Leaning Against the Credit Cycle[1]

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[1]Any views expressed here are those of the authors, and not those of Norges Bank, the European Central Bank or the Federal Reserve Bank of San Francisco.

Introduction

- Recent monetary policy debate: Emphasis on debt
  - Credit typically moves gradually and persistently over time
    - The *"Credit cycle"* (Drehman, Borio, Tsatsaronis, 2012, etc)
  - Schularik and Taylor (2012): Debt matters for the risk and cost of crises
    - *"... policymakers ignore credit at their peril"*
  - Mason and Jayadev (2014): Household leverage largely driven by income growth, inflation and interest rates rather than new borrowing.
  - Svensson (2013): Interest rate hikes likely to raise debt-to-GDP
    - Do not address a high debt-to-GDP ratio with interest rate hikes

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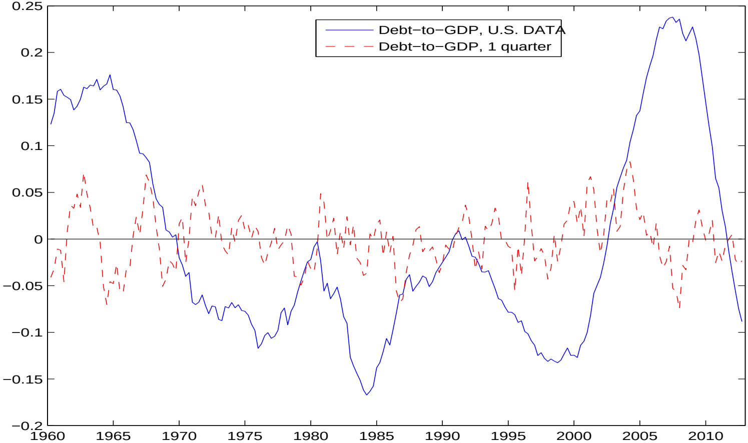
    - Do not address a high debt-to-GDP ratio with interest rate hikes
- **Problem:** Standard DSGE models used for monetary policy analysis do not account well for debt dynamics
  - Key assumption: All debt fully amortized each period.

Mortgage Debt Dynamics – Data vs Standard Model

- **Problem:** Standard DSGE models used for monetary policy analysis do not account well for debt dynamics
  - Key assumption: All debt fully amortized each period.



Our Paper

- Monetary policy in a simple New Keynesian model with long term debt
  - Collateral constraint (Iaccoviello, 2005)
  - Long term debt – only new loans constrained

  - Q1: What is the likely effect of an interest rate hike on the aggregate debt burden?
  - Q2: What are the consequences of mechanically raising the interest rate in response to debt?
  - Q3: What characterizes Debt-to-GDP targeting vs. Inflation targeting?

- Estimate a medium scale DSGE model
  - Is long-term debt quantitatively relevant?
  - Do the answers to Q1-Q3 hold within richer, estimated model and more shocks?

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- Monetary policy in a simple New Keynesian model with long term debt
  - Q1: What is the likely effect of an interest rate hike on the aggregate debt burden?
    - *Small, persistent, possibly positive in the short run.*
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  - Q1: What is the likely effect of an interest rate hike on the aggregate debt burden?
  - Q2: What are the consequences of mechanically raising the interest rate in response to debt?
    - *Indeterminacy*
    - *Debt-to-GDP stabilized only by a* **negative** *debt-to-GDP response*
  - Q3: What characterizes Debt-to-GDP targeting vs. Inflation targeting?
- Estimate a medium scale DSGE model
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  - Q1: What is the likely effect of an interest rate hike on the aggregate debt burden?
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  - Q3: What characterizes Debt-to-GDP targeting vs. Inflation targeting?
    - *Whenever inflation targeting implies a debt-to-GDP* ***increase****, debt-to-GDP stabilization implies a more* ***expansionary*** *policy*

- Estimate a medium scale DSGE model
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- Estimate a medium scale DSGE model
  - Is long-term debt quantitatively relevant?
    - *Correlation patterns in model closer to empirical (US) counterparts*
  - Do the answers to Q1-Q3 hold within richer, estimated model and more shocks?

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  - Do the answers to Q1-Q3 hold within richer, estimated model and more shocks?
    - *Yes.*

Our Paper

- Key mechanism: “Fisher dynamics”

Related Literature

- "Credit cycle": Drehman et al. (2012), Aikman et al. (2013), Strohsal et al. (2015), Runstler and Vlekke (2015), Iacoviello (2015), Galati et al. (2016)
- Monetary policy and debt-to-GDP: Svensson (2013), Laséen and Strid (2013), Robstad (2014), Alpanda and Zubairy (2016), Bauer and Granziera (2016)
- Multiperiod debt: Campbell and Hercowitz (2004), Rubio (2011), Kydland et al. (2012), Justiniano et al. (2013), Garriga et al. (2013), Calza et al. (2013), Chen et al. (2013), Andrées et al. (2014), Guerrieri and Iacoviello (2015)
- Debt and inflation: Mason and Jayadev (2014), Gomes et al. (2014)

Simple NK Model with Housing and Long-Term Debt

- Two household types: Savers (patient) and Borrowers (impatient)
  - Borrowing subject to collateral constraint on new loans only
  - Reduced form law of motion for amortization as in Kydland, Rupert and Sustek (2013)
- Firms owned by Savers
- Central bank
- Fixed supply of houses
- Calvo pricing, price indexation and consumption habits

Household Problem

Maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t \left(c_t, h_t, L_t \right),$$

subject to budget and borrowing constraints:

$$c_{b,t} + q_t (h_{b,t} - h_{b,t-1}) + \frac{1 + r_{t-1}}{\pi_t} b_{b,t-1} = w_{b,t} L_{b,t} + b_{b,t},$$

$$b_{b,t} = \vartheta m \frac{E_t \left(q_{t+1} \pi_{t+1} \right) h_{b,t}}{1 + r_t} + (1 - \vartheta) \left(1 - \delta_{t-1} \right) \frac{b_{b,t-1}}{\pi_t}.$$

- ϑ = refinancing share
- δ_t amortization share

Amortization Process

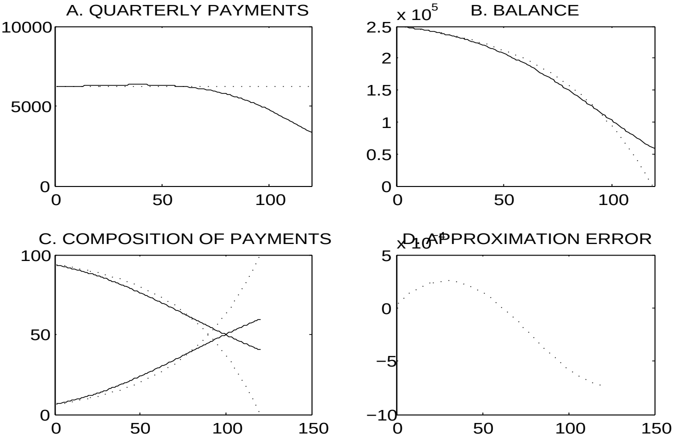
$$\delta_t \;=\; \left(1 - \frac{l_t}{b_t}\right)\delta_{t-1}^{\alpha} \;+\; \frac{l_t}{b_t}\,(1-\alpha)^{\kappa}\,,$$

where

$$l_{b,t} = b_{b,t} - (1-\delta_{t-1})\,\frac{b_{b,t-1}}{\pi_t}$$

- $\alpha \in [0,1)$ and $\kappa > 0$ are parameters and
- l_t/b_{t+1} is the share of new annuity loans in the end-of-period outstanding stock of debt.

Debt Contract



Calibration

- Steady state targets
  - Share of liquidity constrained, relative hours worked and relative labor incomes in Justiniano, Primiceri and Tambalotti (2013)
  - Ratio of housing wealth to yearly consumption in Iaccoviello and Neri (2010)
  - Approximate 30-year annuity loan contract, as in Kydland, Rupert, Sustek (2013)
  - Household debt-to-housing value equal to 0.5

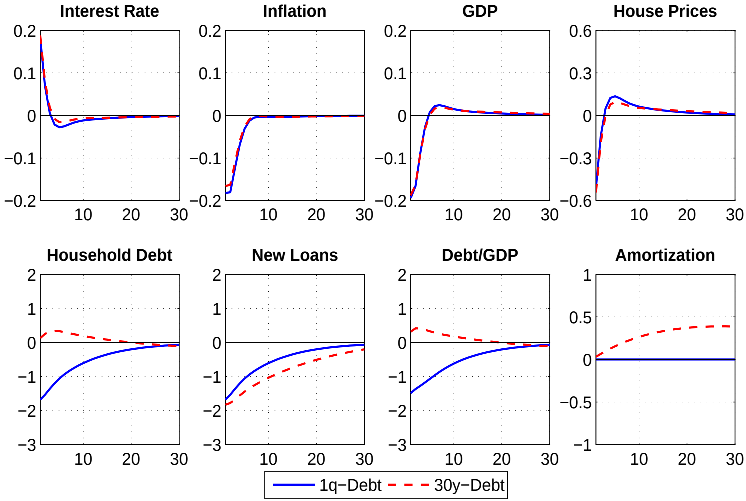
Calibration

- Steady state targets
  - Share of liquidity constrained, relative hours worked and relative labor incomes in Justiniano, Primiceri and Tambalotti (2013) (n, $\nu_{l,l}$, $\nu_{l,b}$, ϖ)
  - Ratio of housing wealth to yearly consumption in Iaccoviello and Neri (2010) (ν_h)
  - Approximate 30-year annuity loan contract, as in Kydland, Rupert, Sustek (2013) (κ, α)
  - Household debt-to-housing value equal to 0.5 (ϑ)

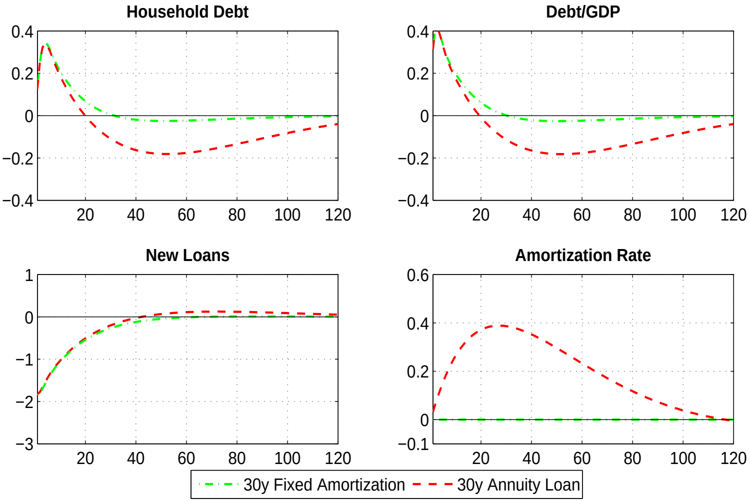
Table: Parameter Values

β_l	0.99	φ	1	ε	6	m	0.8
β_b	0.97	ϵ	0.5	θ	0.75	ρ_z	0.9
ν_h	0.075	n	0.61	ι	0.5	ϑ	0.031
$\nu_{l,l}$	0.10	ϖ	0.5	κ	1.013	ϕ_π	1.5
$\nu_{l,b}$	0.23	ξ	0.33	α	0.996	ϕ_r	0.75

Monetary Policy Shock



Slow-Moving Debt Burden and Variable vs Constant Amortization Rate



Policy Implication?

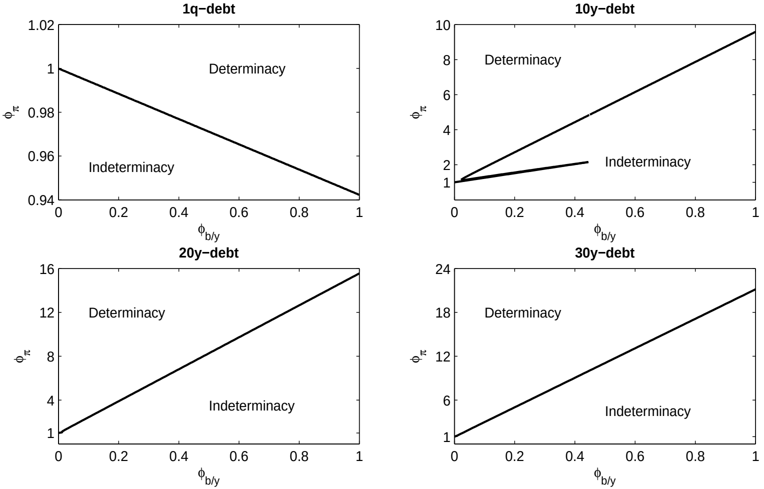
- If we accept that tighter monetary policy raises the debt burden:
  - What is the implication for systematic monetary policy?

- First approach: What are the consequences of letting the interest rate systematically respond to debt-to-GDP?

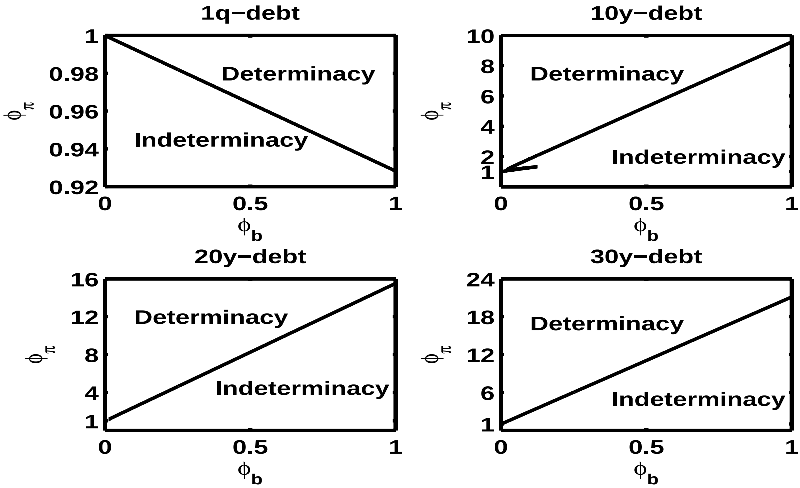
- Simple policy rule

$$R_t = (1+r)\ \pi_t^{\phi_\pi} \left(\frac{b_t}{y_t}\right)^{\phi_{b/y}}$$

Determinacy Analysis – Reacting to Debt-to-GDP



Determinacy Analysis – Reacting to the Real Debt Level



Determinacy Analysis. Intuition

1q-debt:

- An increase in inflation expectations unjustified by fundamentals causes:
  $\Rightarrow$ lower real interest rate

  $\Rightarrow$ relaxation of the collateral constraint
  $\Rightarrow$ increased debt

  - Response to debt implies stronger response to inflationary pressure

Determinacy Analysis. Intuition

30y-debt:

- An increase in inflation expectations unjustified by fundamentals causes:
  $\Rightarrow$ lower real interest rate

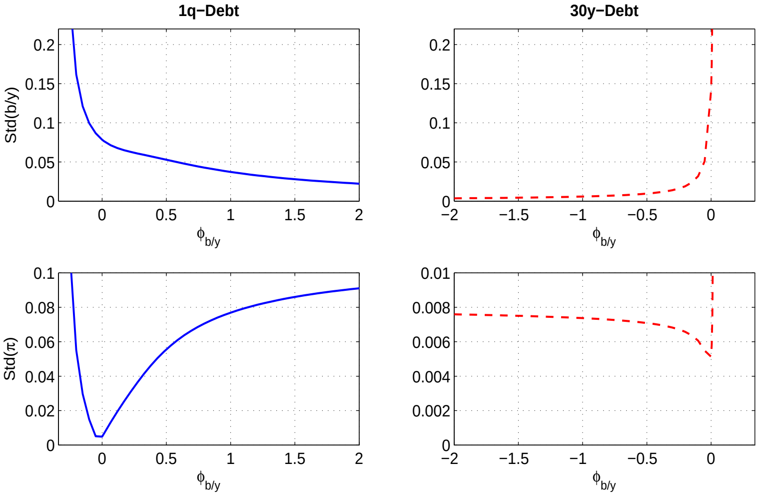
  $\Rightarrow$ relaxation of the collateral constraint
  $\Rightarrow$ increased uptake of new loans

  ... but pre-existing debt is unaffected

  $\Rightarrow$ total stock of real debt (-to-GDP) falls due to higher *current* inflation

  - Response to debt implies weaker response to inflationary pressure

Debt and Inflation Volatility under Simple Policy Rules



An Estimated Medium Scale DSGE Model

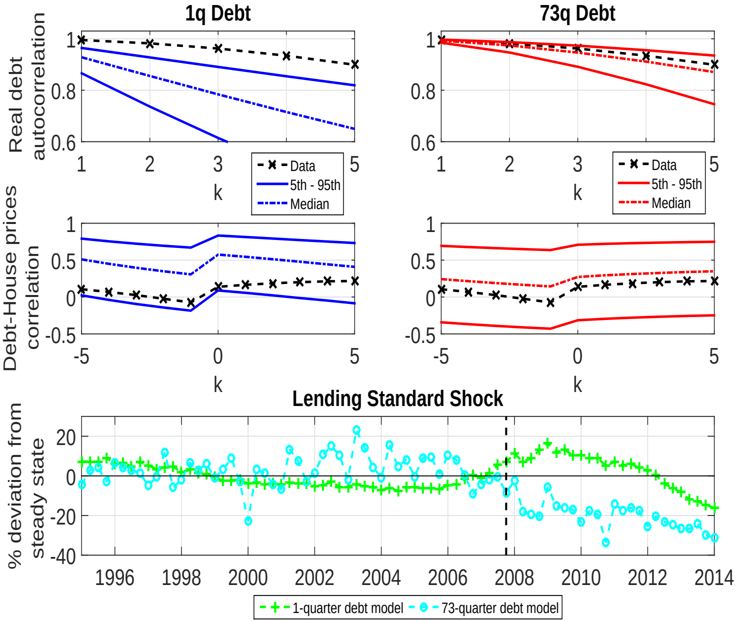
- Do the above findings generalize?

An Estimated Medium Scale DSGE Model

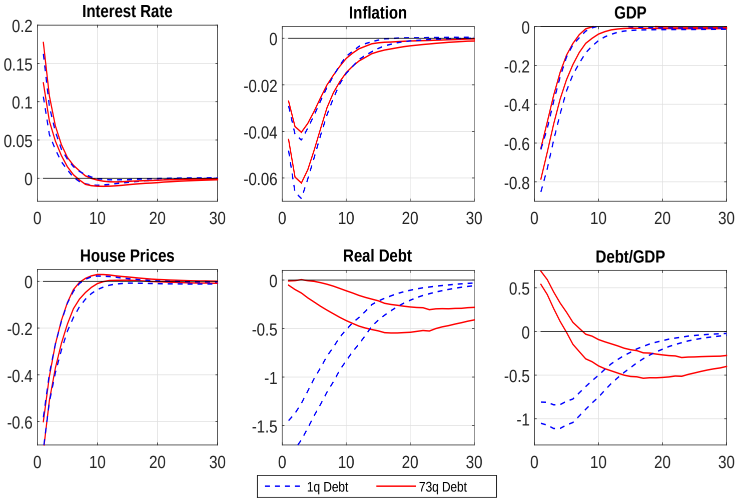
- Richer model of housing and the macro economy: Iacoviello and Neri (2010)
  - Housing construction sector, adjustment costs, etc.
- Model evaluation: Estimation, likelihood comparison, key moments in data vs. model, narrative of 2000s' boom-bust episode
  - Household debt as observable (unlike Iacoviello and Neri, 2010)
- More shocks (10)
- Upshot of estimation:
  - Estimated debt duration: 73 quarters
  - AR-coefficient on ltv-shocks drops from 0.98 to 0.73
  - 1q model: log data density of 6128
  - 73q model: log data density of 6418 ("Decisive evidence", Kass and Raftery, 1995)

Estimates Housing and LTV Shocks

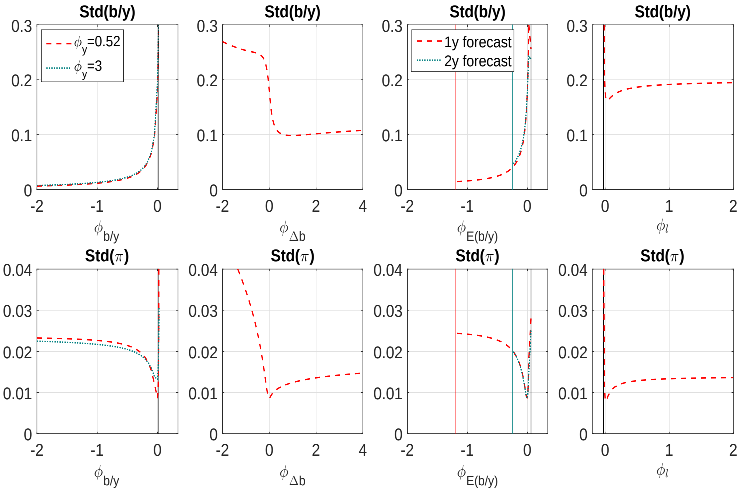
Model Evaluation



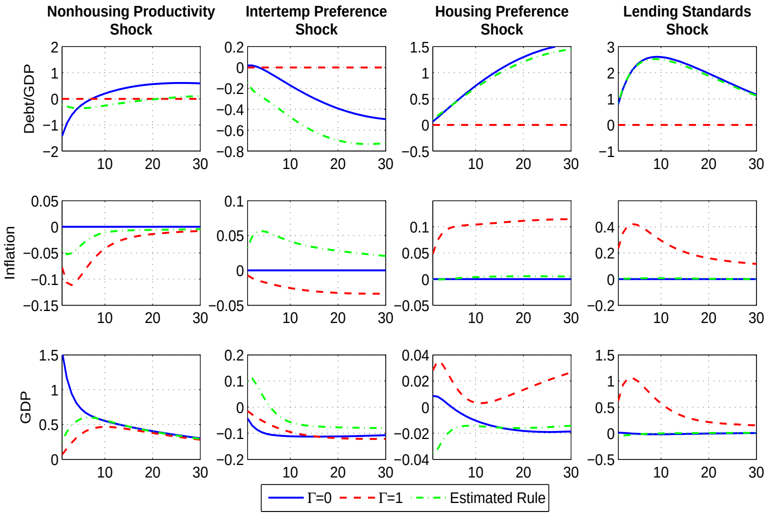
Monetary Policy Shock - Estimated Model



Debt and Inflation Volatility under Simple Policy Rules - Estimated Model



Debt-to-GDP vs. Inflation Targeting - Estimated Model



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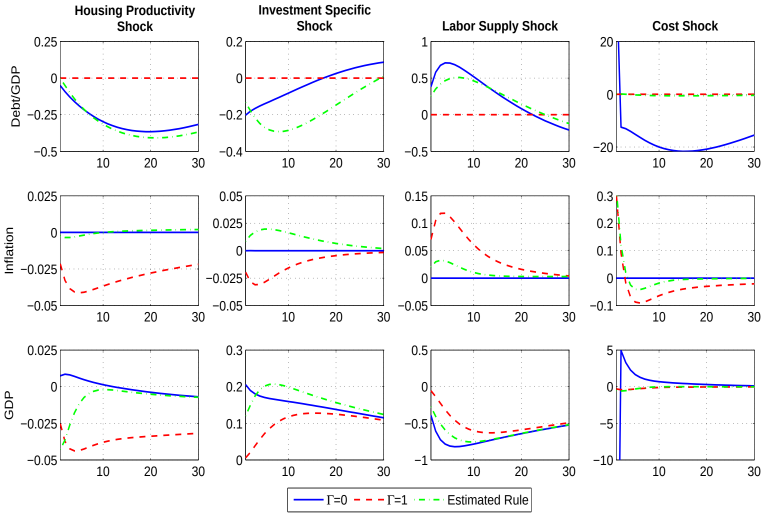


Conclusion

- A tractable model with gradual amortization process captures persistent nature of debt dynamics à la *"credit cycle"*
  - Captures the low contemporary correlation and the lead-lag relationship between debt-to-GDP and house prices

- Policy tightening has minor, but persistent, effect on debt
  - Might even *raise* households' debt-to-GDP in the short run (consistent with Svensson, 2013, Granziera and Bauer, 2016, Robstad, 2015)

- Mechanically increasing the interest rate in response to the debt-to-GDP level causes equilibrium indeterminacy
  - Opposite under 1-quarter-debt
  - Destabilizes debt itself
  - Responding negatively to debt-to-GDP stabilizes debt

Conclusion

- Debt-to-GDP targeting implies *more contractionary* policy than inflation targeting, when the latter makes debt-to-GDP *decrease*.

- Debt-to-GDP targeting implies *more expansionary* policy than inflation targeting, when the latter makes debt-to-GDP *increase*.

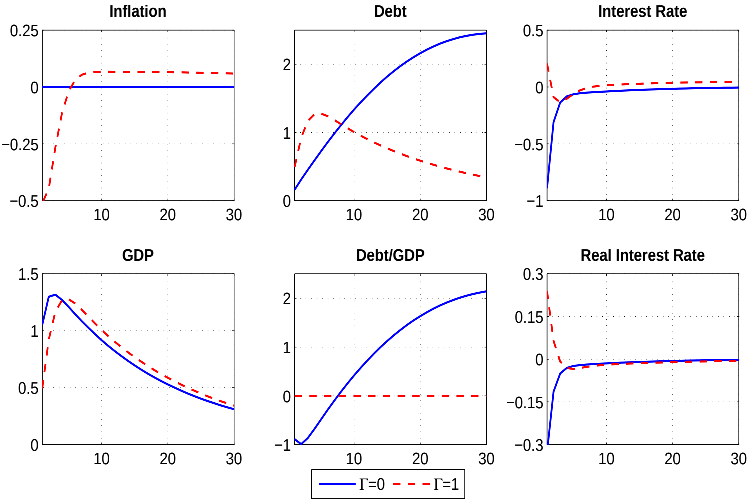
$\Rightarrow$ *"Fisher Dynamics"* are key to how monetary policy should deal with high indebtedness.

Debt-to-GDP vs. Inflation Targeting

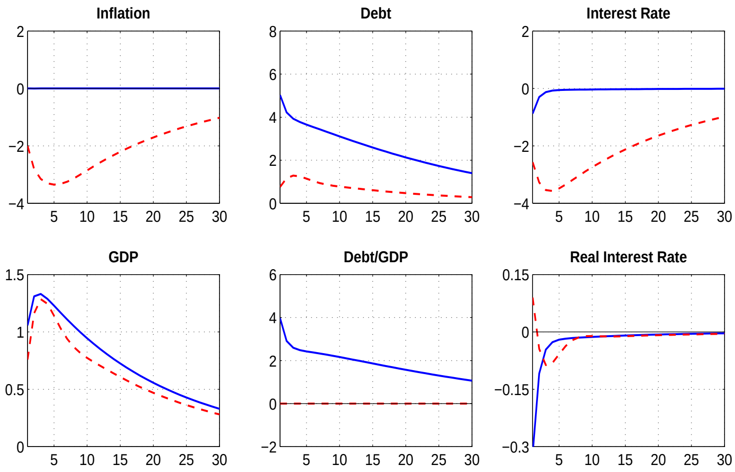
Set i_t so as to minimize:

$$\sum_{j=0}^{\infty} \beta_l^j \left[(1-\Gamma) \left((1-\lambda_y)\, \pi_{t+j}^2 + \lambda_y \left(\frac{y_{t+j}}{y_{t+j}^f} \right)^2 \right) + \Gamma \left(\frac{b_{b,t+j}/y_{t+j}}{b_b/y} \right)^2 \right]$$

Debt-to-GDP vs. Inflation Targeting, 30y-debt



Debt-to-GDP vs. Inflation Targeting, 1q-debt



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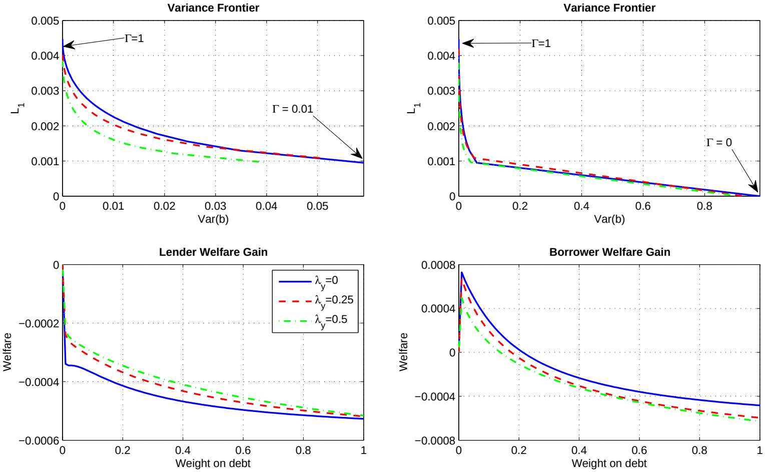
Variance Frontiers and Welfare under Targeting Policies



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Estimation: Structural Parameters

Table 2: Estimation: Prior and Posterior Distribution of the Structural Parameters

	Prior distribution			Posterior distribution			
				1-quarter debt model		Long-term debt model	
Parameter	Distribution	Mean	SD	Median	90% HPD	Median	90% HPD
γ_l	Beta	0.5	0.075	0.29	0.22 – 0.36	0.26	0.20 – 0.32
γ_b	Beta	0.5	0.1	0.42	0.31 – 0.55	0.51	0.41 – 0.62
$\varphi_{L,l}$	Gamma	0.5	0.1	0.39	0.27 – 0.53	0.42	0.30 – 0.51
$\varphi_{L,b}$	Gamma	0.5	0.1	0.54	0.38 – 0.70	0.48	0.34– 0.71
μ_l	Normal	1	0.1	-0.05	-0.08 – -0.02	-0.05	-0.08 – -0.03
μ_b	Normal	1	0.1	1.18	1.02 – 1.31	1.12	0.96 – 1.31
$\phi_{k,c}$	Gamma	10	2.5	20.14	17.09 – 23.29	20.85	18.45 – 23.57
$\phi_{k,h}$	Gamma	10	2.5	10.60	6.76 – 15.02	9.58	7.03 – 12.57
ϖ	Beta	0.65	0.05	0.65	0.57 – 0.73	0.62	0.56 – 0.69
ϕ_R	Beta	0.75	0.1	0.61	0.55 – 0.66	0.63	0.57 – 0.68
ϕ_π	Normal	1.5	0.1	1.42	1.32 – 1.51	1.40	1.31 – 1.50
ϕ_y	Normal	0	0.1	0.56	0.46 – 0.65	0.52	0.44 – 0.68
θ	Beta	0.667	0.05	0.89	0.87 – 0.91	0.89	0.87 – 0.91
υ	Beta	0.5	0.2	0.52	0.41 – 0.65	0.55	0.45 – 0.66
$\theta_{w,c}$	Beta	0.667	0.05	0.77	0.73 – 0.81	0.76	0.72 – 0.80
$\iota_{w,c}$	Beta	0.5	0.2	0.08	0.02 – 0.15	0.07	0.02 – 0.14
$\theta_{w,h}$	Beta	0.667	0.05	0.77	0.72 – 0.81	0.75	0.72 – 0.81
$\iota_{w,h}$	Beta	0.5	0.2	0.40	0.21 – 0.60	0.42	0.23 – 0.61
ζ	Beta	0.5	0.2	0.78	0.66 – 0.91	0.80	0.68 – 0.92
δ	Normal*	0.10	0.02	1	–	0.0307	0.0223 – 0.0412
Log data density				6131.05		6415.67	

*Notes: The median implied value of ϑ is 0.59 in the 1-quarter debt model, and 0.042 in the long-term debt model. * The prior distribution for δ refers only to the long-term debt model because $\delta = 1$ with 1-quarter debt. The sample is 1965q1 to 2014q1.*

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Estimation: Shock Processes

Table 3: Estimation: Prior and Posterior Distribution of the Shock Processes

	Prior distribution			Posterior distribution			
				1-quarter model		Long-term debt model	
Parameter	Distribution	Mean	SD	Median	90% HPD	Median	90% HPD
ρ_z	Beta	0.8	0.1	0.95	0.93 – 0.97	0.96	0.94 – 0.98
ρ_{AH}	Beta	0.8	0.1	0.996	0.991 – 0.999	0.996	0.992 – 0.999
ρ_{AK}	Beta	0.8	0.1	0.92	0.90 – 0.95	0.93	0.90 – 0.95
ρ_{v_h}	Beta	0.8	0.1	0.97	0.95 – 0.99	0.98	0.96 – 0.99
ρ_c	Beta	0.8	0.1	0.96	0.86 – 0.99	0.96	0.95 – 0.99
ρ_{ν_l}	Beta	0.8	0.1	0.97	0.95 – 0.99	0.97	0.95 – 0.99
ρ_m	Beta	0.8	0.1	0.98	0.96 – 0.99	0.78	0.68 – 0.87
σ_z	Inv. Gamma	0.001	0.01	0.0100	0.0091 – 0.0110	0.0100	0.0091 – 0.0110
σ_{AH}	Inv. Gamma	0.001	0.01	0.0213	0.0195 – 0.0233	0.0216	0.0198 – 0.0236
σ_{AK}	Inv. Gamma	0.001	0.01	0.0107	0.0089 – 0.0126	0.0111	0.0096 – 0.0127
σ_{ν_h}	Inv. Gamma	0.001	0.01	0.0382	0.0271 – 0.0508	0.0335	0.0237 – 0.0452
σ_R	Inv. Gamma	0.001	0.01	0.0032	0.0027 – 0.0037	0.0030	0.0027 – 0.0034
σ_c	Inv. Gamma	0.001	0.01	0.0123	0.0047 – 0.0288	0.0122	0.0078 – 0.0185
σ_{ν_l}	Inv. Gamma	0.001	0.01	0.0196	0.0161 – 0.0236	0.0192	0.0157 – 0.0233
σ_p	Inv. Gamma	0.001	0.01	0.0039	0.0035 – 0.0044	0.0039	0.0035 – 0.0044
σ_s	Inv. Gamma	0.001	0.01	0.0280	0.0211 – 0.0348	0.0276	0.0216 – 0.0339
σ_m	Inv. Gamma	0.001	0.01	0.0180	0.0165 – 0.0196	0.1069	0.0764 – 0.1368
$\sigma_{L,h}$	Inv. Gamma	0.001	0.01	0.1647	0.1511 – 0.1793	0.1624	0.1495 – 0.1787
$\sigma_{\omega,h}$	Inv. Gamma	0.001	0.01	0.0051	0.0047 – 0.0056	0.0050	0.0047 – 0.0056

Notes: $\sigma_{L,h}$ and $\sigma_{\omega,h}$ are standard deviations for measurement errors in hours worked and wages in the housing sector. The sample is 1965q1 to 2014q1.

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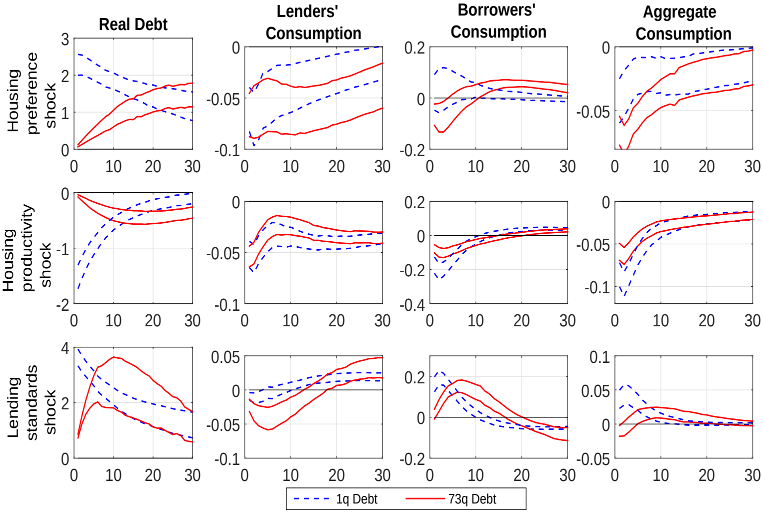
Credit and Housing Shocks - Estimated Model

When does debt duration matter if monetary policy does not react to debt?



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