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New Keynesian Economics with Safe Assets

(based on "Flight-to-Safety in a New Keynesian Model")

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Overview

- This paper: merge
  1. safe asset framework of Brunnermeier, Merkel, Sannikov (2023)
  2. New Keynesian (NK) price setting models

  to study transmission of uncertainty shocks (flight to safety) and policy

- Why interesting? Lessons differ from standard NK frameworks without safe assets (e.g. Basu, Bundick 2017)
  - transmission mechanism: portfolio choice is key (not intertemporal substitution)
  - quantity of safe assets becomes slow-moving state
  - asset pricing implications: overshooting of capital prices
  - policy implications: fiscal policy essential for aggregate demand management

Basic NK Models Are Stateless

- 3-equation (cashless) NK model:
  - two forward-looking equations relating flows
    - Euler equation ("IS curve"):
      relates consumption growth to discount rate
    - optimal price setting ("Phillips curve"):
      relates current inflation to future inflation and marginal costs
  - policy equation for nominal rate
- Model is essentially stateless: does not contain stocks that adjust slowly
- Stabilization policy about managing expectations to achieve "good" solutions

  → interest rate policy ("monetary policy") is sufficient

This Paper: Quantity (Stock) of Safe Assets Matters

- In model:
  - agents face portfolio choice between capital (risky) and nominal gov. bonds (safe)
  - sticky prices $\Rightarrow$ real value of bond stock adjusts sluggishly
- <u>Key change</u>: safe asset supply becomes a state variable
- Changes in portfolio demand for safe assets have aggregate demand effects
- Policy needs to ensure adequate safe asset supply

  $\rightarrow$ goes beyond expectations management, requires adequate fiscal policy

What about HANK Models?

Two remarks:

1. Technically, ours is a HANK model
   - but we abstract from MPC heterogeneity
     $\rightarrow$ wealth distribution does not matter for aggregates
   - deliberate choice to isolate aggregate effects from safe asset demand
   - HA component merely used to generate that safe asset demand
2. HANK papers have many extra (distributional) state variables, often focus on those
   - e.g. Bayer et al. 2019: model with "flight to liquidity" after uncertainty shock
   - but discussion focused on how wealth distribution is affected (and no analytical results)
   - our point: there is something else going on that is not about redistribution

Outline

1. Model
   - Setup
   - Numerical Example
2. Transmission of Uncertainty Shocks
   - Separation of Portfolio Choice
   - Shock Transmission under Flexible and Sticky Prices
   - Comparison to Models without Safe Assets
3. Policy

Outline

Model Setup

- Continuous time, infinite horizon, one consumption good (= final output good)
- Agents
  - households: hold capital (idiosyncratically risky) and government bonds (nominally safe)
  - intermediate goods firms: rent capital, produce differentiated intermediate goods
  - final goods firms: combine intermediate goods outputs (CES technology)
- Government
  - issues nominal bonds
  - taxes capital, sets nominal interest rate
- Frictions
  - financial friction (incomplete markets): households cannot trade idiosynacratic risk
  - price setting friction: intermediate goods firms face price adjustment cost
- Aggregate risk: fluctuations in volatility of idiosyncratic shocks

Households

- Preferences ($i \in [0,1]$ agent index):

$$\mathbb{E}\left[\int_0^\infty e^{-\rho t} \log c_t^i dt\right]$$

- Manages capital k_t^i:
  - capital services (rented out): $u_t^i k_t^i dt$
  - entitles holder to profit redistribution from intermediate goods firms
  - investment technology: $\iota_t^i k_t^i dt$ final goods $\to \Phi(\iota_t^i) k_t^i dt$ capital units
  - capital tax by government: $\tau_t k_t^i dt$
  - capital evolution:

$$\frac{dk_t^i}{k_t^i} = \underbrace{\overbrace{\left(\Phi\left(\iota_t^i\right) - \delta\left(u_t^i\right)\right)}^{=:g(u_t^i,\iota_t^i)} dt}_{\text{investment and depreciation}} + \underbrace{d\Delta_t^{k,i}}_{\text{trading}} + \underbrace{\tilde{\sigma}_t d\tilde{Z}_t^i}_{\text{idio. shocks}}$$

- Can hold government bonds
  - nominally safe bonds
  - make floating nominal interest payments i_t

Government

- Nominal face value of bonds B_t
$$dB_t/B_t = \mu_t^B dt$$

- Flow budget constraint
$$\underbrace{\left(\mu_t^B - i_t\right)}_{=:\breve{\mu}_t^B} B_t + P_t \tau_t K_t = 0 \tag{BC}$$

- Baseline assumption: government adjusts taxes to maintain constant surplus-debt ratio
  $\rightarrow$ implies constant $\breve{\mu}^B$ by (BC)

- Interest policy i_t follows some monetry policy rule
$$i_t = i\left(\mathbf{S}_t\right)$$
  where $\mathbf{S}_t$ is vector of aggregates (e.g. $\mathbf{S}_t = (\tilde{\sigma}_t, \pi_t)$)

Notation: Assets Values

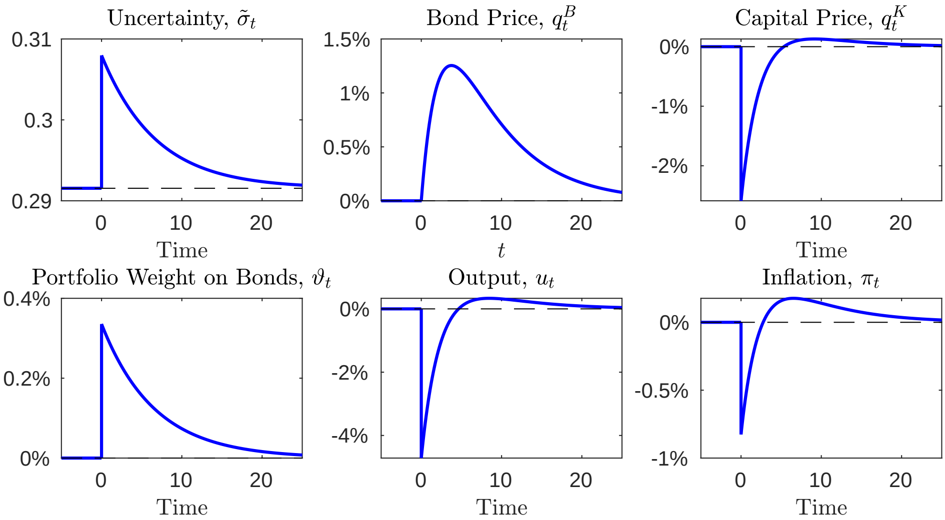
- Assets in positive net supply: capital & bonds
  - capital: aggregate stock K_t, price (per unit) q_t^K
  - bonds: real value per unit of capital $q_t^B := \frac{B_t}{P_t}\frac{1}{K_t}$
- Share of bond wealth

$$\vartheta_t := \frac{B_t/P_t}{q_t^K K_t + B_t/P_t} = \frac{q_t^B}{q_t^K + q_t^B}$$

- In equilibrium:
  - all households choose identical portfolios
  - ϑ_t is also individual portfolio weight in bonds
- Note: B_t and K_t are slow-moving (have only drifts, no dZ_t loadings)

  $\rightarrow$ when P_t is sticky, then so is q_t^B

Impulse Responses



Outline

Households' Portfolio Choice

- Portfolio choice depends only on the relative returns and risk of capital and bonds, **not** on aggregate output and price setting frictions

- "Bond Valuation Equation": ϑ_t satisfies in equilibrium

$$\vartheta_t = \mathbb{E}_t \left[\int_t^\infty e^{-\rho(s-t)} \vartheta_s \left((1 - \vartheta_s)^2 \tilde{\sigma}_s^2 - \breve{\mu}_s^B \right) ds \right].$$

- Separation: if $\breve{\mu}_t^B$ is function of $(\tilde{\sigma}_t, \vartheta_t)$ only (e.g. constant $\breve{\mu}^B$), then

$$\vartheta_t = \vartheta(\tilde{\sigma}_t)$$

  does not depend on bond valuation state q_t^B

  → portfolios adjust "fast" (as under flexible prices)

  → can treat $\{\vartheta_t\}$ as essentially exogenous

Preliminaries: Asset Valuations and Demand

- Goods market clearing (depends on level of asset valuations)

$$\underbrace{u_t a}_{\text{output}} = \underbrace{\rho\left(q_t^B + q_t^K\right)}_{\substack{\text{consumption}\\ \text{demand}}} + \underbrace{\iota\left(q_t^K\right)}_{\substack{\text{investment}\\ \text{demand}}}$$

- Portfolio choice (ϑ_t) determines relative asset valuations

$$q_t^K = \frac{1-\vartheta_t}{\vartheta_t} q_t^B, \qquad q_t^B + q_t^K = \frac{1}{\vartheta_t} q_t^B$$

- Combining the previous:

$$\boxed{u_t = \frac{1}{a}\left(\rho \frac{q_t^B}{\vartheta_t} + \iota\left(\frac{1-\vartheta_t}{\vartheta_t} q_t^B\right)\right)}$$

Shock Transmission under Flexible Prices – Impact Effect

$$u_t = \frac{1}{a}\left(\rho \frac{q_t^B}{\vartheta_t} + \iota\left(\frac{1-\vartheta_t}{\vartheta_t} q_t^B\right)\right)$$

Shock: $\tilde{\sigma}_t \uparrow \quad \rightarrow \quad \vartheta_t \uparrow$

$\rightarrow$ Lower capital price and investment: $q_t^K \downarrow \quad \iota_t \downarrow$

$\rightarrow$ Bond value $q_t^B = B_t/P_t/K_t$ rises to increase consumption demand

$\Rightarrow$ Downward adjustment in price level P_t on impact brings demand back in line with supply

Note: closed-form solutions for q^B and q^K

$$q_t^{K,flex} = \left(\frac{a^2}{\rho\bar{\bar{\delta}}}\frac{\varepsilon-1}{\varepsilon}\right)^{1/2}(1-\vartheta_t)^{1/2}, \qquad q_t^{B,flex} = \left(\frac{a^2}{\rho\bar{\bar{\delta}}}\frac{\varepsilon-1}{\varepsilon}\right)^{1/2}\frac{\vartheta_t}{(1-\vartheta_t)^{1/2}}$$

Shock Transmission under Sticky Prices – Impact Effect

$$u_t = \frac{1}{a}\left(\rho \frac{q_t^B}{\vartheta_t} + \iota \left(\frac{1-\vartheta_t}{\vartheta_t} q_t^B\right)\right)$$

- All terms on right-hand side are already determined
  - ϑ_t by portfolio choice separation (only depends on $\tilde{\sigma}$ path)
  - q_t^B is a state variable under sticky prices

⇒ Demand is completely rigid on impact, unable to adjust

⇒ Supply (utilization u_t) must clear goods market

Capital Price Overshooting

- Portfolio separation result: ϑ_t rises as fast as under flexible prices
- Stickiness of bond value: q_t^B unaffected by shock, whereas $q_t^{B,flex} \uparrow$
- Consequence: capital price *overshoots* relative to flexible price response
  - $q_t^K = (1 - \vartheta_t)/\vartheta_t \cdot q_t^B$ falls by more under sticky prices
- Reminiscent of Dornbusch's (1976) overshooting model
  - original: sticky domestic price $\rightarrow$ volatile exchange rate
  - here: sticky bond value $\rightarrow$ volatile capital price

Shock Transmission under Sticky Prices – Adjustment Dynamics

- After shock, gradual deflation slowly increases q_t^B
- Dynamics guided by two equations (ignoring future shocks for simplicity)
  - Phillips curve (forward looking):

$$d\pi_t = \left(\rho\pi_t - \frac{\varepsilon}{\kappa}\left(a p_t^R - a p^{R,flex}\right)\right) dt$$

  - Bond value evolution (backward looking):

$$dq_t^B = \left(i_t - \pi_t + \breve{\mu}_t^B - g_t\right) dt$$

Note: p_t^R and g_t are functions of $u_t = u(q_t^B, \vartheta_t)$

- Interest rate policy i_t can affect speed of adjustment dynamics

An Economy without Nominal Bonds

- Consider economy with $B_t \equiv 0$
- Demand equation

$$u_t = \frac{1}{a}\left(\underbrace{\rho q_t^K}_{\substack{\text{consumption}\\ \text{demand}}} + \underbrace{\iota\left(q_t^K\right)}_{\substack{\text{investment}\\ \text{demand}}} \right)$$

- Effects of shock depend on effects on return on capital:

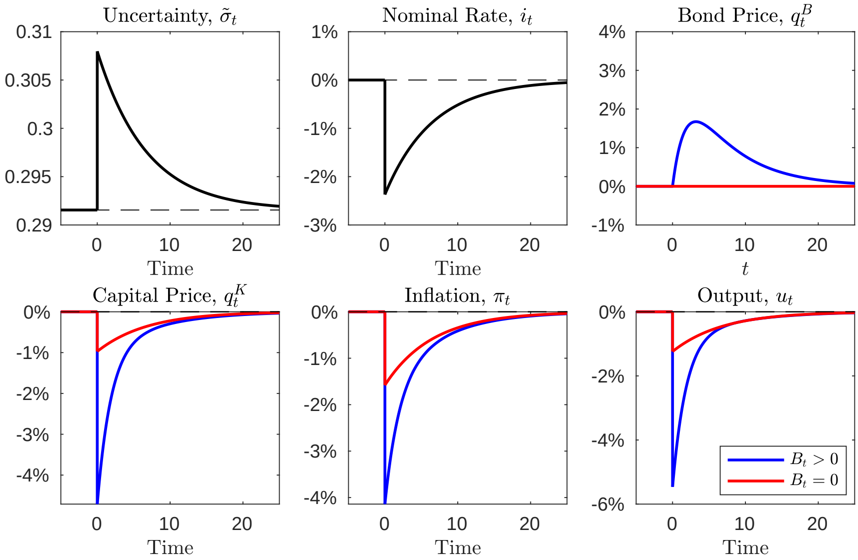
$$r_t^K = r_t^f + \text{risk premium}$$

  - $\tilde{\sigma}_t \uparrow \quad \Rightarrow \quad$ risk premium $\uparrow$
  - $r_t^f = i_t - \pi_t$ effectively controlled by monetary policy

- If policy fails to engineer sufficient reduction in r_t^f (e.g. Basu, Bundick 2017)

$$\tilde{\sigma}_t \uparrow \quad \Rightarrow \quad r_t^K \uparrow \quad \Rightarrow \quad q_t^K \downarrow \quad \Rightarrow \quad u_t \downarrow$$

Shock Amplification with Safe Assets



A Cleaner Comparison: Two Units of Account

- Issue with previous comparison: $B = 0$ economy also has no safe assets
- Affects model dynamics even in the absence of price setting frictions
- Cleaner (but artificial!) comparison to highlight what matters: two units of account
  - good prices are quoted in "goods dollars", subject to price setting frictions
  - bonds are quoted in "bond dollars", adjust flexibly
- Also that model behaves close to $B = 0$ economy
  (exchange rate between two units of accounts does most of the adjustment)

$\Rightarrow$ What really matters: *safe asset is denominated in sticky unit of account*

Outline

Interest Rate Policy

- Without safe assets: can implement flexible price allocation
  - policy prescription: $i_t = r_t^{f,n}$ & appropriate equilibrium selection (e.g. Taylor rule)
  - divine coincidence: $\pi_t = 0$ and zero output gaps
- Conclusion from such models: flight to safety is (mostly) a problem at ZLB
- With safe assets: ineffectiveness of interest rate policy (on impact)
  - changes in i_t do *not* affect the impact effects of the shock
  - but interest rate policy can speed up the recovery
  - Remark: $i_t = r_t^{f,n}$ is still possible, but does not result in zero inflation/output gaps

How Can Policy Stabilize Demand on Impact?

1. Manage *safe asset demand* by distorting portfolio choice
   - use policy instrument $\breve{\mu}_t^B$ (requires adjustments in surplus-debt ratio)
   - may not be optimal (optimal $\breve{\mu}_t^B$ to correct pecuniary externalities depends on $\tilde{\sigma}_t$)

2. Manage *safe asset supply* by introducing second safe asset whose value is not sticky
   a. long-term bonds
      - monetary policy can adjust bond value through expected future rates
      - *but*: cannot control i_t and q_t^B independently

      → insufficient to implement flexible price allocation
   b. use lump-sum transfers
      - PV of lump-sum transfers is alternative safe asset
      - agents only care about total quantity of safe assets (bonds plus PV of transfers)

      → can adjust PV of transfers to absorb variations in safe asset demand at constant bond values

Conclusion

- New Keynesian model with (nominal) safe assets
  - uncertainty shocks lead to flight to safety (portfolio reallocation towards bonds)
  - safe asset stock becomes a state variable
- Shock transmission:
  - rigid safe asset supply and separate portfolio choice generate demand shortage
  - amplification through capital price overshooting
  - interest rate policy can only affect recovery, not depth of initial recession
- [In paper] Coordinated monetary-fiscal policy can implement constrained optimal allocation
  - optimal portfolio distortion independent of price stickiness
  - combination of natural rate policy and lump-sum transfers eliminate sticky price distortions