A Monetary Policy Asset Pricing Model

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What we do: Asset price implications of monetary policy

Chair Powell, September 2022 FOMC press conference:

- "Monetary policy does, famously, work with long and variable lags..."
- "Our policy decisions affect **financial conditions** immediately..."
- "Financial conditions begin to affect activity...within a few months"

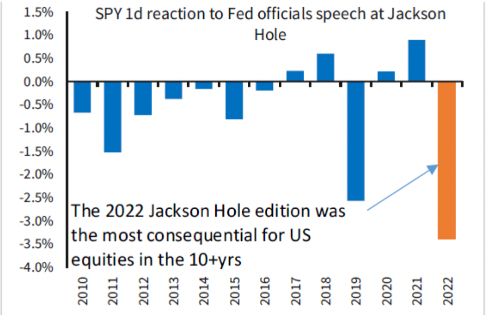
Financial conditions: Summary measure of **aggregate asset prices**

- Stock/house valuations, interest rates/spreads... (Goldman's FCI)

We reverse engineer the Fed's policy problem to solve for **"pystar"**

Under optimal policy, asset prices can't deviate much from "pystar"...

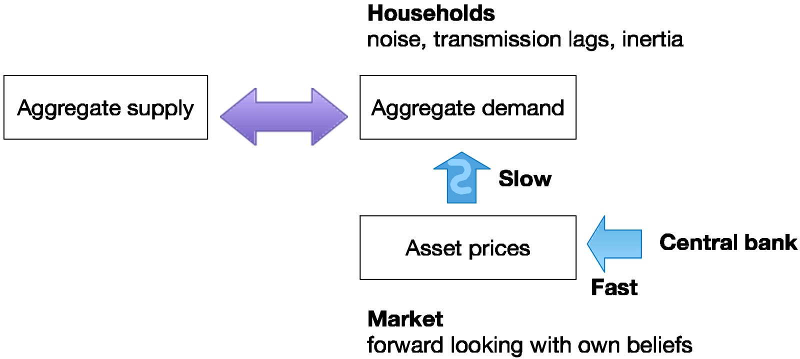
The Fed reversed market rallies inconsistent with "pystar"



Source: Bloomberg

Neel Kashkari (Pres. Minneapolis Fed): "I was actually happy to see how Chair Powell's Jackson Hole speech was received. . ."

We characterize the “pystar” in a two-speed economy



Results: Fed's belief about macro needs drives "pystar"

Baseline (standard) model without lags: CB ensures AD=AS

- **Macro** (AD vs AS) drives "pystar" (finance drives relative prices)

Main model with transmission lags: CB needs to anticipate future

- "pystar" is driven by **the CB's beliefs about future AD vs AS**
- More precise news$\Longrightarrow$Less output volatility, **more market volatility**

Inertia:

- CB **overshoots** asset prices in **opposite** direction of **output gaps**
- Demand and supply-driven **inflation** is bad news for asset prices

CB-market disagreements: Market perceives "mistakes"

- Market demands **policy risk premium** & thinks "**behind the curve**"

Roadmap

1. Baseline model: Macro vs finance drivers of asset prices
2. Asset pricing with transmission lags
3. Asset pricing with inertia
4. Disagreements: Policy risk premium and “behind-the-curve”

Supply side: Demand-driven output (Keynes)

- Potential output $Y_t^* \simeq A_t$. Subject to supply shocks (in logs):

$$y_{t+1}^* = y_t^* + z_{t+1}, \quad \text{where } z_{t+1} \sim N\left(0, \sigma_z^2\right)$$

- Nominal rigidities. Output is determined by **aggregate demand**
  - Fully sticky prices. In the paper, we introduce a Phillips curve

- Labor is supplied by hand-to-mouth agents. They generate multiplier but are otherwise uninteresting

- Capital is held by asset-holding households. They drive demand...

Demand depends on asset prices

- Asset-holding households have standard time-separable log utility
- But they do not **necessarily** make optimal decisions. Follow **rules**
  - Shortcut to introduce frictions such as transmission lags and inertia
- **Baseline:** Mostly follow the optimal consumption rule with log utility:

$$C_t^H = \underbrace{(1-\beta)}_{\text{MPC}} \times \underbrace{(\alpha Y_t + P_t \exp(\delta_t))}_{\text{Wealth (Market portfolio)}} \text{ where } \underbrace{\delta_t \sim N\left(0, \sigma_\delta^2\right)}_{\text{demand shocks}}$$

Wealth effect captures channels that link demand to asset prices P_t

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  Wealth effect captures channels that link demand to asset prices P_t
- **Transmission lags:** React to **past** asset prices P_{t-1}
- **Inertia:** Partly react to **past spending** C_{t-1}^H

Finance: Standard asset pricing with SDF driven by wealth

- Market portfolio: Claim on αY_t with log return (approximately):

$$r_{t+1} = \kappa + (1-\beta)\, y_{t+1} + \beta p_{t+1} - p_t$$

- Risk-free asset is in zero net supply. Central bank sets $i_t = \log R_t^f$

Market: Managers choose portfolio weight ω_t to maximize log **wealth**

- Equilibrium is like CAPM: Risk premium is the **variance** of wealth:

$$i_t = E_t^M [r_{t+1}] + \frac{1}{2} var_t^M [r_{t+1}] - \underbrace{var_t^M [r_{t+1}]}_{\text{risk premium}}$$

Central bank (the Fed) controls P to close output gaps

CB tools: It controls the **aggregate asset price** p_t, by adjusting i_t

CB objectives: It minimizes the expected quadratic gaps:

$$\sum_{h=0}^{\infty} \beta^h E_t^F \left[\tilde{y}_{t+h}^2\right] \qquad \text{where } \tilde{y}_t = y_t - y_t^*$$

In the baseline model, it closes the gaps at all times:

$$\tilde{y}_t = 0 \qquad (\text{or } Y_t = Y_t^*)$$

We reverse engineer Fed's problem to solve for "pystar"

$$
\begin{aligned}
C_t^H &= (1-\beta)\left(\alpha Y_t + P_t \exp\left(\delta_t\right)\right) \text{ and } Y_t = C_t^H/\alpha \\
&\Longrightarrow \\
Y_t &= \frac{1}{\alpha\beta}\left(1-\beta\right) P_t \exp\left(\delta_t\right) \\
&\Longrightarrow \\
y_t &= m + p_t + \delta_t
\end{aligned}
$$

- The Fed sets $y_t = y_t^* \Longrightarrow$

$$
p_t^* \equiv y_t^* - m - \delta_t
$$

Macro needs drive "pystar" (finance drives relative prices)

- Market belief shocks: Suppose $z_{t+1} \sim^M N\left(b_t, \sigma_z^2\right), b_t \sim N\left(0, \sigma_b^2\right)$

Result: Fed implements "pystar" by setting the appropriate rate:

$$
\begin{aligned}
p_t^* &= y_t^* - m - \delta_t \\
i_t &= \rho + \delta_t + b_t - \frac{1}{2} rp_t \text{ where } rp_t = \sigma_z^2 + \beta^2 \sigma_\delta^2
\end{aligned}
$$

Corollary: AD shocks create "excess" policy-induced price volatility

- **Note:** This volatility plays a useful macroeconomic stabilization role

Corollary (Fed put): Financial forces (b_t) don't affect p_t. Absorbed by i_t

- Finance drives **relative prices,** e.g., P_t^s vs P_t^b where $P_t = P_t^s + P_t^b$

Roadmap

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Monetary policy works with long lags and inertia

- So far, monetary policy is powerful: It can set $y_t = y_t^*$ at all states
- In practice, MP has much weaker control over aggregate demand
- Important constraint: MP affects demand with lags and inertia

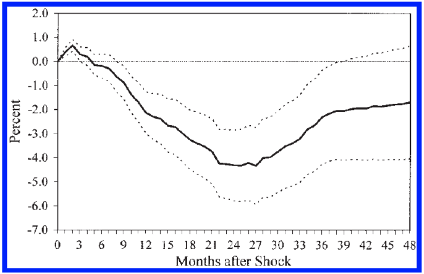

FIGURE 2. THE EFFECT OF MONETARY POLICY ON OUTPUT

Figure: Romer-Romer (2004), "A New Measure of Monetary Shocks"

- Stock market wealth effect also works with very similar lags

Transmission lags: The Fed's belief drives policy

- We capture lags by modifying the consumption rule:

$$\begin{aligned} C_t^H &= (1-\beta)\left(\alpha Y_t + P_{t-1}\exp\left(\delta_t\right)\right) \\ &\Longrightarrow \\ y_t &= m + p_{t-1} + \delta_t \end{aligned}$$

- With lags, the Fed *can't* set $y_t = y_t^*$. Optimal policy implies:

$$\begin{aligned} E_t^F\left[y_{t+1}\right] &= E_t^F\left[y_{t+1}^*\right] \\ \tilde{y}_{t+1} &= \tilde{\delta}_{t+1} - E_t^F\left[\tilde{\delta}_{t+1}\right] \text{ where } \tilde{\delta}_{t+1} \equiv \delta_{t+1} - z_{t+1} \end{aligned}$$

Transmission lags: The Fed's belief drives asset prices

- The Fed targets $E_t^F[y_{t+1}] = E_t^F\left[y_{t+1}^*\right] \implies$

$$p_t^* = y_t^* - E_t^F\left[\tilde{\delta}_{t+1}\right] - m$$

Result: "pystar" is decreasing in **the Fed's belief** about **future net AD**

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Result: "pystar" is decreasing in **the Fed's belief** about **future net AD**

Macro news: Suppose agents receive signal about future AD:

$$s_t = \delta_{t+1} + e_t$$

- Fed's posterior belief is $\delta_{t+1} \sim N\left(\gamma s_t, \sigma_{\tilde{\delta}}^2\right)$ where $\sigma_{\tilde{\delta}}^2 < \sigma_\delta^2$. Then:

$$p_t^* = y_t^* - \gamma s_t - m \quad \text{and} \quad y_{t+1} = y_t^* + \delta_{t+1} - \gamma s_t$$

Result: More precise news$\Longrightarrow$Less volatile y_{t+1} **but more volatile** p_t

Roadmap

Inertia: The Fed overshoots asset prices opposite to gap

$$C_t^H \sim \left[\eta\beta C_{t-1}^H + (1-\eta)(1-\beta) P_{t-1}\right] \exp(\delta_t)$$

$$\Longrightarrow$$

$$y_t \sim \eta y_{t-1} + (1-\eta) p_{t-1} + \delta_t$$

- The Fed still targets $E_t^F [y_{t+1}] = E_t^F \left[y_{t+1}^*\right] \Longrightarrow$

$$p_t^* = y_t^* - \underbrace{\frac{\eta}{1-\eta}\tilde{y}_t}_{\textbf{overshooting}} - \frac{E_t^F\left[\tilde{\delta}_{t+1}\right]}{1-\eta} - m$$

Result: With output gaps, Fed **overshoots** p & induces "**disconnect**"

Corollary: Output gap and aggregate asset price are **negatively** correlated

Inflation is bad news for asset prices and returns

- We introduce inflation via **the standard NKPC**

$$\pi_t = \kappa \tilde{y}_t + \beta E_t \left[\pi_{t+1}\right]$$

- The Fed now minimizes $E_t^F \left[\sum \beta^h \left(\tilde{y}_{t+h}^2 + \psi \pi_{t+h}^2\right)\right]$

Result: With common beliefs:

- $E_t \left[\tilde{y}_{t+1}\right] = E_t \left[\pi_{t+1}\right] = 0$ ("divine coincidence" *in expectation*)

Inflation depends **only on current demand & supply shocks:**

$$\pi_t = \kappa \tilde{y}_t$$

Corollary of overshooting:

- Demand and supply-driven **inflation is bad news** for asset prices
- Inflation risk premium (extra return on i_t^n vs i_t) is typically positive

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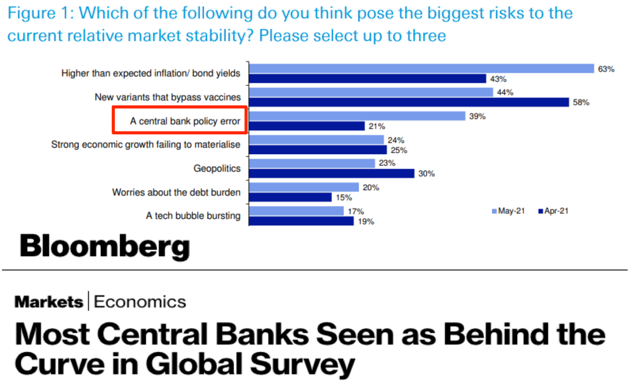
Markets disagree with the Fed and perceive "mistakes"



How do disagreements and perceived "mistakes" affect asset prices?

Suppose Fed and Market disagree about future demand

- Back to model without inflation. Suppose agent $j \in \{F, M\}$ thinks:

$$s_t + \mu_t^j =^j \delta_{t+1} + e_t$$

  - Heterogeneous interpretations μ_t^F, μ_t^M with $corr\left(\mu_t^F, \mu_t^M\right) = 1 - \frac{D}{2}$
  - $D \geq 0$ captures the scope for **new disagreements**

- **Posterior beliefs are not the same:**

$$E_t^j\left[\delta_{t+1}\right] = \gamma\left(s_t + \mu_t^j\right)$$

- Agents think **other agent's belief** is a noisy version of own belief:

$$Var^M\left(\text{Fed's belief}\right) = Var^M\left(\text{Own belief}\right) + \gamma^2 D \sigma_\mu^2$$

Disagreements induce “mistakes” and policy risk premium

- The Fed targets the same “pystar” as before *under its belief:*

$$p^*_{t+1} = y^*_{t+1} - \frac{\eta}{1-\eta}\tilde{y}_{t+1} - \frac{\gamma\left(s_{t+1} + \mu^F_{t+1}\right)}{1-\eta} - m$$

- Market perceives “mistake”: Price “should” depend on μ^M_{t+1}

- Market perceives excess price volatility $var^M_t\left(p_{t+1}\right) \sim \frac{\gamma^2 D\sigma^2_\mu}{(1-\eta)^2}$

Policy risk premium is increasing in the scope for disagreement:

$$rp_t = rp^{common}_t + \beta^2 \frac{\gamma^2 D\sigma^2_\mu}{(1-\eta)^2}$$

Disagreements induce a behind-the-curve phenomenon

- A demand-optimistic market expects a positive gap/**demand boom**:

$$E_t^M [\tilde{y}_{t+1}] = \gamma \left(\mu_t^M - \mu_t^F \right) > 0$$

- It also expects **policy reversal** and a **lower future asset price:**

$$E_t^M [p_{t+1}] = y_t^* - \frac{\eta}{1-\eta} E_t^M [\tilde{y}_{t+1}] - m$$

Behind-the-curve: Dovish Fed will reverse and tighten to undo "mistake"

- Rates: Dovish Fed steepens the yield curve (hawkish $\Longrightarrow$ inverts)

Disagreements affect the policy interest rate

$$i_t = E_t^M [r_{t+1}] - \frac{rp_t}{2}$$

$$\text{where } E_t^M [r_{t+1}] \sim (\beta + \eta) \frac{\gamma \left(s_t + \mu_t^F\right)}{1-\eta} + (1 - \beta - \eta) \frac{\gamma \left(s_t + \mu_t^M\right)}{1-\eta}$$

Result: Disagreements are absorbed by i_t (**do not** affect p_t)

- Higher policy risk premium (D) reduces i_t
- "Behind-the-curve" has subtle effects on i_t via $E_t^M [r_{t+1}]$

Disagreements affect relative asset prices (rp_t and i_t) but not "pystar"

Conclusion: A monetary policy asset pricing model

Central banks affect the economy via aggregate asset prices

This leads to an asset pricing theory ("pystar") with several implications:

- **Macro** drives **aggregate** asset prices and finance drives relative prices
- **Transmission lags: Fed's belief** about future AD-AS drive "pystar"
  - More precise news: More stable output but more volatile asset prices
- **Inertia:** Fed **overshoots asset prices** & induces $cov_{t-1}(p_t, \tilde{y}_t) < 0$
  - Both demand and supply-driven inflation is bad news for asset prices
- Fed-market disagreements affect rp and rates but not "pystar"
  - Market demands policy risk premium and thinks "behind-the-curve"

Related literature

Risk-centric macroeconomics (e.g., CS (2020), Pflueger et al. (2020)

- We focus on **the spillback** effects from macroeconomy to asset prices
- Similar to Lucas (1978), but with nominal rigidities and other frictions
- Similar to Bianchi et al. (2022), but with asset prices driving demand

Excess volatility: Time-varying risk premia/beliefs/supply-demand...

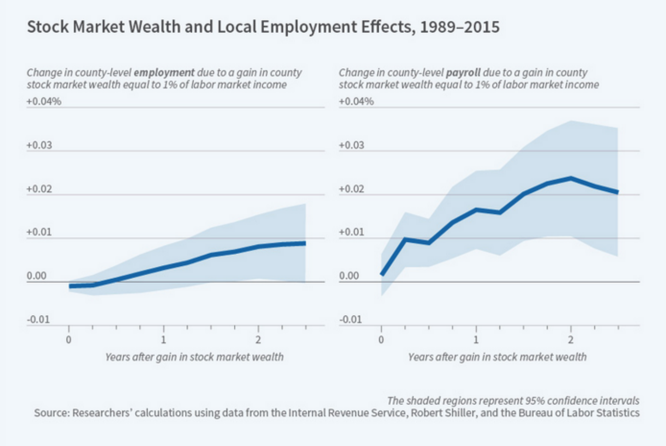
- We highlight **AD shocks** (& policy) as a source of "excess" volatility

Excess volatility in bonds and **stock-bond market covariance**

- We explain bond volatility. Covariance with stocks depends on shocks

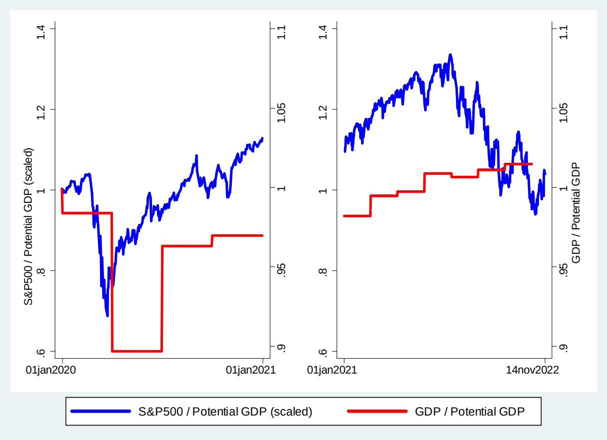
Monetary policy works through markets (large empirical literature)

A key friction: Transmission delays from asset prices



- Chodorow-Reich et al. (2021): Long lags for stock wealth effect

Wall/Main Street disconnect during Covid-19



- CS (2022a): Similar ingredients (inertia but no lags or risk) $\Longrightarrow$ Overshooting
- Quantitative: Overshooting via rates can explain high prices in 2021...

Behind-the-curve affects the policy rate the Fed sets

- "Behind-the-curve" affects $E_t^M[r_{t+1}]$ and $i_t = E_t^M[r_{t+1}] - \frac{rp_t}{2}$
- **Cash-flows** vs **capital gains**

$$E_t^M[r_{t+1}] = \rho + \frac{\eta \tilde{y}_t + \gamma\left(s_t + \mu_t^F\right)}{1-\eta} + \left[(1-\beta) - \frac{\beta\eta}{1-\eta}\right]\gamma\left(\mu_t^M - \mu_t^F\right)$$

- Low $\eta \implies$ Fed partially **accommodates** the market's belief
- High $\eta \implies$ Fed **doubles down** on its own belief

Disagreements microfound monetary policy shocks

- Suppose the market learns μ_t^F later in the period. Initially thinks:

$$\mu_t^F \simeq \tilde{\beta}\mu_t^M + \tilde{\varepsilon}_t^F$$

- Asset price before and after the market observes Fed's belief:

$$\begin{aligned} E_t^M [p_t] &\sim -\frac{\gamma}{1-\eta}\tilde{\beta}\mu_t^M \\ p_t &\sim -\frac{\gamma}{1-\eta}\mu_t^F \end{aligned}$$

Result: Fed belief surprises drive asset prices & **microfound MP shocks:**

$$\Delta p_t = -\frac{\gamma\tilde{\varepsilon}_t^F}{1-\eta} \text{ and } \Delta i_t = \frac{\beta+\eta}{1-\eta}\gamma\tilde{\varepsilon}_t^F$$