A Macroeconomic Model of Equities and Real, Nominal, and Defaultable Debt

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Workshop on Asset Pricing Theory and Computation
Stanford Institute for Theoretical Economics
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Motivation

Goal: Show that a simple macroeconomic model (with Epstein-Zin preferences) is consistent with a wide variety of asset pricing facts

- equity premium puzzle
- long-term bond premium puzzle (nominal and real)
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Implications for Macro:

- show how to match risk premia in DSGE framework
- start to endogenize asset price–macroeconomy feedback

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- rare disasters: Rietz (1988), Barro (2006), et al.
- long-run risks: Bansal-Yaron (2004) et al.
- heterogeneous agents: Mankiw-Zeldes (1991), Guvenen (2009), Constantinides-Duffie (1996), Schmidt (2015), et al.
- financial intermediaries: Adrian-Etula-Muir (2013)

Households

Period utility function:

$$u(c_t, l_t) \equiv \log c_t - \eta \frac{l_t^{1+\chi}}{1+\chi}$$

- additive separability between c and l
- SDF comparable to finance literature
- log preferences for balanced growth, simplicity

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Calibration: (IES $= 1$), $\chi = 3$, $l = 1$ ($\eta = .54$)

Generalized Recursive Preferences

Household chooses state-contingent $\{(c_t, l_t)\}$ to maximize

$$V(a_t;\theta_t) \;=\; \max_{(c_t,l_t)} u(c_t,l_t) - \beta\alpha^{-1}\log\left[E_t \exp(-\alpha V(a_{t+1};\theta_{t+1}))\right]$$

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Calibration: $\beta = .992$, RRA (R^c) $= 60$ $\quad (\alpha = 59.15)$

Firms

Firms are very standard:

- continuum of monopolistic firms (gross markup λ)
- Calvo price setting (probability $1-\xi$)
- Cobb-Douglas production functions, $y_t(f) = A_t k^{1-\theta} l_t(f)^\theta$
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Calibration: $\lambda = 1.1$, $\xi = 0.8$, $\theta = 0.6$, $\sigma_A = .007$, $(\rho_A = 1)$, $\frac{k}{4Y} = 2.5$

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No government purchases or investment:

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Calibration: $\phi_\pi = 0.5$, $\phi_y = 0.75$, $\overline{\pi} = .008$, $\rho_{\bar{y}} = 0.9$

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Divide nonstationary variables (Y_t, C_t, w_t, etc.) by A_t

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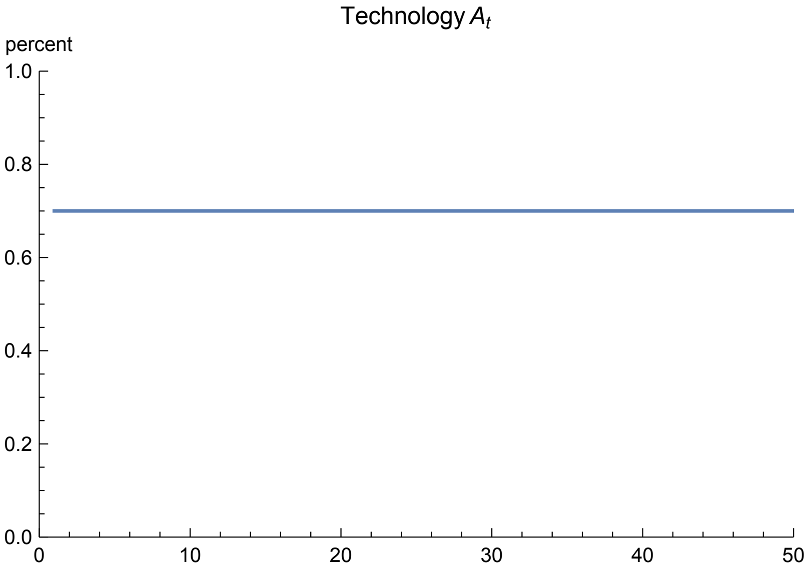
Model has 2 endogenous state variables ($\bar{y}_t$, Δ_t), one shock (ε_t)

Impulse Responses



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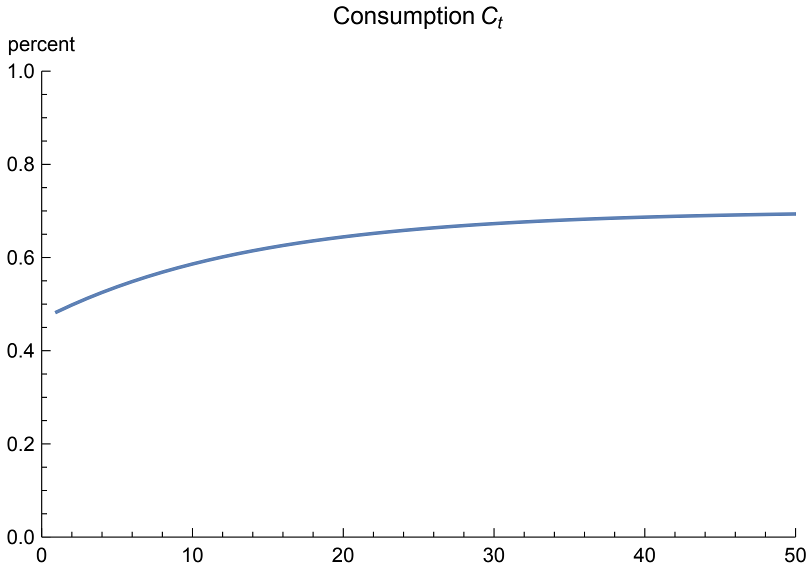

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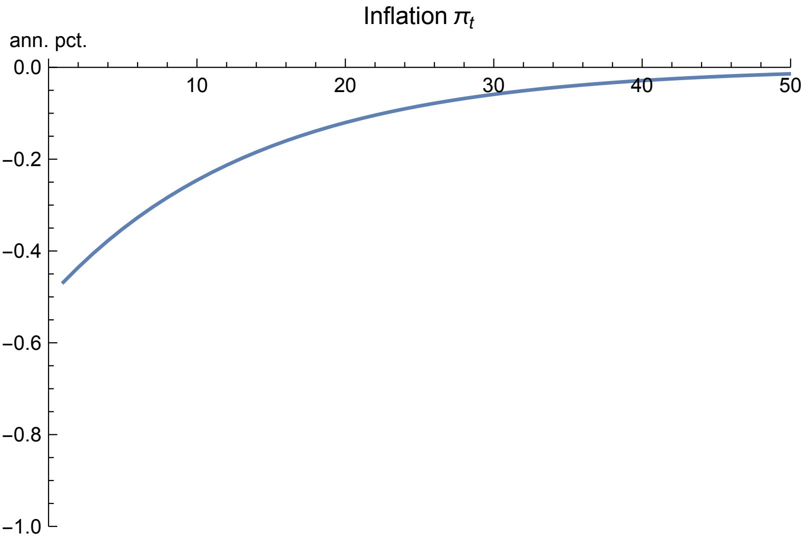

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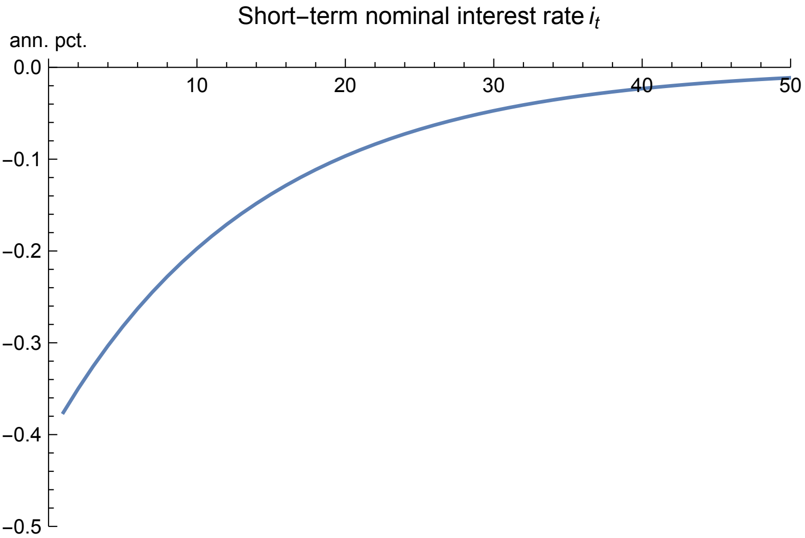

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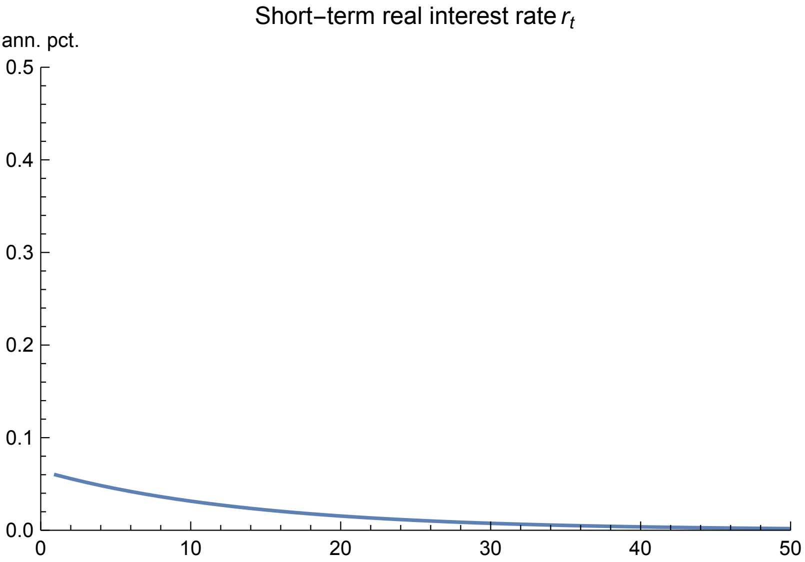

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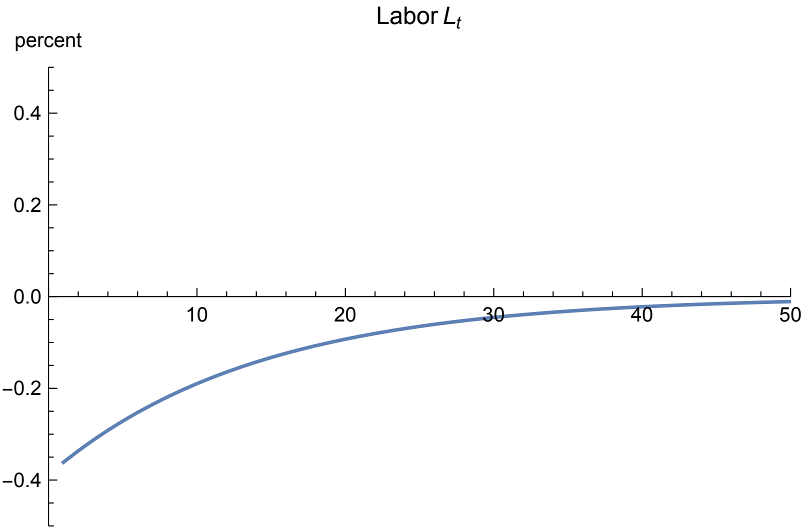

Equity: Levered Consumption Claim

Equity price

$$p_t^e = E_t m_{t+1}(C_{t+1}^{\nu} + p_{t+1}^e)$$

where ν is degree of leverage

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Calibration: $\nu = 3$

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60	.99	1.08
60	.98	0.53
60	.95	0.17

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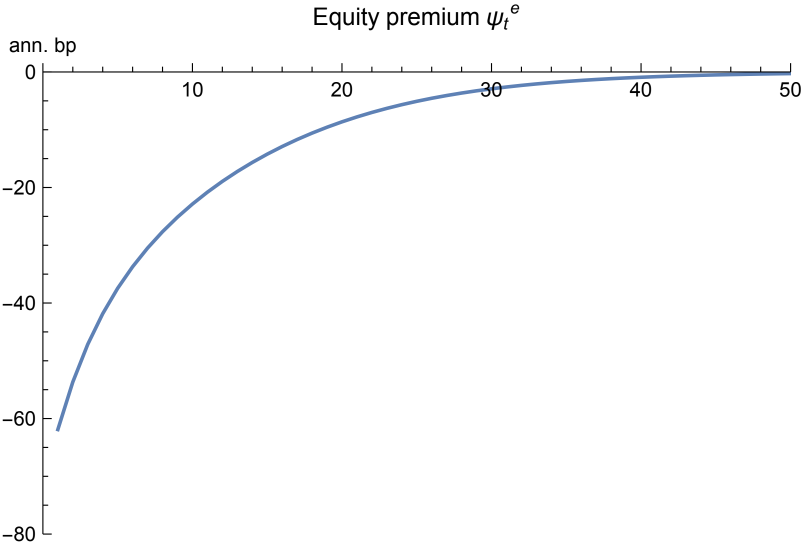

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Real Yield Curve

Table 3: Real Zero-Coupon Bond Yields

	2-yr.	3-yr.	5-yr.	7-yr.	10-yr.	(10y)−(3y)
US TIPS, 1999–2018[a]			1.15	1.39	1.65	
US TIPS, 2004–2018[a]	0.12	0.25	0.54	0.80	1.10	0.85
US TIPS, 2004–2007[a]	1.42	1.53	1.75	1.92	2.10	0.57
UK indexed gilts, 1983–1995[b]	6.12	5.29	4.34		4.12	−1.17
UK indexed gilts, 1985–2018[c]		1.53	1.69	1.80	1.90	0.37
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macroeconomic model	1.94	1.93	1.93	1.93	1.93	0.00

[a] Gürkaynak, Sack, and Wright (2010) online dataset
[b] Evans (1999)
[c] Bank of England web site

Nominal Yield Curve

Table 4: Nominal Zero-Coupon Bond Yields

	1-yr.	2-yr.	3-yr.	5-yr.	7-yr.	10-yr.	(10y)−(1y)
US Treasuries, 1961–2018[a]	5.07	5.29	5.48	5.76	5.97		
US Treasuries, 1971–2018[a]	5.16	5.40	5.60	5.92	6.17	6.44	1.28
US Treasuries, 1990–2007[a]	4.56	4.84	5.06	5.41	5.68	5.98	1.42
UK gilts, 1970–2018[b]	6.52	6.69	6.85	7.10	7.29	7.49	0.97
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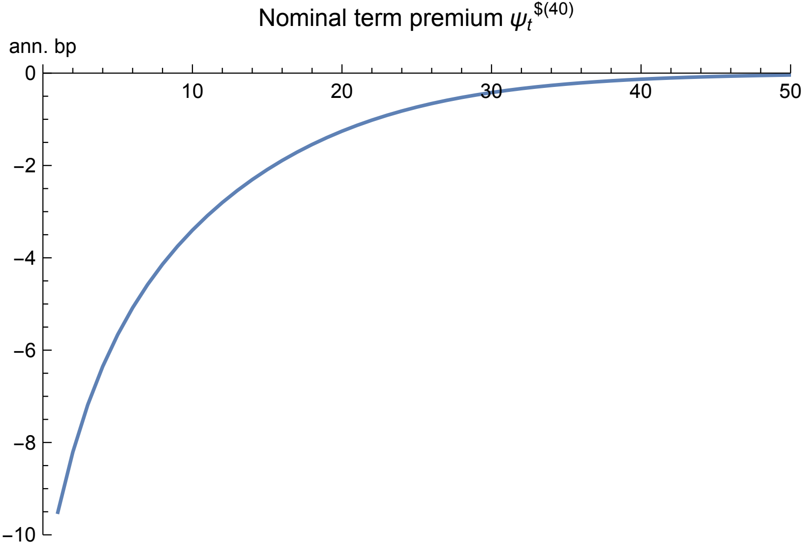
Supply shocks make nominal long-term bonds risky: inflation risk

Nominal Term Premium



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The credit spread is $i_t^d - i_t^c$

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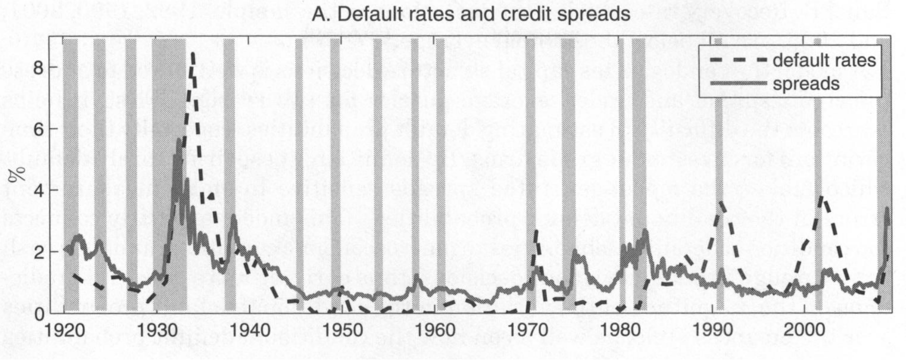
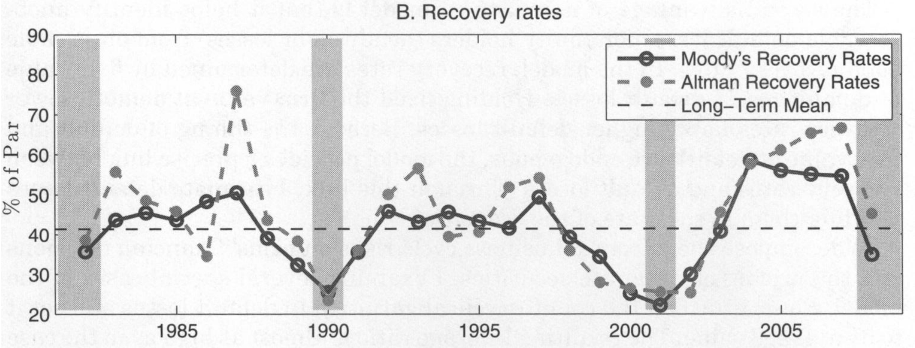
If default isn't cyclical, then it's not risky

Default Rate is Countercyclical



source: Chen (2010)

Recovery Rate is Procyclical



source: Chen (2010)

Table 5: Credit Spread

average ann. default prob.	cyclicality of default prob.	average recovery rate	cyclicality of recovery rate	credit spread (bp)
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.006	−0.3	.42	2.5	143.1
.006	−0.15	.42	2.5	78.9
.006	−0.6	.42	2.5	367.4
.006	−0.3	.42	1.25	137.0
.006	−0.3	.42	5	155.2

Discussion

1. IES ≤ 1 vs. IES > 1
2. Volatility shocks
3. Endogenous conditional heteroskedasticity
4. Monetary and fiscal policy shocks
5. Financial accelerator

Intertemporal Elasticity of Substitution

Long-run risks literature typically assumes IES > 1, for two reasons:

- ensures equity prices rise (by more than consumption) in response to an increase in technology
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Model here satisfies both criteria with IES $= 1$ (or even < 1).

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$$\psi_t^e = -\text{Cov}_t\left(\frac{m_{t+1}}{E_t m_{t+1}}, r_{t+1}^e\right)$$

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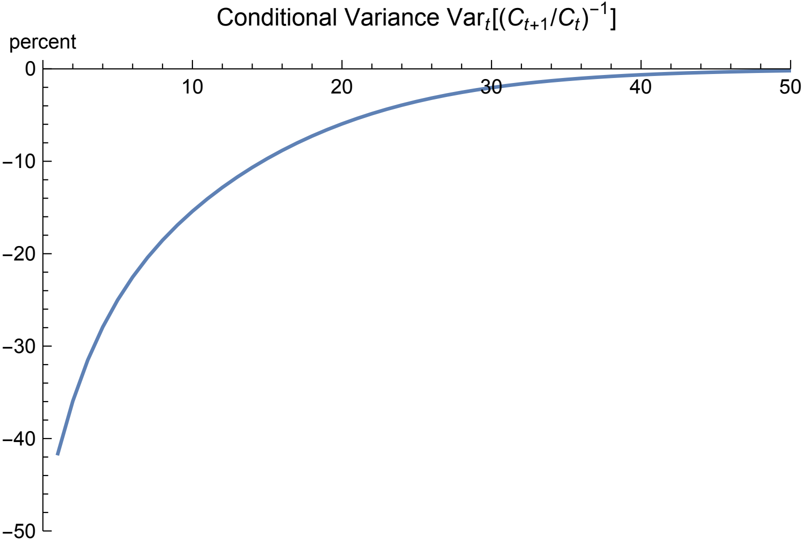
Here, conditional heteroskedasticity is **endogenous**

Nonlinear solution contains terms of form

$$x_t \varepsilon_{t+1}$$

so covariance Cov_t depends on state x_t

Impulse Responses for Conditional Variance



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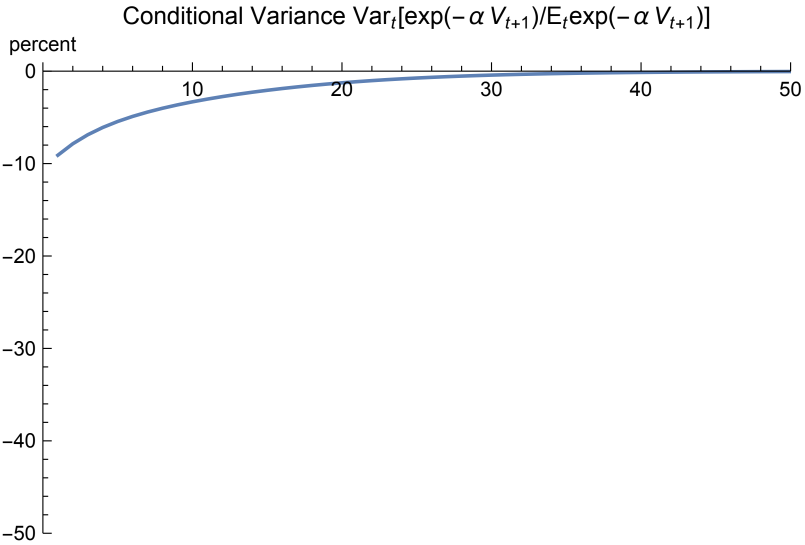
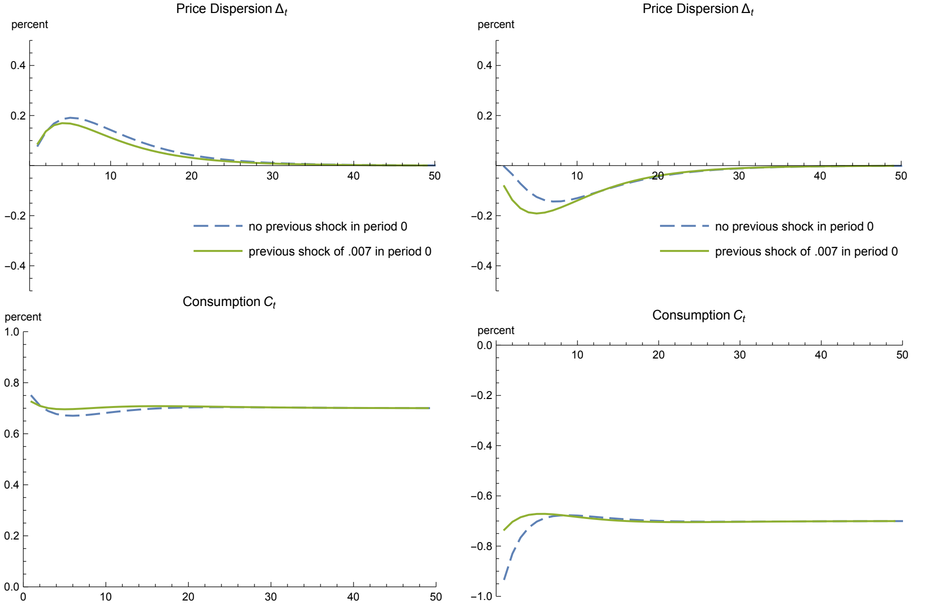


Impulse Responses to Pos. and Neg. Tech. Shocks



Monetary and Fiscal Policy Shocks

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- government purchases shock
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All three shocks help the model fit macroeconomic variables

But technology shock is most important (by far) for fitting asset prices:

- technology shock is more persistent
- technology shock makes nominal assets risky

No Financial Accelerator

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Economy affects $m_{t+1} \Rightarrow$ economy affects asset prices

However, asset prices have no effect on economy

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...but not in this paper

Conclusions

1. The standard textbook New Keynesian model (with Epstein-Zin preferences) is consistent with a wide variety of asset pricing facts/puzzles
2. Unifies asset pricing puzzles into a single puzzle—Why does risk aversion and/or risk in macro models need to be so high? (Literature provides good answers to this question)
3. Provides a structural framework for intuition about risk premia
4. Suggests a way to model feedback from risk premia to macroeconomy