A Semi-Structural Model with Household Debt for Israel

Alex Ilek and Nimrod Cohen

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Agenda

- Questions
- Stylized facts
- The Model
- Analysis
- Conclusions

Main questions

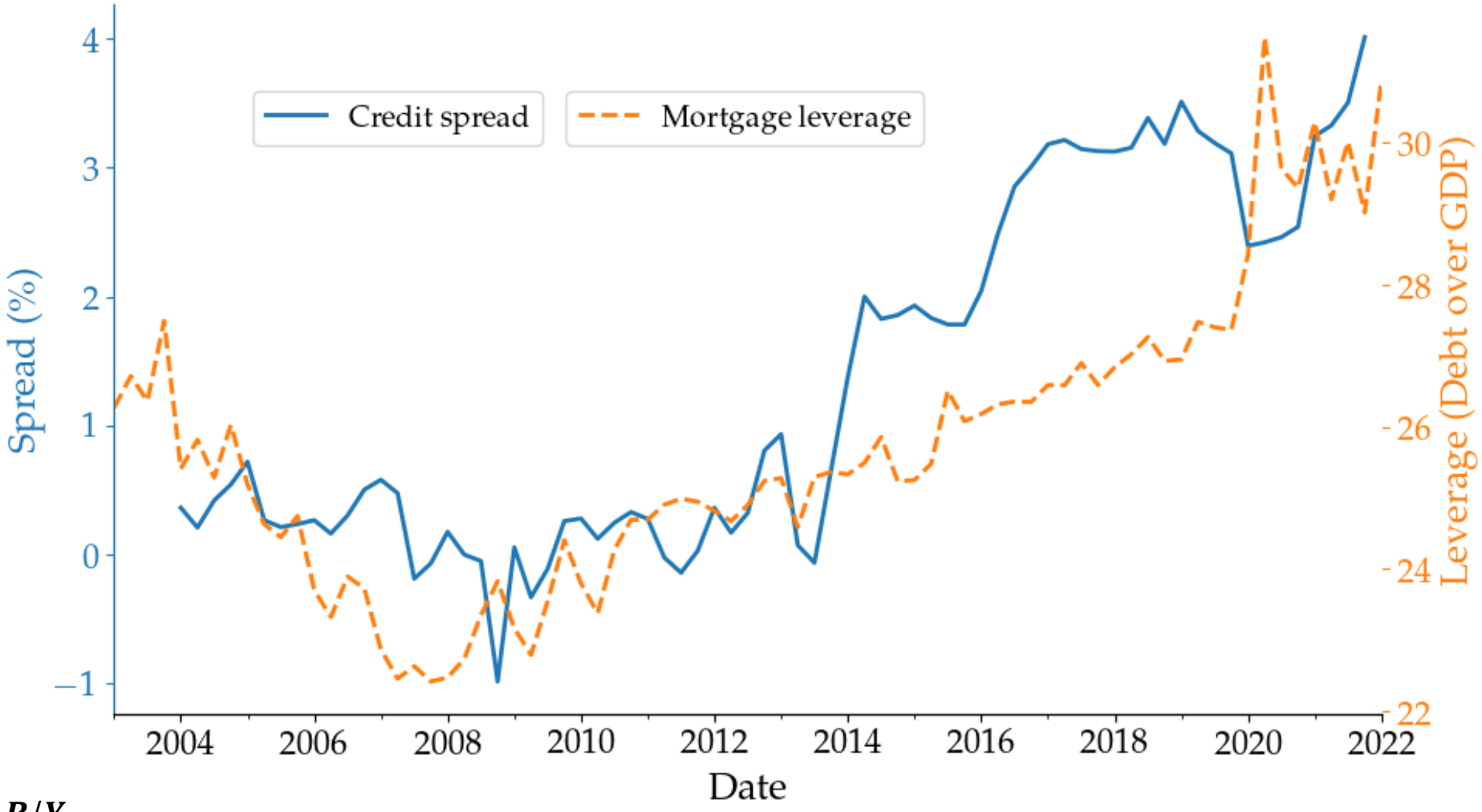
- We specify and calibrate a semi-structural DSGE model for Israel, which contains a financial friction in the households' credit market. Aim answering:
- What are the implications of the financial friction (and of macroprudential policy) on the economy?
- Should monetary interest rate react to financial variables, like credit spread or leverage?

STYLIZED FACTS & EMPIRICAL EVIDENCE FOR THE ISRAELI HOUSEHOLDS' CREDIT MARKET

Main Stylized facts for the Israeli households' credit market

- Borrowers are ~40% of the population.
- Households hold only domestic debt (~2/3 in mortgages).
- Positive relationship between credit spread and leverage.
  - Still valid after controlling for macroprudential measures.

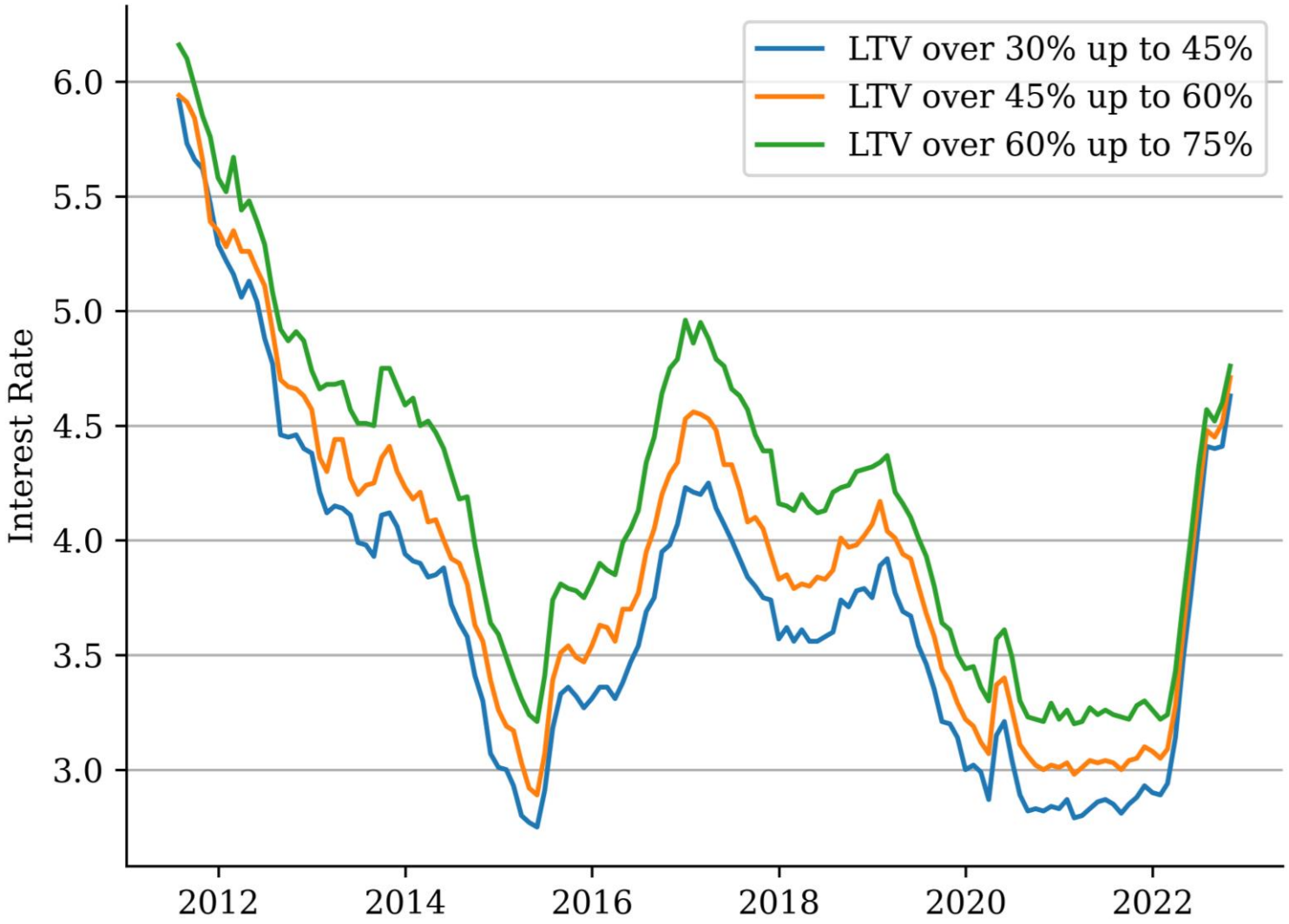
Positive Leverage-Spread relationship (for Israel)



* Leverage: $\boldsymbol{B/Y}$
* Spread: Mortgage weighted Interest Rate over capital market long term bonds (10 years)

Positive Leverage-Spread relationship (for Israel)

Average Mortgage Nominal Fixed Interest Rate, for various LTV



Positive Leverage-Spread relationship (for Israel)

- Relationship between credit spread and mortgage leverage:

$$spread_t^H = \underset{(0.00)}{-5.89} + \underset{(0.00)}{0.07} Lev_t^H - \underset{(0.00)}{0.16}\,\pi_t^H - \underset{(0.15)}{0.06}\,\pi_{t-1}^H - \underset{(0.06)}{0.07}\,\pi_{t-2}^H - \underset{(0.10)}{0.06}\,\pi_{t-3}^H$$

- Adding macro-prudential measures by interaction term, (e.g., LTV and PTI restrictions, increasing provisions or capital requirements) : $\gamma Lev_t^H \cdot dum_t$
  - The interaction coefficient is positive and significant.
  - The leverage coefficient is still positive (smaller) and significant.
- This relation is robust to alternative specifications of spread and leverage, also when we control for (average) maturity of mortgages.
- For non-housing credit we do not find significant relationship (due to very short sample available).

THE MODEL

The Model

- Semi-structural DSGE model for Israel
  - Small open economy [Laxton et al. (2006), Chen Zion (2021)]
  - Two type of agents: Lenders & Borrowers (micro-founded) [Benigno et al. (2020)]
  - Borrowers can borrow only domestically
  - Lenders can save domestically and abroad

The Economy

Phillips curve

$$\pi_t = A^{\pi}_{ld}\pi^{4q}_{t+4} + (1 - A^{\pi}_{ld})\pi^{4q}_{t-1} + A^{y}\widehat{y}_{t-1}$$
$$+A^{\pi}_{z}\Delta z_t + A^{\pi}_{oil}\pi^{oil}_{t} + A^{\pi}_{oil,lag}\pi^{oil}_{t-1} + \varepsilon^{\pi}_{t}$$

UIP equation for real exchange rate

$$z_t = D^{z}_{zld}z_{t+1} + (1 - D^{z}_{zld})z_{t-1} - (r_t - r^{*}_{t} - \Delta^{fx}_{t})$$

Country risk premia

$$\Delta^{fx}_{t} = \Delta z^{n}_{t} + (r^{n}_{t} - r^{nw}_{t}) + \varepsilon^{fx}_{t}$$

IS equation

$$\hat{y}_t = \beta^{y}_{yld}\widehat{y}_{t+1} + (1 - \beta^{y}_{yld})\widehat{y}_{t-1} - \beta^{y}_{r}\widehat{r}_{t-1} + \beta^{y}_{z}\widehat{z}_{t-1} + \beta^{y}_{y^w}\widehat{y}^{w}_{t}$$

monetary stance

$$\widehat{r}_t = r_t - r^{n}_{t}$$

Benchmark Real IR

$$r^{n}_{t} = \alpha + \alpha^{NRI}_{g} g^{n}_{t+1} + \alpha^{NRI}_{g^w} g^{w}_{t+1} - \alpha^{NRI}_{\Delta}\widehat{\Delta}_t - \chi^{NRI}_{cb}\Delta\varepsilon^{cb}_{t+1}$$

Contractionary effect

+ Potential Growth + World economy

Credit Block

Leverage ratio $\widehat{lev}_t = \hat{b}_t - \hat{y}_t$

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Interest rate spread $\widehat{\Delta}_t = i_t^b - i_t$

Equation for spread $\widehat{\Delta}_t = \beta_{lev}^{\Delta} \widehat{lev}_t + \varepsilon_t^{\Delta}$

Credit Block

Leverage ratio $\widehat{lev}_t = \hat{b}_t - \hat{y}_t$

Interest rate spread $\hat{\Delta}_t = i^b_t - i_t$

Equation for spread $\hat{\Delta}_t = \beta^{\Delta}_{lev}\widehat{lev}_t + \varepsilon^{\Delta}_t$

Borrowers Euler equation $\hat{c}^b_t = \beta^{c^b}_{ld}\hat{c}^b_{t+1} + (1-\beta^{c^b}_{ld})\hat{c}^b_{t-1}$

$$-\beta^{c^b}_{r}(\hat{R}^b_t - (\pi_{t+1} - \overline{\pi}) + v\ \widehat{lev}_t - \hat{g}^n_{t+1}) - \Delta\varepsilon^{cb}_{t+1}$$

Budget constraint of borrowers $\hat{b}_t = \hat{R}^b_t + \beta^b_{lag}\left(\hat{b}_{t-1} - (\pi_t - \overline{\pi}) - \hat{g}^n_t\right) + \beta^{c^b}_b\hat{c}^b_t - \beta^y_b\hat{y}_t$

Monetary Policy

$$i_t = G^i_{lag} i_{t-1} + (1 - G^i_{lag})(r^n_t + \overline{\pi} + G^i_{\pi} \begin{pmatrix} w(\pi^{4q}_{t+4} - \overline{\pi}) + \\ (1-w)(\pi^{4q}_t - \overline{\pi}) \end{pmatrix} + G^i_y \widehat{y}_t) + \varepsilon^i_t$$

Benchmark
Real IR

ANALYSIS

Implications of Financial Frictions & Macro-prudential Policy (MP)

$$\widehat{\Delta}_t = \beta_{lev}^{\Delta} \widehat{lev}_t + \varepsilon_t^{\Delta}$$

Credit Supply Shock

- Leverage-elasticity of the Spread $\beta_{lev}^{\Delta} = \beta_{lev}^{PB} + \beta_{lev}^{MP}$

Implications of Financial Frictions & Macro-prudential Policy (MP)

$$\widehat{\Delta}_t = \beta^{\Delta}_{lev}\widehat{lev}_t + \varepsilon^{\Delta}_t$$

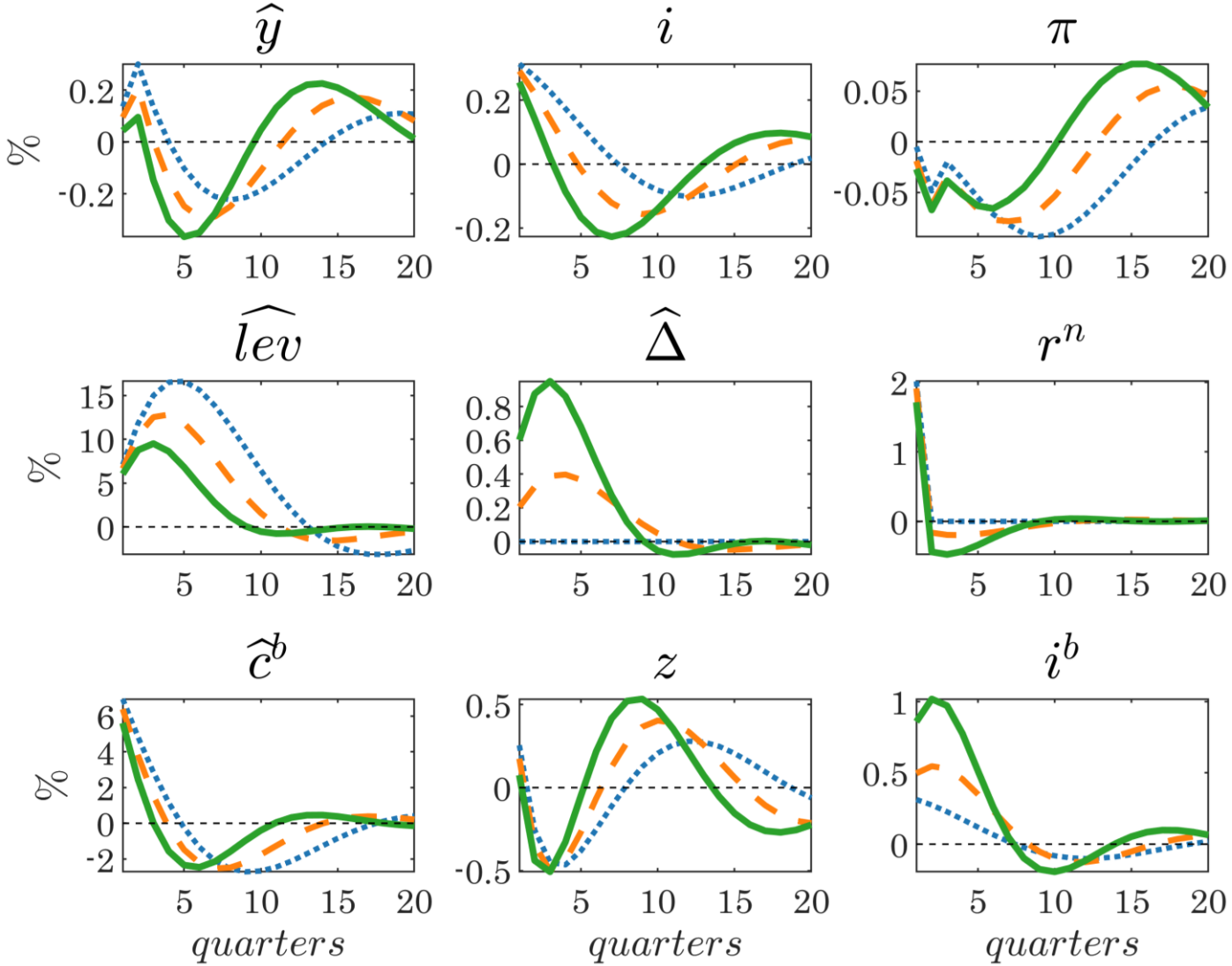
- Leverage-elasticity of the Spread

$$\beta^{\Delta}_{lev} = \beta^{PB}_{lev} + \beta^{MP}_{lev}$$

  - without financial friction and MP: $\beta^{\Delta}_{lev} = 0$
  - with financial friction (estimated): $\beta^{\Delta}_{lev} = 0.031$
  - with tight macro-prudential policy: (calibrated for exercise) $\beta^{\Delta}_{lev} = 0.1$

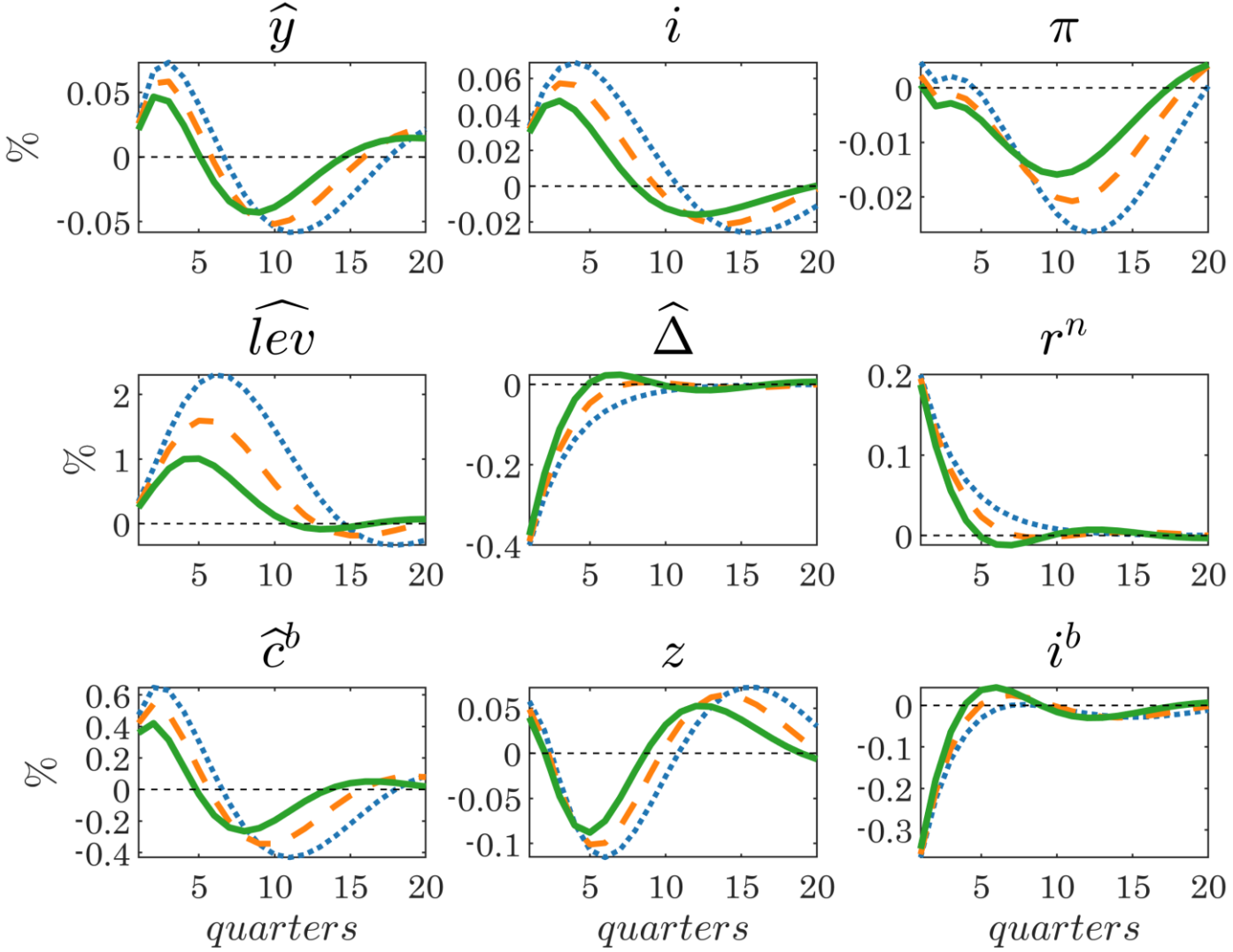
Positive Credit Demand Shock

- Increase in Borrowers' demand gives rise to leverage buildup
- Macro-prudential policy (*ex-ante/prevention policy*) has trade-off:
  - Benefit: Rising spread mitigates increase in leverage
  - Cost: Weaker real activity



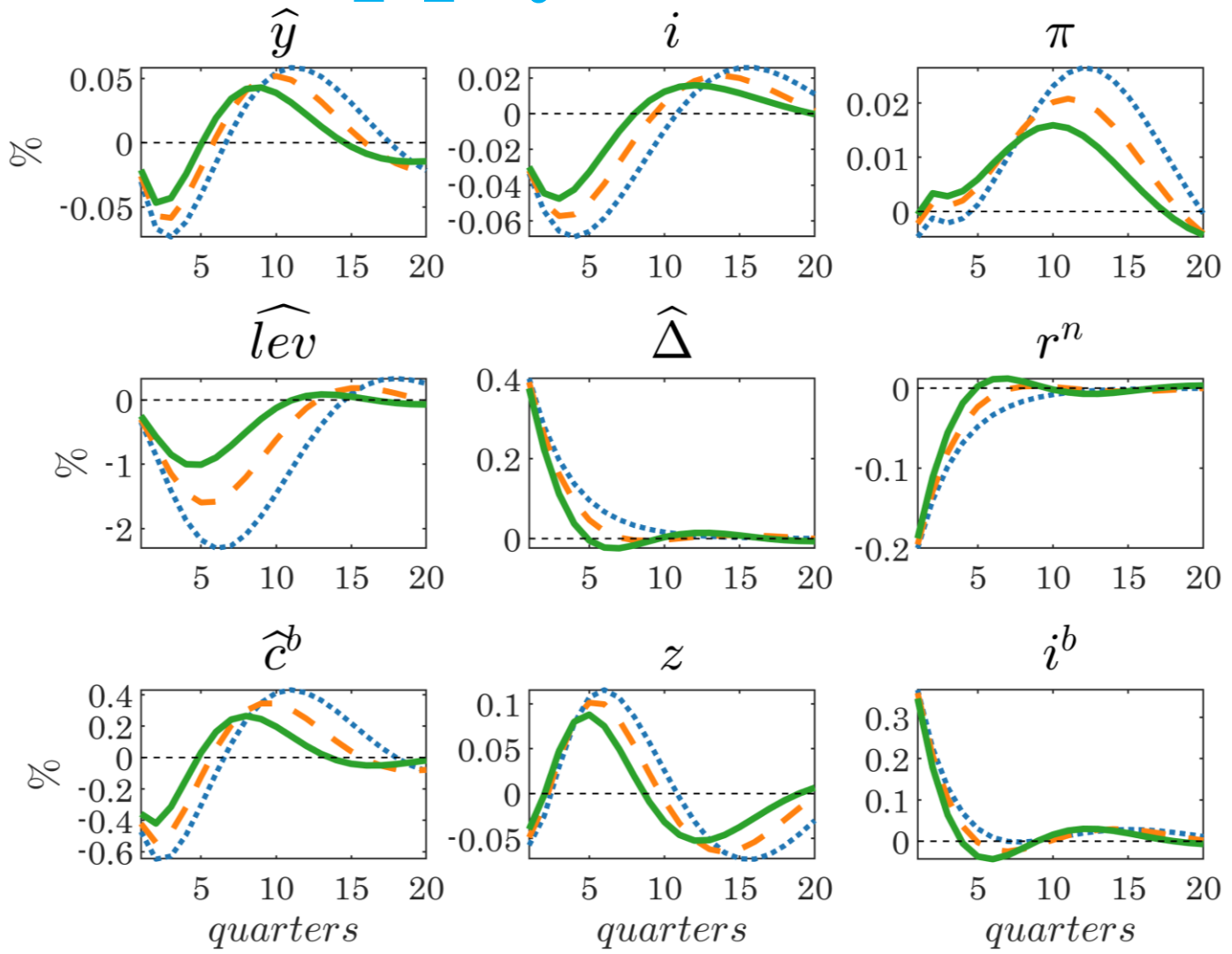
Positive Credit Supply Shock

- Negative spread shock results in credit easing and economic expansion
- **Macro-prudential** policy (*ex-ante policy*) – limits excess credit buildup



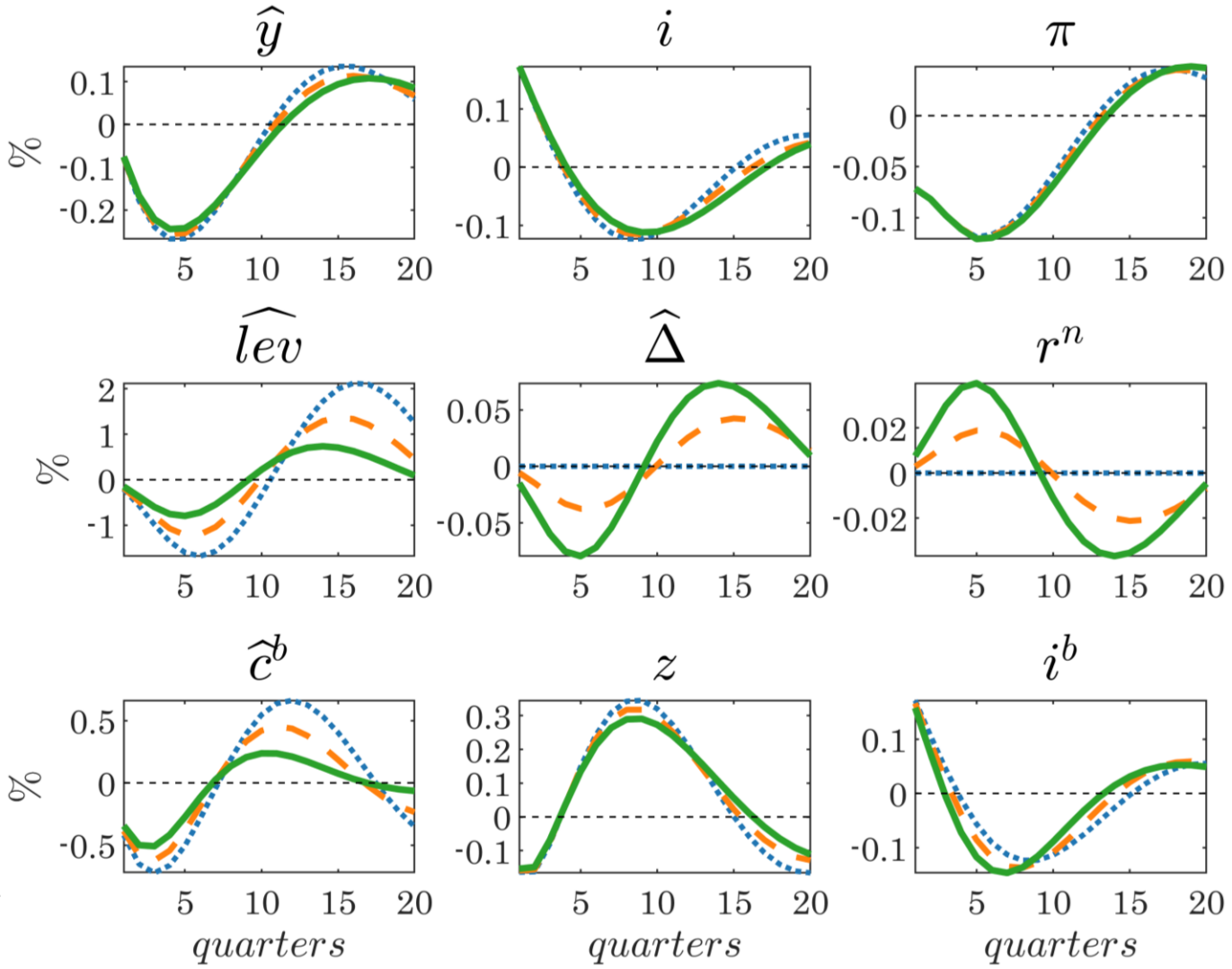
Negative Credit Supply Shock

- Positive spread shock results in debt deleveraging and recession
- Under **macro-prudential policy** (*ex-post policy*)
  - as the borrowers deleverage the spread is reduced
  - thus, we get weaker deleveraging and smoother path for all macro variables



Monetary Policy Shock

- A fall in output and households' debt.
- Decline in leverage and spread → financial **decelerator** (mitigates the effect of shock rather than amplifies it)



Financial Accelerator or Decelerator?

- Do credit spreads rise or fall after a monetary policy tightening?

	Financial Accelerator	Financial Decelerator
Model	BGG 1999	Curdia & Woodford 2016
Empirics	Gertler and Karadi 2015	Brzoza-Brzezina at el. 2016

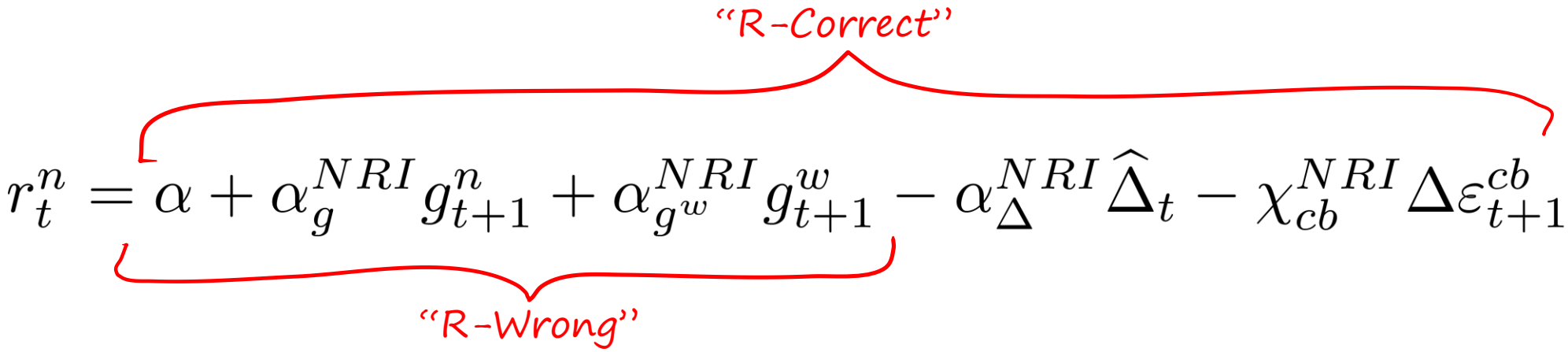
- What about Israel?
  - In the calibrated model we get decelerator, which is robust for all acceptable calibrations
  - Empirically:

$$spread_t^H = \underset{\text{-0.75}}{\alpha \epsilon_t^{mon}} + \beta X_{t-1} + \gamma Z_t + u_t$$

MONETARY POLICY ANALYSIS

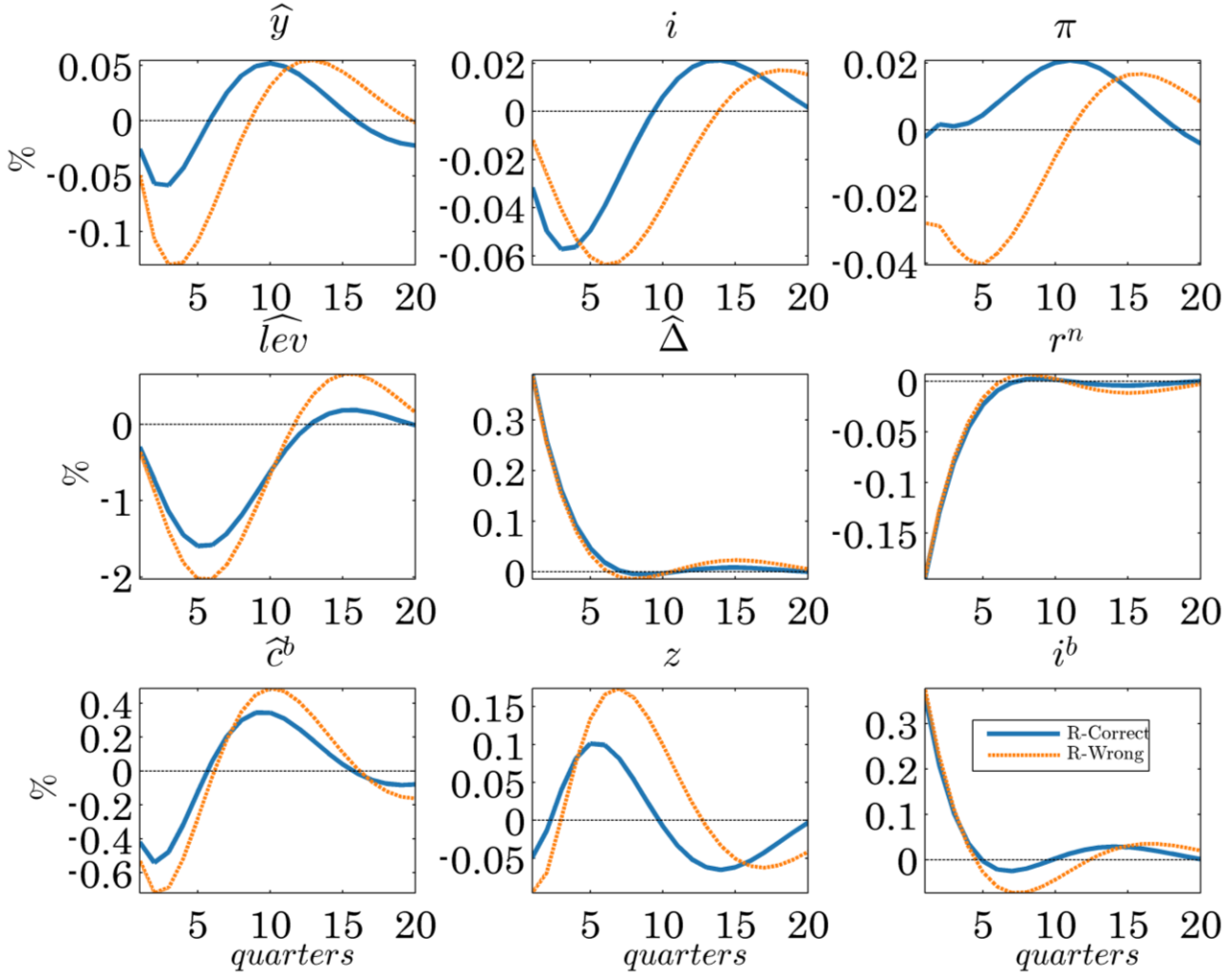
What if CB ignores the financial sector?

- **"R-Correct"** : CB reacts to correct benchmark real interest rate
- **"R-Wrong"** : CB reacts to misspecified benchmark real interest rate (ignores last two components)



What if CB ignores the financial sector?

- e.g., negative credit supply shock:
- spread negatively affects real activity (in lag), but CB doesn't response to it.
- In line with (Adrian 2020, CW 2016): under the correct policy rule the responses are much less volatile



R-Wrong: CB reacts to wrong benchmark IR.
R-Correct: CB reacts to correct benchmark IR.

What if CB ignores the financial sector?

- If CB ignores the financial sector ("R-Wrong"):
  - Credit spread negatively affects real activity, and the CB doesn't response to it (previous slide)
  - The CB ignores also credit demand shocks
- In total – The CB **"loss function"**:

$$var(\pi_t - \pi) + \alpha \cdot var(\hat{y}_t)$$
$$var(\pi_t - \pi) + \alpha \cdot var(\Delta y_t - g_t^n)$$
$$var(\pi_t - \pi) + \alpha \cdot var(\hat{y}_t) + \beta \cdot var(\Delta i_t)$$
$$var(\pi_t - \pi) + \alpha \cdot var(\Delta y_t - g_t^n) + \beta \cdot var(\Delta i_t)$$

	R-Correct	R-Wrong	
Loss	Case 1:FI	Case 2: PI	Ratio
Version 1	0.08	0.24	3.12
Version 2	0.26	0.56	2.18
Version 3	0.25	0.28	1.13
Version 4	0.43	0.60	1.40

CONCLUSIONS

Main conclusions

- Households' credit spreads positively depend on leverage (in Israel).
- Macro-prudential policy can strengthen the sensitivity of the spread to leverage, as evident in the Israeli data (based on MP measures history).
- Consequentially,
  - Macro-prudential policy can mitigate over-borrowing and reduce risk of future default crises. However, this could be at the cost of a weaker real activity.
  - And may have expansionary effect on real activity in case of demand weakness or deleveraging (ex-post).
- Monetary policy may lose effectiveness to achieve its main goals if it ignores developments in the credit market, such as credit spread and leverage.

THANK YOU

APPENDIXES

Reference

- Adrian, Duarte, Liang, and Zabczyk, 2020, Monetary and Macroprudential Policy with Endogenous Risk. *IMF Working Papers*.
- Benigno, Eggertsson and Romei, 2020. Dynamic Debt Deleveraging and Optimal Monetary Policy. *American Economic Journal: Macroeconomics*
- Cúrdia and Woodford. 2010, Credit Spreads and Monetary Policy. *Journal of Money, Credit and Banking*
- Cúrdia and Woodford, 2016, Credit Frictions and Optimal Monetary Policy. *Journal of Monetary Economics*
- *Gertler, Mark, and Peter Karadi. Monetary Policy Surprises, Credit Costs, and Economic Activity. American Economic Journal: Macroeconomics 7, no. 1 (January 1, 2015)*
- Goodfriend and McCallum. 2007. Banking and Interest Rates in Monetary Policy Analysis: A Quantitative Exploration. *Journal of Monetary Economics*

Calibration

Parameter		Value	Source or Target
Elasticity of the Spread to Debt-GDP	β^{Δ}_{lev}	0.031	Appendix A
Elasticity of the NRI to 1. Spread	α^{NRI}_{Δ}	0.5	Benigno et al. (2020) and authors considerations
2. Domestic expected potential growth	α^{NRI}_{g}	0.4	Ilek and Segal (2022)
3. Actual growth abroad	$\alpha^{NRI}_{g^*}$	0.6	Ilek and Segal (2022)
4. Preference shock	α^{NRI}_{cb}	0.2	Authors calibration
Elasticity of the Output Gap to NRI	β^{y}_{r}	-0.1	Argov et al. (2012), Ilek and Segal (2022)
Euler equation of borrowers			
Borrowers' debt aversion	v	$(0.0225, 1.25)$	Benigno et al. (2020) and authors considerations
	$\beta^{c^b}_{r}$	$\beta^{y}_{r} \times 5$	Cúrdia and Woodford (2016) and authors considerations

Adrian et al. 2020: **Monetary and Macroprudential Policy** with Endogenous Risk

- How monetary and macroprudential policy could reduce risks to financial stability? Jointly or Separately?
- Stylized model: Financial frictions give rise to a "financial accelerator" term in the IS curve:

$$y_t^{gap} = \boldsymbol{E}_t y_{t+1}^{gap} - \frac{1}{\sigma}\boldsymbol{E}_t\left(i_t - \pi_{t+1}\right) - \frac{1}{\sigma}spr_t - \frac{1}{\sigma}V(\boldsymbol{X}_{t-1})\epsilon_t^{ygap}$$

Negative effect of financial conditions (spread) on real activity

$$SPR_t = (1-b)\,\sigma_0 + bSPR_{t-1} - (1+\theta)\,b\sigma_1\epsilon_t + \theta b^2\sigma_1\epsilon_{t-1}$$

- Fit well to stylize facts. But, "*Clearly, our setup is too stylized to provide answers to such questions, which we believe would be worth studying in a model with a fully micro-founded specification for financial conditions.*"

Cúrdia and Woodford 2010, 2016 and Benigno et al. 2020

- [All]: Reduced-form intermediation technology: a positive relationship between households' credit spread and their leverage.
- *[CW]:"an adjustment for variations in credit **spreads** can improve upon the standard Taylor rule, but the optimal size of adjustment depends on the source of the variation in credit spreads. A response to the **quantity** of credit is less likely to be helpful."*
- [All]: No macroprudential policy analysis