Risk-premium shocks and the zero bound on nominal interest rates

Robert Amano    Malik Shukayev
Bank of Canada   Bank of Canada

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Motivation

Is zero bound on nominal interest rates relevant for optimal monetary policy design?

Eggertsson & Woodford (2003): YES

- If shocks large enough, efficient response may require negative (ex-ante) real interest rate
- In a low inflation environment (typical for optimal monetary policies) zero-bound makes that infeasible
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Are historically-measured shocks large enough to drive real rates to zero?
- Christiano (2004): Not likely, with endogenous investment
- Schmitt-Grohe & Uribe (2005): Highly unlikely
What we do?

In a standard DSGE model, we identify which of commonly considered aggreg. shocks, have large enough historical magnitudes to drive real interest rates to zero.

Aggregate shocks:

1. Neutral technology shocks
2. Investment specific technology shocks
3. Government spending shocks
4. Money demand shocks
5. Risk – premium shocks (RP shocks)
What we find?

Historical magnitude of risk-premium shocks is large enough to drive real rates on government bonds to zero.

Historical magnitudes of other four aggregate shocks make them unlikely candidates to do the same.
Risk-premium shocks

Ex-ante risk premium on equity of US corporations relative to government bonds (net of default-risk compensation)

Model

- Rep. household cares about consumption, leisure, and real money balances
- Firms produce with capital and labour
- Sticky nominal prices
- Measured aggregate shocks:
  - Neutral technology shocks, from TFP
  - Investment-specific technology shocks, as in Fisher (2005)
  - Government spending shocks, from NIPA
  - Money demand shocks, from money demand variation
Households

\[
\max_{C_t, H_t, M_t, I_t, B_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{\gamma}{\gamma - 1} \log \left( \frac{\gamma - 1}{C_t^\gamma + \mu_t^\gamma \left( \frac{M_t}{P_t} \right)^{\frac{\gamma - 1}{\gamma}}} \right) + \eta \log (1 - H_t) \right]
\]

subject to

\[
P_t \left( C_t + I_t + CAC_t \right) + \frac{B_t}{R_t} + M_t = W_t H_t + P_t^k \left( q_t - \tau_{t-1} \right) K_{t-1} + B_{t-1} + M_{t-1} - T_t
\]

\[
CAC_t = \frac{\varphi}{2} \left( \frac{K_t}{K_{t-1}} - g_k \right)^2 \frac{K_{t-1}}{X_t}
\]

\[
K_t = (1 - \delta) K_{t-1} + X_t I_t
\]
Simplified FOCs for bonds and capital

From

\[ 1 = \beta \mathbb{E}_t \left[ \frac{\lambda_{t+1}}{\lambda_t} \frac{R_t}{\pi_{t+1}} \right] \]

\[ 1 = \beta \mathbb{E}_t \left[ \frac{\lambda_{t+1}}{\lambda_t} \frac{X_t}{X_{t+1}} (q_{t+1} - \tau_t) \right] \]

obtain

\[ \mathbb{E}_t \left[ \frac{R_t}{\pi_{t+1}} \right] + \tau_t \approx \mathbb{E}_t [q_{t+1}] \]
Technology

Final good

\[ C_t + I_t + G_t + CAC_t = \left( \int_0^1 \frac{\theta-1}{\theta} Y_{j,t} \, dj \right)^{\frac{\theta}{\theta-1}} \]

Monopolistically competitive intermediate producers

\[ Y_{j,t} = A_t \left( H_{j,t} \right)^{2/3} \left( K_{j,t} \right)^{1/3} \]

Intermediate goods prices:

Calvo sticky – price adjustment probability, 1/3
Monetary policy

Zero-(net) inflation rate: \[ \pi_t = \frac{P_t}{P_{t-1}} = 1 \]

Nearly optimal in sticky-price models

But, calibrate model with forward-looking Taylor rule:
\[
\ln\left(\frac{R_t}{\bar{R}}\right) = (1 - \rho_R) \left[ \beta_\pi E_t \ln\left(\frac{\pi_{t+1}}{\bar{\pi}}\right) + \beta_y \ln\left(\frac{y_t}{\bar{y}}\right) \right] + \rho_R \ln\left(\frac{R_{t-1}}{\bar{R}}\right)
\]
Aggregate shocks

1. Equity risk-premia, BBB corporations (1974q1-1998q1)
   \[ \tau_t = 0.16 \bar{\tau} + 0.84 \tau_{t-1} + \varepsilon_t^\tau, \quad \varepsilon_t^\tau \sim N(0, 0.8^2) \]

2. Neutral technology:
   \[ \ln \left( \frac{A_t}{A_{t-1}} \right) = 0.19 + \varepsilon_t^A, \quad \varepsilon_t^A \sim N(0, 0.6^2) \]

3. Invest-specif tech:
   \[ \ln \left( \frac{X_t}{X_{t-1}} \right) = 0.29 + \varepsilon_t^X, \quad \varepsilon_t^X \sim N(0, 0.6^2) \]

4. Gov. spend.:
   \[ \frac{G_t}{Y_t} = 0.02 \bar{G} + 0.98 \frac{G_{t-1}}{Y_{t-1}} + \varepsilon_t^G, \quad \varepsilon_t^G \sim N(0, 0.2^2) \]

5. Money dem:
   \[ \ln \mu_t = 0.02 \ln \bar{\mu} + 0.98 \ln \mu_{t-1} + \varepsilon_t^\mu, \quad \varepsilon_t^\mu \sim N(0, 1^2) \]
Calibrating structural parameters

1. Most parameters calibrated from first moments

2. Capital adjustment cost parameter $\varphi$ in

$$CAC_t = \frac{\varphi}{2} \left( \frac{K_t}{K_{t-1}} - g_k \right)^2 \frac{K_{t-1}}{X_t}$$

and three Taylor rule coefficients in

$$\ln \left( \frac{R_t}{R} \right) = (1 - \rho_R) \left[ \beta_\pi E_t \ln \left( \frac{\pi_{t+1}}{\pi} \right) + \beta_y \ln \left( \frac{y_t}{\bar{y}} \right) \right] + \rho_R \ln \left( \frac{R_{t-1}}{R} \right)$$

jointly calibrated to match four second moments
## Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Matched moment</th>
<th>Moment value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Real risk-free rate (90-days T-bill)</td>
<td>2.5</td>
</tr>
<tr>
<td>$\bar{\pi}$</td>
<td>PCE inflation rate</td>
<td>3.6</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Fraction of time worked</td>
<td>0.25</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Consumption share of GDP</td>
<td>0.65</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Labour income share</td>
<td>0.58</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>St.dev. of Investm./Consump. Ratio, %</td>
<td>3.26</td>
</tr>
<tr>
<td>$\beta_\pi$</td>
<td>St.dev. of risk-free rate, %</td>
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<td>$\beta_y$</td>
<td>St.dev. of labour income share, %</td>
<td>0.92</td>
</tr>
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<td>$\rho_R$</td>
<td>AR(1) coef. of risk-free rate</td>
<td>0.95</td>
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</table>
## Calibration results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data (74q1-98q1)</th>
<th>Model</th>
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<tr>
<td></td>
<td>St.dev,%</td>
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<td>Investment/GDP ratio</td>
<td>1.60</td>
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<tr>
<td>Inflation</td>
<td>0.68</td>
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<td>Aggregate hours</td>
<td>0.80</td>
<td>0.99</td>
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Zero inflation policy

Stabilizes the economy and the risk-free rate (RFR)

<table>
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<tr>
<th>St. deviation of</th>
<th>Taylor rule</th>
<th>Zero-inflation</th>
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<tr>
<td>Hours</td>
<td>0.80</td>
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<tr>
<td>Investm./Output ratio</td>
<td>1.64</td>
<td>1.58</td>
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<tr>
<td>Consum./Output ratio</td>
<td>1.89</td>
<td>1.85</td>
</tr>
<tr>
<td>Detrended Output</td>
<td>1.86</td>
<td>1.56</td>
</tr>
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<td>Risk-free rate</td>
<td>0.63</td>
<td>0.31</td>
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Probability of RFR in [0, 5 bp] range is 1.7 percent, or once in 15 years

Which shock has largest effect on RFR?
Risk – premium shocks

IRFs for risk free rate, basis points

Key:
- blue: neutral prod.
- green: money demand
- red: government spending
- cyan: investment-specific
- purple: risk-premium
## Zero inflation policy

<table>
<thead>
<tr>
<th>St. deviation of</th>
<th>With risk-premium shocks</th>
<th>No risk-premium shocks</th>
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<tr>
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Without risk-premium shocks, lowest (simulated) RFR is 6 standard deviations away from zero.
Why RP shocks move RFR so much?

From (simplified) FOCs for risk-free bonds and capital

\[ 1 = \beta E_t \left[ \frac{\lambda_{t+1}}{\lambda_t} \frac{R_t}{\pi_{t+1}} \right] \]

\[ 1 = \beta E_t \left[ \frac{\lambda_{t+1}}{\lambda_t} \frac{X_t}{X_{t+1}} (q_{t+1} - \tau_t) \right] \]

obtain

\[ E_t \left[ \frac{R_t}{\pi_{t+1}} \right] + \tau_t \approx E_t [q_{t+1}] \]

RP shock has a first order effect on real risk-free rate
Sensitivity Analysis: Smaller RP shocks

Use equity risk-premia of AAA & AA corporations (1974q1-1998q1)

\[ \tau_t = 0.12\bar{\tau} + 0.88\tau_{t-1} + \varepsilon_t^\tau, \quad \varepsilon_t^\tau \sim N\left(0, 0.3^2\right) \]

instead of those for BBB corporations

\[ \tau_t = 0.16\bar{\tau} + 0.84\tau_{t-1} + \varepsilon_t^\tau, \quad \varepsilon_t^\tau \sim N\left(0, 0.8^2\right) \]
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With RP shocks: probability of RFR in [0, 5 bp] range = 0.6 percent

No RP shocks: lowest RFR 4 standard deviations away from zero
Conclusions

To the extent risk-premium shocks are important, zero bound on nominal interest rates is relevant for monetary policy design.
Thank you