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New Keynesian Economics with Safe Assets

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

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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
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
In model:
- agents face portfolio choice between capital (risky) and nominal gov. bonds (safe)
- sticky prices $\Rightarrow$ real value of bond stock adjusts sluggishly

Key change: 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
- 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
     → 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
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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 idiosyncratic risk
  - price setting friction: intermediate goods firms face price adjustment cost

- Aggregate risk: fluctuations in volatility of idiosyncratic shocks
Households

- Preferences \((i \in [0, 1] \text{ agent index})\):
  \[
  \mathbb{E} \left[ \int_{0}^{\infty} e^{-\rho t} \log c_t^i dt \right]
  \]

- 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: \(i_t^i k_t^i dt\) final goods \(\rightarrow \Phi(i_t^i) k_t^i dt\) capital units
  - capital tax by government: \(\tau_t k_t^i dt\)
  - capital evolution:
    \[
    \frac{dk_t^i}{k_t^i} = g(u_t^i, i_t^i)
    \]
    \[
    =: \left( \Phi(i_t^i) - \delta(u_t^i) \right) dt + d\Delta_t^k + \tilde{\sigma} d\tilde{Z}_t^i
    \]
    \[
    \text{investment and depreciation} \quad \text{trading} \quad \text{idio. shocks}
    \]

- 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
  \[ \left( \mu_t^B - i_t \right) B_t + P_t \tau_t K_t = 0 \]
  \[ =: \bar{\mu}_t^B \] (BC)

- Baseline assumption: government adjusts taxes to maintain constant surplus-debt ratio
  \[ \rightarrow \text{implies constant } \bar{\mu}_t^B \text{ by (BC)} \]

- Interest policy $i_t$ follows some monetary policy rule
  \[ i_t = i(S_t) \]
  where $S_t$ is vector of aggregates (e.g. $S_t = (\tilde{\sigma}_t, \pi_t)$)
Notation: Assets Values

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

- Share of bond wealth
  \[
  \vartheta_t := \frac{B_t/P_t}{q^K_t K_t + B_t/P_t} = \frac{q^B_t}{q^K_t + q^B_t}
  \]

- In equilibrium:
  - all households choose identical portfolios
  - $\vartheta_t$ is also individual portfolio weight in bonds

- Note: $B_t$ and $K_t$ are slow-moving (have only drifts, no $dZ_t$ loadings)
  - when $P_t$ is sticky, then so is $q^B_t$
Impulse Responses

**Uncertainty, $\tilde{\sigma}_t$**

**Bond Price, $q^B_t$**

**Capital Price, $q^K_t$**

**Portfolio Weight on Bonds, $\vartheta_t$**

**Output, $u_t$**

**Inflation, $\pi_t$**
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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”: \( \vartheta_t \) satisfies in equilibrium

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

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

\[
\vartheta_t = \vartheta(\tilde{\sigma}_t)
\]

does not depend on bond valuation state \( q_t^B \)

\( \rightarrow \) portfolios adjust “fast” (as under flexible prices)

\( \rightarrow \) can treat \( \{\vartheta_t\} \) as essentially exogenous
Preliminaries: Asset Valuations and Demand

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

\[
\frac{u_t \theta_a}{\text{output}} = \rho \left( q_t^B + q_t^K \right) + \iota \left( q_t^K \right)
\]

- Portfolio choice \((\vartheta_t)\) determines relative asset valuations

\[
q_t^K = \frac{1 - \vartheta_t}{\vartheta_t} q_t^B, \quad q_t^B + q_t^K = \frac{1}{\vartheta_t} q_t^B
\]

- Combining the previous:

\[
u_t = \frac{1}{a} \left( \rho \frac{q_t^B}{\vartheta_t} + \iota \left( \frac{1 - \vartheta_t}{\vartheta_t} q_t^B \right) \right)
\]
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: \( \bar{\sigma}_t \uparrow \rightarrow \vartheta_t \uparrow \)

\( \rightarrow \) Lower capital price and investment: \( q_t^K \downarrow \iota_t \downarrow \)

\( \rightarrow \) 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 \( q_t^B \) and \( q_t^K \)

\[ q_t^{K, \text{flex}} = \left( \frac{a^2 (\alpha - 1)}{\rho \delta \vartheta_t} \right)^{1/2} (1 - \vartheta_t)^{1/2}, \quad q_t^{B, \text{flex}} = \left( \frac{a^2 (\alpha - 1)}{\rho \delta \vartheta_t} \right)^{1/2} \frac{\vartheta_t}{(1 - \vartheta_t)^{1/2}} \]
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
  - \( \vartheta_t \) 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
Portfolio separation result: $\vartheta_t$ rises as fast as under flexible prices

Stickiness of bond value: $q_{tB}$ unaffected by shock, whereas $q_{tB,\text{flex}}$ ↑

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 → volatile exchange rate
  
  here: sticky bond value → volatile capital price
Shock Transmission under **Sticky Prices** – Adjustment Dynamics

- After shock, gradual deflation slowly increases $q^B_t$

- Dynamics guided by two equations (ignoring future shocks for simplicity)
  - Phillips curve (forward looking):
    \[ d\pi_t = \left( \rho\pi_t - \frac{\varepsilon}{\kappa} \left( ap^R_t - ap^{R,\text{flex}}_t \right) \right) dt \]
  - Bond value evolution (backward looking):
    \[ dq^B_t = \left( i_t - \pi_t + \ddot{\mu}^B_t - g_t \right) dt \]

  Note: $p^R_t$ and $g_t$ are functions of $u_t = u(q^B_t, \vartheta_t)$

- 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

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

Effects of shock depend on effects on return on capital:

$$r^K_t = r_f^t + \text{risk premium}$$

- $\tilde{\sigma}_t \uparrow \implies \text{risk premium} \uparrow$
- $r_f^t = i_t - \pi_t$ effectively controlled by monetary policy

If policy fails to engineer sufficient reduction in $r_f^t$ (e.g. Basu, Bundick 2017)

$$\tilde{\sigma}_t \uparrow \implies r^K_t \uparrow \implies q^K_t \downarrow \implies u_t \downarrow$$
Shock Amplification with Safe Assets

![Graphs showing the responses of uncertainty, nominal rate, bond price, capital price, inflation, and output to a shock.](image)

- **Uncertainty, $\tilde{\sigma}_t$:** Decreases over time.
- **Nominal Rate, $i_t$:** Initially decreases, then increases to a new level.
- **Bond Price, $q_i^B$:** Increases initially, then decreases.
- **Capital Price, $q_i^K$:** Increases significantly, then decreases.
- **Inflation, $\pi_t$:** Shows an initial decrease, then increases.
- **Output, $u_t$:** Shows a significant decrease initially, then increases.

Different scenarios are represented by different line styles:
- Blue line: $B_t > 0$
- Red line: $B_t = 0$
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*
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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 $\ddot{\mu}_t^B$ (requires adjustments in surplus-debt ratio)
   - may not be optimal (optimal $\ddot{\mu}_t^B$ to correct pecuniary externalities depends on $\tilde{\sigma}_t$)

2. **Manage safe asset supply** by introducing second safe asset whose value is not sticky
   - 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
   - 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