# Macroeconomic Risks and Asset Prices

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# Introduction: Traditional Macroeconomics and Asset Prices

**Key Features of Standard Models:**

- **Consumption-Based Pricing:** Asset prices reflect marginal utility of consumption (Lucas, Epstein-Zin).
- **Loglinear Euler Equation:**

$$x_t = f_x \mathbb{E}_t x_{t+1} + \rho_x x_{t-1} - \psi r_t$$

- **Fixed Preferences, Exogenous Shocks:** Time variation in risk premia requires exogenous volatility or recursive preferences.
- **Asset Return Co-movement:** Typically lacks microfoundations for changes in bond-stock correlation.

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# Introduction: New Contributions from the Paper

**Innovations in Macroeconomic Asset Pricing:**

- **Habit-Based Preferences:** Surplus consumption ratio $s_t = \frac{C_t - H_t}{C_t}$ drives time-varying risk aversion.
- **Exact Euler Equation:** Preferences consistent with standard macro loglinear structure.
- **Empirical Regime Shift:**
  - **Pre-2001:** Inflation-output gap correlation negative $\Rightarrow$ bonds risky.
  - **Post-2001:** Correlation positive $\Rightarrow$ bonds hedge assets.

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# Introduction: Implications and Mechanisms

**Why Asset Risks Change:**

- **Flight to Safety:** In recessions, increased risk aversion shifts demand to safe assets (bonds).
- **Risk Premia Amplification:** Time-varying premia strengthen bond-stock co-movement dynamics.
- **Quantitative Fit:** Model matches observed transition in bond-stock correlation (positive $\rightarrow$ negative).
- **Policy Implication:** Structural macro changes (e.g., Fed reaction function) reshape asset risk profiles.

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# Literature Review: What Came Before

**Two Streams in Macro-Finance:**

- **Consumption-Based Asset Pricing (Lucas, 1978; Mehra-Prescott, 1985):**
  - Explains asset prices using marginal utility of consumption.
  - Cannot generate realistic equity premium or time-varying risk premia under smooth consumption.
- **Habit Formation (Campbell-Cochrane, 1999):**
  - Introduces surplus consumption ratio to induce endogenous risk aversion.
  - Powerful for equity volatility and predictability, but not naturally embedded in macro models.

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# Literature Review: New Keynesian Models and Macroeconomic Frictions

**Key Ideas of the New Keynesian Approach:**

- **Loglinear Euler Equation:**

$$x_t = f_x \mathbb{E}_t x_{t+1} + \rho_x x_{t-1} - \psi r_t$$

- **Nominal Rigidities:** Sticky prices and wages create real effects of monetary policy.
- **Monetary Rules:** Taylor rules guide central bank responses to inflation and output gaps.
- **Focus:** Business cycle dynamics, inflation targeting, but usually ignore asset prices.

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# Literature Review: How Macro Models Influence Asset Prices

**Mechanisms Linking Macro to Markets:**

- **Euler Equation as Pricing Kernel:** Determines real interest rate and discount factor.
- **Inflation and Output Risk:** Affect real payoffs of nominal assets (bonds).
- **Monetary Policy Regime:** Changes in policy reaction functions shift return dynamics.
- **Expectations Channel:** Bond prices reflect expectations of future inflation and policy.
- **Risk Premia Channel:** Surplus consumption dynamics feed back into required returns.

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# Framework of the Model

**Goal:** Integrate macroeconomic dynamics and asset pricing in a unified structure.

**Three Building Blocks:**

- **Preferences:** Habit formation à la CampbellCochrane, generating endogenous, time-varying risk aversion.
- **Macroeconomic Dynamics:** Loglinear, homoskedastic processes for the output gap, inflation, and the nominal interest rate.
- **Asset Pricing:** Bonds and stocks priced as claims on consumption; returns depend on macro state and surplus consumption.

**Key Innovation:** Preferences are designed to be consistent with an *exact* loglinear Euler equation  a bridge between asset pricing and structural macro models.

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# Framework: Key Formulas of the Model

**Preferences and Surplus Consumption:**

$$U_t = \frac{(C_t - H_t)^{1-\gamma} - 1}{1-\gamma}, \quad S_t = \frac{C_t - H_t}{C_t}, \quad \mathrm{RRA}_t = \frac{\gamma}{S_t}$$

**Euler Equation (output gap version):**

$$x_t = f_x \mathbb{E}_t x_{t+1} + \rho_x x_{t-1} - \psi r_t$$

**Inflation and Interest Rate Laws of Motion:**

$$\pi_t = b_{\pi x} x_{t-1} + b_{\pi\pi} \pi_{t-1} + b_{\pi i} i_{t-1} + \varepsilon_t^{\pi}$$
$$i_t = b_{ix} x_{t-1} + b_{i\pi} \pi_{t-1} + b_{ii} i_{t-1} + \varepsilon_t^{i}$$

**Bond Pricing Recursion:**

$$P_t^n = \mathbb{E}_t \left[ M_{t+1} e^{-\pi_{t+1}} P_{t+1}^{n-1} \right],$$

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# Framework: Risk Premia in the Model

**Risk Premia Driven by Surplus Consumption:**

- Time-varying risk premia arise from variation in the surplus consumption ratio $S_t$:

$$\mathrm{RRA}_t = \frac{\gamma}{S_t}, \quad \text{so higher risk aversion when } S_t \downarrow$$

**Stock Risk Premium:**

$$\mathbb{E}_t[R^{\text{stock}}_{t+1} - r_t] + \frac{1}{2}\,\mathrm{Var}_t(R^{\text{stock}}_{t+1}) = \gamma(1 + \lambda(S_t))\sigma_x^2$$

- Positively related to output gap volatility and surplus sensitivity.

**Bond Risk Premium (e.g. 2-period nominal bond):**

$$\mathbb{E}_t[R^b_{t+1} - r_t] + \frac{1}{2}\,\mathrm{Var}_t(R^b_{t+1}) = \gamma(1 + \lambda(S_t)) \cdot \mathrm{Cov}_t(x_{t+1}, -i_{t+1} - \pi_{t+1})$$

# Framework: Calibration and Estimation Strategy

**Objective:** Match model-implied moments to empirical moments using Simulated Method of Moments (SMM).

**Parameter Vector:**

$$\theta = [b_{\pi x}, b_{\pi\pi}, b_{\pi i}, b_{ix}, b_{i\pi}, b_{ii}, \sigma_\pi, \sigma_i, \sigma^*, \rho_{\pi i}, \rho_{\pi^*}, \rho_{i^*}]$$

**Objective Function:**

$$W(\theta) = \left(\hat{\Psi} - \Psi(\theta)\right)^\top \hat{W} \left(\hat{\Psi} - \Psi(\theta)\right)$$

- $\hat{\Psi}$: vector of empirical moments
- $\Psi(\theta)$: vector of model-implied simulated moments
- $\hat{W}$: weighting matrix (diagonal, inverse variances)

**Targeted Moments:**

- Impulse responses (VAR) for $x_t, \pi_t, i_t$
- Correlation between 20-quarter average Fed Funds rate and output gap

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# Framework: Machine Learning Methods for Calibration

**Enhancing SMM Calibration with Machine Learning:**

**1. Neural Network Surrogate Model**

- Approximates the mapping $\theta \mapsto \Psi(\theta)$ using a feedforward neural network trained on simulated data.
- Allows fast evaluation of moments without solving the full model each time.
- Facilitates gradient-based optimization in high-dimensional parameter space.

**2. Bayesian Optimization**

- Global optimization method using probabilistic surrogate (e.g., Gaussian process).
- Efficiently explores the parameter space with few evaluations.
- Balances exploration (new areas) and exploitation (known good fits).

# Results: Model Performance

**Asset Pricing Successes:**

- **Stocks:** Realistic Sharpe ratios and excess return volatility.
- **Bonds:** Positive bond-stock correlation in period 1, negative in period 2.
- **Risk Premia:** Endogenous and nonlinear; respond to surplus consumption dynamics.

**Macroeconomic Dynamics:**

- Captures switch in inflation-output gap correlation (negative positive).
- Smooth and hump-shaped impulse responses to interest rate shocks.
- Matches long-term Fed Fundsoutput gap correlation across regimes.

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# Results: Calibration and Estimation

**Estimation Insights:**

- Two subperiods: 1979Q32001Q1 and 2001Q22011Q4.
- Break in inflation-output gap cyclicality validated by QLR tests.
- Lag parameters (especially $b_{ix}$) drive regime shift in bond risk.

**Key Estimates:**

- Period 1: Bonds *risky*, positively correlated with stocks.
- Period 2: Bonds *hedges*, negatively correlated with stocks.
- Time-varying stock and bond risk premia explain 7080% of the shift in bond-stock correlation.

**Conclusion:** The SMM-calibrated model explains asset return regime shifts using only macro targets.

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# Post-Estimation: ML-Based Calibration Results

**Goal:** Evaluate whether ML methods improve or confirm SMM-based calibration.

**Using Machine Learning Methods:**

- **Neural Network Surrogate:** Improved the speed of moment evaluations significantly.
- **Bayesian Optimization:** Found better-fitting parameter regions under fewer simulations.

**Results:**

- Slightly better match to long-horizon Fed Fundsoutput gap correlation.
- Improved fit to the bond return variance and bond-stock beta in period 2.
- Reduced numerical instability in asset pricing recursion for low surplus states.

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# References I


- Campbell, J. Y., Pfueger, C., & Viceira, L. M. (2019). *Macroeconomic Drivers of Bond and Equity Risks*. NBER Working Paper No. 14-031.
- Campbell, J. Y., & Cochrane, J. H. (1999). By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior. *Journal of Political Economy*, 107(2), 205251.
- Clarida, R., Gali, J., & Gertler, M. (1999). The Science of Monetary Policy: A New Keynesian Perspective. *Journal of Economic Literature*, 37(4), 16611707.
- Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press.
- Christiano, L. J., Eichenbaum, M., & Evans, C. L. (2005). Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. *Journal of Political Economy*, 113(1), 145.


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# Data and Code Availability

**All data, code, and calibration tools used in this presentation are freely available at:**

github.com/andrealandini/
Empirical-Asset-Processing-Project2025

**Includes:**

- Replication data (macro series, impulse responses, returns)
- Calibration code (SMM + machine learning)
- Presentation slides and LaTeX source

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