$

- Shocks $\varepsilon_t^y, \varepsilon_t^\pi, \varepsilon_t^r$ are AR(1) processes with iid shocks.
- ε_t^d is a deleveraging shock

Model: the financial block

- **Credit demand**:

$$\underbrace{b_t}_{credit} = \gamma^y y_t + \gamma^b b_{t-1} - \gamma^r (r_t - \pi_{t-1} + s_t) + \varepsilon_t^b + \varepsilon_t^d$$

- Borrowing spreads/**Credit supply**:

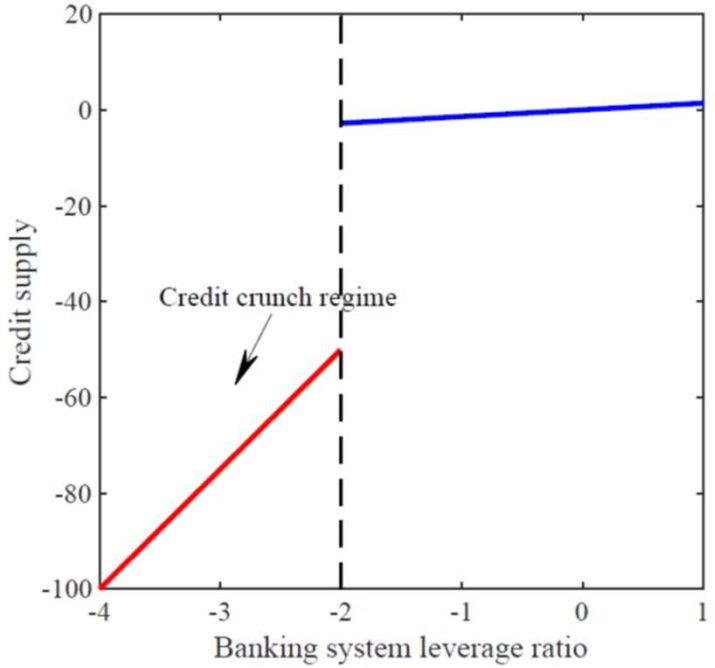
$$s_t = f^s s_{t-1} + f^b b_t - \tilde{f^{kb}} \underbrace{k_{t-1}}_{capital\ ratio} + \varepsilon_t^s$$

- **Bank capital ratio** evolution:

$$k_t = \delta^k k_{t-1} - \delta^r \Delta r_t + \delta^s (r_{t-1} + s_{t-1}) + \varepsilon_t^k$$

- Shocks $\varepsilon_t^b, \varepsilon_t^s$ are AR(1) processes with iid shocks.
- The variable ε_t^k captures banks' (pro-cyclical) credit losses $\varepsilon_t^k = \nu^y y_{t-1} + \rho^k \varepsilon_{t-1}^k + u_t^k$

Nonlinear constraints



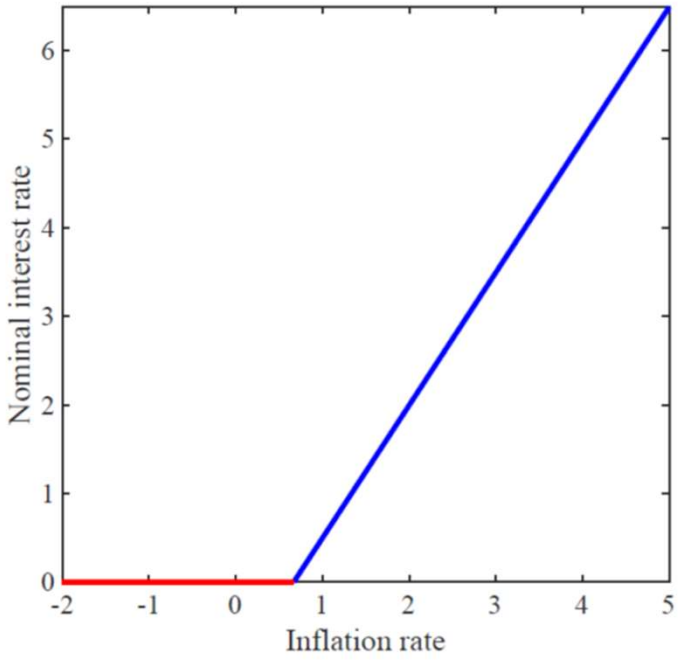


FIGURE A.III: Baseline results and single-indicator model

Decomposition of GDP-at-Risk 3-years ahead: US