The Equity Premium, Long-Run Risk and Optimal Monetary Policy

Anthony M. Diercks

February 27, 2016

The analysis and conclusions set forth are those of the author and do not indicate concurrence by other members of the research staff or the Board of Governors.

Question

What is the optimal inflation rate?

- "2 % is most consistent over the longer run with the Federal Reserve's mandate for price stability and maximum employment."
  $\rightarrow$ Official Federal Reserve Website.
- United States, United Kingdom, Euro Area, Japan, Sweden, Switzerland, Australia: $\approx$ 2%
- "I don't see anything magical about targeting 2 percent inflation."
  $\rightarrow$ Ben Bernanke

Existing Quantitative Studies

72 published studies about optimal monetary policy

- **17** studies $\Longrightarrow$ **Negative** optimal inflation rate.
  - Friedman Rule (Set MC of money to zero)
- **35** studies $\Longrightarrow$ **Zero** optimal inflation rate
  - Sticky Prices $\Longrightarrow$ Price Dispersion $\Longrightarrow$ Inefficient Production
- **11** studies $\Longrightarrow$ **Positive** optimal inflation rate
  1. Distortionary Taxes
  2. Govt. Transfers
  3. Sticky Wages
  4. Price/Wage Markup Shocks
  5. Zero-Lower Bound
  6. Price indexation or Flexible Prices

Zero quantitative studies imply 2% optimal inflation rate.

Issue with Existing Literature

Almost all existing models use either

(1) Log-linearization $\Longrightarrow$ No risk.

(2) Power utility or log preferences $\Longrightarrow$ No risk.

(3) EZ or Habits $\Longrightarrow$ Not calibrated to equity premium.

Contribution of this Paper

Standard New Keynesian model

(1) Long-run growth uncertainty

(2) Recursive preferences

$\Longrightarrow$ Higher Equity Premium

$\Longrightarrow$ Higher Welfare Costs of Recessions

Punchline: Asset pricing matters.

$\Longrightarrow$ Optimal inflation rate and volatility rise with equity premium.

$\Longrightarrow$ Model-based optimal inflation rate $\approx$ 3.5%.

Households

Households choose state contingent $\{c_t, 1-h_t\}$ to maximize

$$v_t = \left\{(1-\beta)(c_t^{\iota}(1-h_t)^{1-\iota})^{1-\frac{1}{\psi}} + \beta(E_t[v_{t+1}^{1-\gamma}])^{\frac{1-\frac{1}{\psi}}{1-\gamma}}\right\}^{\frac{1}{1-\frac{1}{\psi}}}$$

- Disentangles γ and ψ.
- When $\gamma > \frac{1}{\psi}$, agents prefer early resolution of uncertainty

$\Longrightarrow$ dislike shocks to long-run expected growth.

$$c_t + i_t + \tau_t = w_t h_t + u_t k_t + \tilde{\Phi}_t$$

Calibration: IES(ψ)=0.2, $\iota = 0.35$, $\beta = 0.999$, $RA = 5.5$

Dynamic IS Curve

Key component of Dynamic IS Curve is Stochastic Discount Factor

$$1 = E_t[\mathbf{SDF_{t+1}} R_{t+1}]$$

Now, $SDF_{t+1} = SDF_{t+1,CRRA} \cdot \underbrace{\left[\frac{v_{t+1}}{E_t[v_{t+1}^{1-\gamma}]^{\frac{1}{1-\gamma}}}\right]^{\frac{1}{\psi}-\gamma}}_{\text{Sensitive to LRR News}}$

Nonlinear framework $\Longrightarrow$ More weight on bad states.

$\Longrightarrow$ How policy reacts in bad states matters more.

Firms: Phillips Curve

- Continuum of monopolistic firms (gross markup μ)
- Calvo price setting (probability α)
- Cobb-Douglas Production Function: $Y_t(i) = K_t^{\theta}(i)(A_t H_t)^{1-\theta}$

Key component of Dynamic New Keynesian Phillips Curve is SDF

$$P^*_{t,i} = Markup \cdot PV(MarginalCosts)$$

where

$$PV(MarginalCosts) \approx \underbrace{mc_t}_{\text{Myopic}} + \underbrace{\sum_{j=1}^{\infty} \overbrace{\alpha^j}^{\text{P(stuck)}} \cdot E_t\left[\mathbf{SDF_{t+j|t}} \cdot mc_{t+j}\right]}_{\text{Forward looking PDV}}$$

Calibration: Calvo(α) $= 0.75$, Markup(μ) $= 15\%$, $\theta = 0.25$

Productivity Risks

Both short-run and long-run productivity risks:

$$\log \frac{A_{t+1}}{A_t} \equiv \Delta a_{t+1} = \mu_a + x_t + \sigma_a \varepsilon_{a,t+1},$$

$$x_t = \rho x_{t-1} + \sigma_x \varepsilon_{x,t},$$

$$\begin{bmatrix} \varepsilon_{a,t+1} \\ \varepsilon_{x,t+1} \end{bmatrix} \sim^{i.i.d} N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \right), \quad t = 0, 1, 2, \cdots.$$

x_t captures small, persistent time variation
in conditional expectation of productivity growth.
$\rightarrow E_t[\Delta a_{t+1}] = \mu_a + x_t$
$\rightarrow$ Long-run News

Calibration: $\mu_a = 2\%$, $\rho = 0.92$, $\sigma_a = 0.015$, $\sigma_x = 0.15 \cdot \sigma_a$

Government Policy

Fiscal Policy: Lump sum taxes to fund exogenous spending.

Monetary Policy: Ramsey Policy

Chooses state contingent nominal interest rate $\{R_t\}_{t=0}^{\infty}$

to maximize V_t

s.t.

λ_n(N-1 Equilibrium Conditions)

Solution

Divide nonstationary variables (y_t, c_t, w_t, etc.) by A_t

To solve: Take FOC wrt to N endog. variables and N-1 Multipliers.

$\Longrightarrow$ 2N-1 Ramsey Conditions and 2N-1 Endog. Variables

Solve w/ perturbation methods around deterministic steady state.

$\Longrightarrow$ 2nd Order Approximation to capture risk.

$\Longrightarrow$ Nonlinear $\Longrightarrow$ Policy can influence first moments.

Ramsey Planner Tradeoffs

(1) Consumption Volatility $\Longrightarrow$ Concave, Nonlinear utility

(2) Price Dispersion $\Longrightarrow$ Inefficient production

(3) Markup $\Longrightarrow$ Implicit tax

Optimal Ramsey Policy: Low Equity Premium

	$E(\pi)$	$\sigma(\pi)$	$\sigma(CL)$	$E(\mu)$	$Perp.(\$)$
Panel A: RA = 2, no LRR					
Ramsey Optimal	0.05	0.04	0.64	0.153	–
Inflation Targeting	0.00	0.00	0.65	0.154	$62

Low equity premium: Ramsey cares only about inflation.

$\Longrightarrow$ Ramsey enacts almost strict price stability.

$\Longrightarrow$ Confirms many existing studies.

Optimal Ramsey Policy: High Equity Premium

	$E(\pi)$	$\sigma(\pi)$	$\sigma(CL)$	$E(\mu)$	$Perp.(\$)$
Panel B: RA = 5.5, with LRR					
Ramsey Optimal	3.61	1.38	1.35	0.09	–
Inflation Targeting	0.00	0.00	1.49	0.15	$10,593

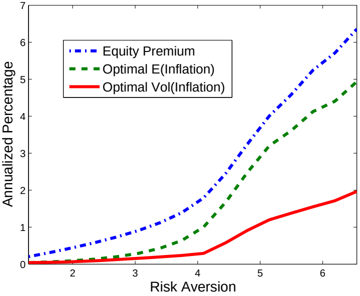
High equity premium: Ramsey cares less about inflation

$\Longrightarrow$ Wants to stabilize Consumption-Leisure bundle.

$\Longrightarrow$ Reduce average markup.

$\Longrightarrow$ Comes at expense of higher, more volatile inflation.

Equity Premium vs Optimal Inflation Moments

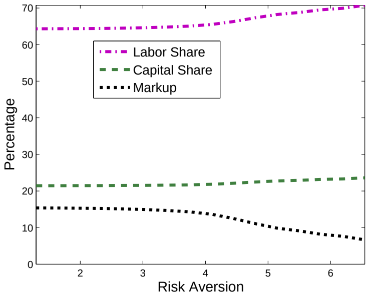


Higher Risk Aversion $\Longrightarrow$ Higher Equity Premium

$\Longrightarrow$ Higher optimal average inflation

$\Longrightarrow$ Higher optimal inflation volatility

Risk Aversion vs Markup & Factor Shares



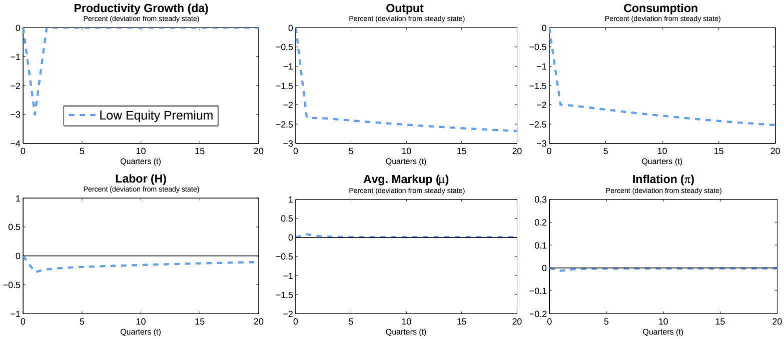
Higher Risk Aversion:

$\Longrightarrow$ Higher labor share of income

$\Longrightarrow$ Lower markup

Ramsey: Push output above natural (inefficient) level in bad states.

IRF for Negative Short Run Shock

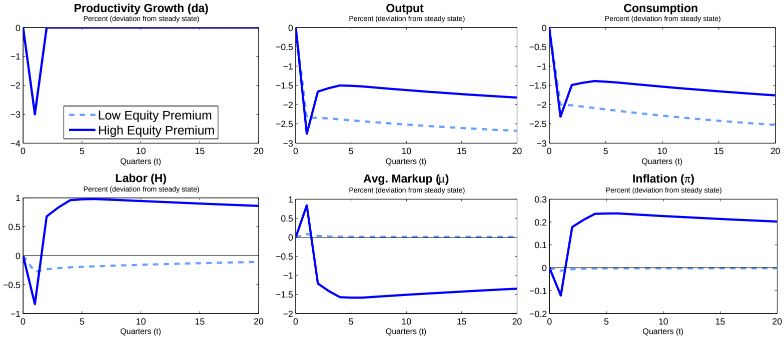


Low equity premium:

$\Longrightarrow$ Complete price stability

$\Longrightarrow$ Replicates flexible price, natural (inefficient) level of output

IRF for Negative Short Run Shock

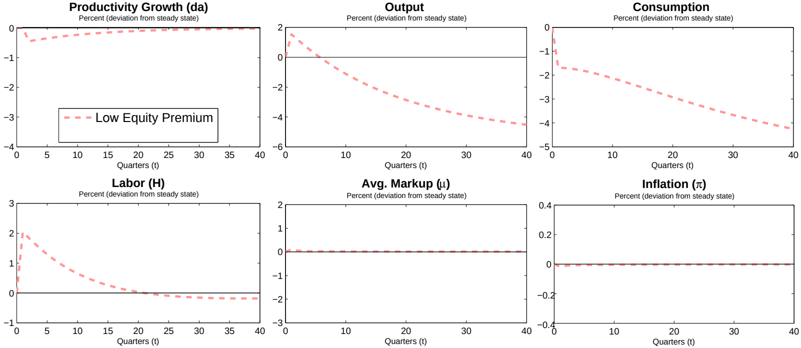


High equity premium:

$\Longrightarrow$ Pushes output past natural, stabilizing medium-long term.

$\Longrightarrow$ Reduces average markup over medium-long term.

IRF for Negative Long Run Shock

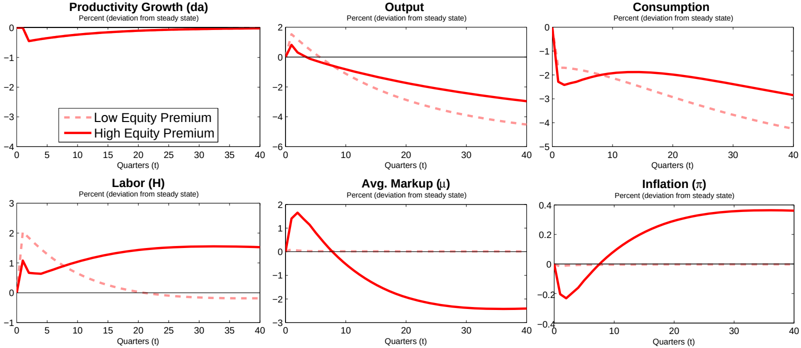


Low equity premium:

$\Longrightarrow$ Complete price stability

$\Longrightarrow$ Replicates flexible price, natural (inefficient) level of output

IRF for Negative Long Run Shock



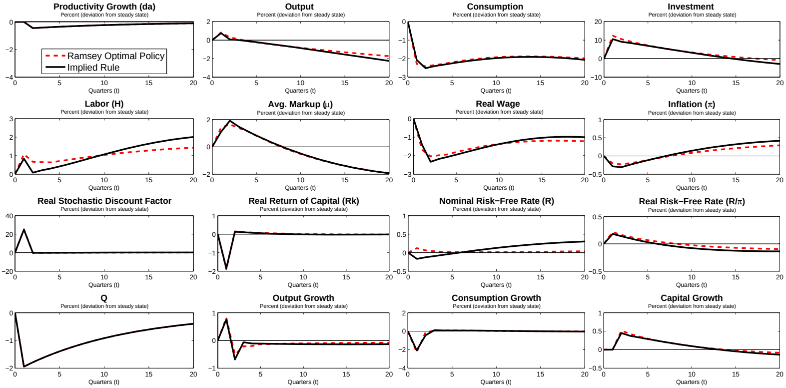
High equity premium:

$\Longrightarrow$ Pushes output past natural, stabilizing medium-long term.

$\Longrightarrow$ Reduces average markup over medium-long term.

Which Rule Replicates Ramsey?

$$\hat{R}_t = 0.95 \cdot \hat{R}_{t-1} + (1 - 0.95) \cdot (5 \cdot \hat{\pi}_t + 9 \cdot \Delta k_t + 1 \cdot q_t)$$



Which Rule Replicates Ramsey?

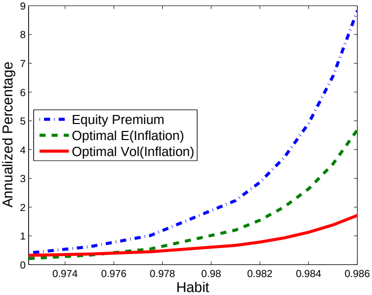
$$\hat{R}_t = 0.95 \cdot \hat{R}_{t-1} + (1 - 0.95) \cdot (5 \cdot \hat{\pi}_t + 9 \cdot \Delta k_t + 1 \cdot q_t)$$

Ramsey cares about long-run.

$\Longrightarrow$ Wants to stabilize investment.

$\Longrightarrow$ Smooth interest rate $\Longrightarrow$ Greater long-run effects.

PRELIMINARY: Internal Habits



Assume no long run risk, only short run shocks.
$\Longrightarrow$ Similar outcome.

Caveats and Disclaimers

(1) Still very stylized model (on purpose).
(2) No financial accelerator or intermediaries
    - Little to say about responding to asset prices.
(3) Agents know exactly how policy is conducted.
(4) Analysis says nothing directly about "target inflation rate."
    - Instead, this is about average rate over time.

Takeaways & Conclusion

- Asset pricing matters for policy and welfare analysis.

  $\Longrightarrow$ Low equity premium $\Longrightarrow$ $E(\pi) = 0\%$

  $\Longrightarrow$ High equity premium $\Longrightarrow$ $E(\pi) > 3\%$

- The net costs associated with inflation $> 2\%$ are potentially less than suggested by previous studies.