Getting in all the Cracks: Monetary Policy, Financial Vulnerabilities, and Macro Risk

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¹ Disclaimer: The views expressed herein are those of the author and do not represent the position of the Federal Reserve Board, or of the Federal Reserve System.

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"While monetary policy may not be quite the right tool [to pursue financial stability], it has one important advantage relative to supervision and regulation-namely that it gets in all of the cracks." Jeremy Stein, 2013.

Should monetary policy (MP) respond to the build-up of financial vulnerabilities that pose macroeconomic risks?

Post-GFC view:

• Vulnerabilities are best addressed through supervisory, regulatory and macroprudential tools.

Benchmark Framework

Cost-benefit analysis of "leaning against the wind" (LATW).

- Costs: Raising rates to LATW weakens the macro outlook.
- Benefits: LATW may lower vulnerabilities and risk of financial crisis.

Example: Svensson's view.

- MP affects crisis probability via nonfinancial borrowing ("credit"), only.
- Costs of LATW are likely to outweigh benefits.

Shortcomings of such frameworks

Lack of comprehensive empirical assessment of the effect of

- interest rates policy on wider range of vulnerabilities
- vulnerabilities on macro risks

Objective of this paper: quantify terms of trade-off.

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This Paper

Assess potential:

Costs: MP \longrightarrow Macro Outcomes

$$\frac{dY^M_{t+h|t}}{dR_t}$$

Benefits: MP \longrightarrow Vulnerabilities \longrightarrow Macro Risk

$$\frac{dPr(Y_{t+h}^{M} \leq q|t)}{dR_{t}} = \underbrace{\frac{dY_{t+h|t}^{V}}{dR_{t}}}_{A} \times \underbrace{\frac{dPr(Y_{t+h}^{M} \leq q|t)}{dY_{t+h|t}^{V}}}_{B}$$

• A: effect of change in policy rate, R_t , on vulnerabilities, $Y_{t+h|t}^V$:

• **B**: effect of change in vulnerabilities on macro tail risk $Pr(Y_{t+h}^M \leq q|t)$

This Paper

First step: MP \longrightarrow Vulnerabilities – Estimate Factor-Augmented proxy SVAR:

- extract common factors from large dataset of vulnerability indicators (Aikman et al., 2017). Model interaction with macro variables.
- study transmission of event-study MP shocks to macro variables and vulnerability factors and, "through the cracks", to vulnerabilities indicators.
 - caveat: focus on unexpected component of policy.

Second step: Vulnerabilities \longrightarrow Macro Risk – Exploit few vulnerability factors and estimate quantile regressions (QRs) to study:

• how vulnerabilities affect Growth and Inflation at risk.

Final Step: Compare Costs and Benefits of LATW.

Literature

Cost-benefit analysis of "leaning against the wind" (LATW): Svensson (2017, 2018), Gourio et al. (2017), Ajello et al. (2019), reviews in Adrian and Liang (2018).

Financial Conditions/Vulnerabilities and Growth at Risk: Adrian, Boyarchenko, Giannone (2016), Giglio, Kelley, Pruitt (2016), Caldara et al. (2022)., Adrian, Grinberg, and Liang (forthcoming).

Transmission of MPS on financial variables and/or via proxy SVARS: Kuttner (2001), Gertler and Karadi (2015), Gilchrist, Lopez-Salido and Zakrajsek (2015), Del Negro and Otrok, (2007) Jarocinski and Smets (2008), Kuttner, (2014), Miranda Agrippino-Ricco (2021), Swanson (2021).

FAVAR and DFM estimation: Bernanke et al. (2005), Stock and Watson (2012).

SVAR and QR: Forni, Gabetti, Sala (2021).

Preview of the Results - FAVAR

Does MP affect financial vulnerabilities? **Yes, with some trade-offs** across vulnerability classes.

Surprise MP tightening weakens the outlook and, on average, reduces financial vulnerabilities, with some trade-offs:

- **1** Moderate decrease in asset valuation pressure (higher price of risk).
- Ø Modest reduction in credit growth (lower quantity of risk).
- Modest slowdown in Mortgage Debt/GDP ratio (increased debt sustainability).
- **4** Mixed evidence on indicators of **quality of credit**.
 - Higher risky leverage (lower asset valuations)
 - Higher Debt over Income ratios.
 - Deterioration of most debt service ratios.

Preview of the Results - QR

Can vulnerabilities predict increased macro risk (crises)? Yes.

- lower asset valuation pressure predicts higher short-run risks.
- build-up in credit growth predicts higher medium-run risks.

Should monetary policy lean against vulnerabilities? Costs appear larger than benefits.

- A 100bps increase in the 2-year Treasury yield
 - short term (1 year): weakening outlook and sizable increase in downside macro risk, via lower asset valuation pressure.
 - left tail of one-year out predicted GDP growth shifts down by around 1%. Risk dissipates within one year.
 - medium term (2-to-3 years): modest, yet persistent, reduction in downside macro risk, via slower credit growth.
 - left tail of 2-to-3-year out GDP growth shifts up by 0.2% for two years, via slower credit growth.

The Data

Extensive dataset of indicators by Aikman, Kiley, Lee, Palumbo, and Warusawitharana (2017) to "map the heat" of system vulnerabilities.

- Asset Valuation Pressure (e.g., price to earning ratios for real estate, equity markets, credit spreads, lending standards, volatility).
- **Nonfinancial Leverage** (e.g., credit growth, debt service ratios, leverage ratios).
- Financial Leverage (e.g., bank and non-bank leverage).
- Funding risk, Maturity transformation (e.g., short-term debt reliance, runnability, maturity gap).

Class and Overall Indexes aggregate indicators and assess vulnerabilities relative to historical distribution.

Mixed-frequency unbalanced panel: balance sheet indicators interpolated monthly. Trending and near-unit-root variables transformed in 12-month differences.

FAVAR, parsimonious representation of joint dynamics of macro and financial vulnerability indicators.

- Macro Variables:
 - Policy indicator (2-year Treasury yield)
 - Inflation (PCE core)
 - GDP growth (monthly estimates from Caldara et al., 2022)
 - or Unemployment

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• Macro Variables:

$$X_t^M = [R_t, \pi_t, \Delta logGDP_t]$$

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- Financial Vulnerability Variables:
 - 41 vulnerability indicators, explained by K = 4 latent factors.
 - Asset valuation indicators include typical measures of financial conditions (credit spreads, lending standards, PE ratios...)

FAVAR, parsimonious representation of joint dynamics of macro and financial vulnerability indicators.

• Macro Variables:

$$X_t^M = [R_t, \pi_t, \Delta logGDP_t]$$

• Financial Vulnerability Variables:

$$Y_{i,t}^{V} = \Lambda X_t^{V} + \Omega \eta_{i,t}$$

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$$Y_{i,t}^{V} = \Lambda X_t^{V} + \Omega \eta_{i,t}$$

• Macro and vulnerability factors, $X_t = [X_t^M, X_t^V]$, interact dynamically in state equation.

$$X_t = \Phi(p)X_{t-1} + \Sigma \varepsilon_t$$

States follow unrestricted VAR(p=6) $\varepsilon_t \sim N(0, I)$, structural shocks $\perp \eta_{i,t}$.

Model Estimation

Two-step estimation:

- Factors X_t^V extracted via ML through Expectation Maximization algorithm on unbalanced panel with missing observations.
- State-equation VAR estimated by unrestricted OLS.
- Equivalent to one-step estimation via EM (Bańbura and Modugno, 2014).

Restrictions:

- PCA rotation: orthogonal X_t^V with $Cov(X_t^V) = I$ with diagonal $\Lambda\Lambda'$.
- Optimal number of factors $K^V = 4$ (Bai and Ng (2002) IC).
- Number of lags p = 6.

Sample period for model estimation: 1988.1 - 2020.2

Interested in identifying impact of Monetary Policy Shocks on state variables X_t .

Follow proxy SVAR literature with proxy IV (Gertler and Karadi, 2015), to estimate impact of shocs on on X_t .

• Miranda-Agrippino and Ricco (2021): changes in FF4 quotes around FOMC statement releases, netted of info component predicted by changes in Tealbook forecast. Sample period: 1991.7 - 2016.12

Robustness checks: Laubach, Kim, Wei, 2020; Swanson, 2021, Jarocinski, 2022, Bauer and Swanson, 2022.

Vulnerability Factors and Observables



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Vulnerability Factors and Observables



Costs of LATW: Effect of MPS on Macro Outcomes

 $\mathsf{MP} \longrightarrow \mathsf{Macro}\ \mathsf{Outcomes}$

 $\frac{dY_{t+h|t}^M}{dR_t}$

How do macro mean outcomes respond to policy tightening?

Costs of LATW: Effect of MPS on Macro Outcomes



Hawkish MP surprise: tightening of financial conditions, small drop in inflation, slowdown in GDP growth.

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Effect of MPS on Financial Vulnerabilities

$MP \longrightarrow Vulnerabilities \longrightarrow Macro Risk$



How do vulnerability factors respond to policy tightening?

Effect of MPS on Financial Vulnerabilities



- Impulse responses of vulnerability factors (in st. dev.)
- Green: lower vulnerabilities. Red: higher vulnerabilities.

Effect of Surprise Hike in 2005 - IRFs in Historical Context

Assume that in June 2005, the Committee surprised markets on the upside.

All other shocks left unchanged.

Hawkish surprise (around +100 bps on 2-year Treas. yield).

Use model to simulate macro outcomes and vulnerability indicators with and without the surprise tightening.

Aggregate vulnerabilities and use historical percentiles as an overall "heat" index, following methodology in Aikman et al.(2017).

Lucas' critique applies.

IRFs in Historical Context



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Benefits of LATW: Effect of Vulnerabilities on Macro Risk

$$\frac{dPr(Y_{t+h}^{M} \leq q|t)}{dR_{t}} = \underbrace{\frac{dX_{t+h|t}^{V}}{dR_{t}}}_{A} \times \underbrace{\frac{dPr(Y_{t+h}^{M} \leq q|t)}{dX_{t+h|t}^{V}}}_{B}$$

We looked at A through the model, now focus on B.

Benefits of LATW: Quantile Regressions

Estimate univariate Quantile Regressions (QRs) of predicted macro outcome, Y_{t+h}^M , on vulnerabilities:

$$Y_{t+h}^{M} = \sum_{i=1}^{4} \beta_{i,q} X_{i,t}^{V} + \beta_{Y^{M},q} Y_{t-1}^{M} + \varepsilon_{t,q}$$

- $Y_{j,t+h}^M$: observed h-period ahead macro outcome
- $\beta_{i,q}$ q-quantile response to one-stdev increase in factor $X_{i,t}^V$,
- Estimator β_q from generic model with LHS Y and RHS X minimize weighted absolute loss function.

$$\min_{\beta_q} \sum_{j: Y_j \geq X_j \beta_q}^N q|Y_j - X_j \beta_q| + \sum_{j: Y_j < X_j \beta_q}^N (1-q)|Y_j - X_j \beta_q|,$$

- Y_t^M : GDP growth, and PCE core inflation.
- Focus on medium-term (2-to-3 years) and short-term (1 year) horizons.



- Plot shows [0.1, 0.5, 0.9] quantile coefficients of Factor 1 on GDP growth at 2-to-3-year horizon. Medium Term.
- Higher debt growth increases downside risk to growth (+1 stdev factor 1 pushes 0.1-quantile down -0.5%)

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• Higher risk appetite modestly increase downside risk to growth (+1 stdev factor 2 pushes 0.1-quantile down -0.2%)



- Faster growth of Mortgage / GDP muted effect on downside risk to growth.
- Drop in net leverage of risky firms increases downside risk to growth (-1 stdev factor 4 pushes 0.1-quantile up +0.9%)



- Short horizon: higher vulnerabilities decrease downside risk to growth.
- Standard growth-at-risk result: lower risk appetite (drop in F2) predicts higher tail risk to growth.

Vulnerabilities \longrightarrow Inflation Risk



• Medium horizon: higher credit growth mildly **increases downside risk to inflation** (+1 stdev, 0.1-quantile down -0.06 ppt)

• Short horizon: higher credit growth mildly reduces downside risk to inflation (+1 stdev 0.1-quantile up +0.1 ppt)

Tying it together - Growth@Risk



• To quantify effect of rate hike on tail risk, we multiply 0.1-quantile QR coefficients (top) by impulse responses of factors (bottom).

Tying it together - Growth@Risk



In the medium run, decrease in downside risk.

Tying it together - Growth@Risk



- In the short run, increase in downside risk.
- How do costs and benefits compare?

G@R Trade-offs



100bps tightening delivers lower expected GDP growth and inflation, and:

- Short term: sizable increase in downside risk: -1.2% shift in left tail.
- Medium term: downside risk decreases by little, somewhat persistently: +0.2% shift in left tail.

Results are robust to:

- QR Model Selection, choosing factors/predictors that maximize out-of-sample *R*².
- Extraction of two factors via Partial Quantile Regressions (PQR),
 - estimating loadings on vulnerability indicators that best predict downside risk at short- and medium-term horizons.
- Including PQR factors directly into SVAR, to account for lagged and cross dependence.

Conclusions

- Monetary policy shocks affect a large set of financial stability indicators.
- In the wake of MP tightening shock:
 - Macro outlook weakens.
 - Credit growth slows down
 - Risk appetite subsides
 - Mortgage/GDP ratio slows down
 - However, some indicators of credit quality deteriorate.
- Taming risk appetite and credit growth:
 - can decrease tail risk in the medium term.
 - trade-off: medium-term decrease vs. short-term increase in tail risk.
- Quantitatively, short-term costs are sizable. Medium-term benefits of reduced downside risk are modest, yet persistent.

APPENDIX

Vulnerability Factors and Observables



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Vulnerability Factors and Observables



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- Is the effect of monetary policy on vulnerabilities state-dependent? Preliminary findings suggest it is and most effective in supporting outlook during downturns.
- Confirm results in parsimonious unified approach combining FAVAR and QR \longrightarrow MS-FAVAR (Caldara, Castaldi-Garcia, Cuba-Borda, Loria, 2020)
- Differentiate between shocks to policy rate, expected path, longer-maturity yields (QE).
- Look at the effect of changes in systematic component of policy (Sims, 1988; Wolf and McKay, 2021)

Effect of MPS on Macro Outcomes



Hawkish MP surprise: tightening of financial conditions, drop in inflation, increase in unemployment.

IRFs in Historical Context - Unemployment



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State-Dependent Effects of Monetary Policy on Vulnerabilities

Is effect of interest-rate policy on vulnerabilities state dependent?

$$\underbrace{\frac{dPr(Y_{t+h}^{V} \leq q|t)}{dR_{t}}}_{C}$$

C: effect of change in policy rate, R_t , on distribution of predicted vulnerabilities, $Pr(Y_{t+h}^V \leq q|t)$.

Quantile Regressions (QRs) to estimate effect of monetary policy shocks on predicted vulnerabilities.

$$X_{j,t+h}^{V} = \beta_{mps,q}^{j} MPS_{t} + \beta_{i,q} X_{j,t-1}^{V} + \varepsilon_{t,q}$$

X^V_{j,t+h}: observed h-period ahead vulnerability factor j
β^j_{ipps,q} q-quantile response of factor X^V_{it} to 1 ppt MP shock.

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State-Dependent Effects of Monetary Policy on Vulnerabilities



Vulnerabilities \longrightarrow Unemployment Risk



Through the Cracks of Aikman et al. (2017): Indexes by Vulnerability Class



Through the Cracks of Aikman et al. (2017): Non-Financial Leverage



Through the Cracks of Aikman et al. (2017): Non-Financial Business Leverage



- Debt Growth slows down
- Debt/Income ratios worsen
- Leverage and Debt Service of Risky Firms deteriorates.

Through the Cracks of Aikman et al. (2017): Asset Valuations



Through the Cracks of Aikman et al. (2017): Financial Leverage, Maturity and Liquidity Transformation



Preview of the Results - QR

Is the effect of monetary policy state-dependent? $\ensuremath{\textbf{Yes}}$

In expansions, leaning against the wind:

- Slows down Mortgage/GDP ratio.
- Puts downward pressure on risky business leverage
- However, taming vulnerabilities increases downside risk to the macro outlook at all horizons.
- Weak effect of policy on credit growth and risk appetite.

In recessions:

- MP most effective on credit growth and risk appetite.
- Easing policy supporting lending and asset valuations boosts macro outcomes
- Lean with the wind!

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π **QR** Trade-offs



Unexpected tightening delivers:

• Short and Medium term: modest increases in downside risk: -0.1%shift in left tail.

Baseline (gray) vs. VAR with EBP only (blue)



- Similar persistence
- More amplification if model interactions only with risk appetite (EBP)