Price-Level Targeting and Risk Management in a Low-Inflation Economy

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Motivation: Inflation is bad, but deflation is worse.

- Inflation ultimately reduces standards of living. Thus, policymakers typically aim for low inflation.

- For a number of reasons, however, inflation can be too low:
  - Zero lower bound (ZLB) on nominal interest rates—\( i_t \geq 0 \);
  - Measurement bias in inflation—0.5% bias for PCE inflation;
  - Downward wage rigidity (Tobin 1972);
  - Debt-Deflation (Fisher 1933).

- Low-probability catastrophes or “downside tail risks”, such as a sustained deflation or recession, can be very difficult to resolve.

- Can policymakers protect the economy against lower-tail risks?
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Contribution: Price-level targeting (PLT) cures deflation.

- Inflation targeting (IT) does not pin down the price-level path.
- Targeting directly the price-level path helps policymakers shape private-sector expectations of inflation more effectively.
- The economics literature provides intuition about PLT and the ZLB:
- Such studies, however, do not quantify the effectiveness of PLT for managing tail risks of deflation or recession...
- ...this paper does.
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Small New-Keynesian model with sticky-price à la Calvo.

\[ \pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u_t \quad \text{(Phillips curve)} \]

\[ x_t = E_t x_{t+1} - \varphi (i_t - E_t \pi_{t+1} - r^n_t) \quad \text{(Euler equation)} \]

\[ u_t = \rho_u u_{t-1} + \sigma_{\varepsilon u} \varepsilon_{ut} \quad \text{(Mark-up shock)} \]

\[ r^n_t = \rho_r r^n_{t-1} + (1 - \rho_r) \bar{r} + \sigma_{\varepsilon r} \varepsilon_{rt} \quad \text{(Real-rate shock)} \]

where the innovations are normally distributed: \( \varepsilon_{ut}, \varepsilon_{rt} \sim \mathcal{N}(0, 1) \).
Policy is conducted through a simple interest-rate rule subject to the ZLB.

$$i_t = \max [0, i_{t-1} + \phi_\pi (\pi_t - \pi^*) + \phi_x (x_t - x^*)] \quad \text{(Simple IT Rule)}$$

where $$\pi_t \equiv p_t - p_{t-1}$$ and $$p_t$$ is the price level in period $$t$$.

$$i_t = \max \left[ 0, i_{t-1} + \phi_p (p_t - \bar{p}_t) + \phi_x (x_t - x^*) \right] \quad \text{(Simple PLT Rule)}$$

where the price-level path $$\{\bar{p}_t\}$$ grows deterministically at target rate $$\pi^*$$. 
Optimal simple policy rules maximize social welfare.

\[
(\phi_{x}^{op}, \phi_{\pi}^{op} \text{ or } \phi_{p}^{op}) = \arg \max -E_{0} \sum_{t=0}^{\infty} \beta^{t} \left[ \pi_{t}^{2} + \lambda x_{t}^{2} \right]
\]

where the weight \( \lambda \equiv \frac{\kappa}{\theta} > 0 \) is a function of the structure of the economy and

\[
\kappa \equiv \frac{(1-\alpha)(1-\alpha\beta)}{\alpha} \frac{\varphi^{-1} + \omega}{1 + \omega \theta} > 0.
\]
Find solution with numerical procedure of Billi (2007).

The solution is an equilibrium response function

\[ y(\mathbf{s}_t) \equiv (\pi_t, x_t, i_t \geq 0) \subset \mathbb{R}^3 \]

over the state space

\[ \mathbf{s}_t \equiv (u_t, r^t_n, i_{t-1} \geq 0, \hat{p}_{t-1}) \subset \mathbb{R}^4 \]

where \( \hat{p}_{t-1} \equiv p_{t-1} - \bar{p}_{t-1} \) is a state variable for PLT, but not IT.
Calibration to recent U.S. data (Quarterly Model).

<table>
<thead>
<tr>
<th>Parameter Definition</th>
<th>Assigned Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective discount factor</td>
<td>$\beta = 0.9926$</td>
</tr>
<tr>
<td>Real-rate elasticity of output</td>
<td>$\varphi = 6.25$</td>
</tr>
<tr>
<td>Share of firms keeping prices fixed</td>
<td>$\alpha = 0.66$</td>
</tr>
<tr>
<td>Price elasticity of demand</td>
<td>$\theta = 7.66$</td>
</tr>
<tr>
<td>Elasticity of firms’ marginal cost</td>
<td>$\omega = 0.47$</td>
</tr>
<tr>
<td>Slope of the Phillips Curve</td>
<td>$\kappa = 0.024$</td>
</tr>
<tr>
<td>Weight on output gap in the utility function</td>
<td>$\lambda = 0.003$</td>
</tr>
<tr>
<td>Steady state real interest rate</td>
<td>$r_{ss} = 3.0%$ per year</td>
</tr>
<tr>
<td>s.d. real-rate shock innovation</td>
<td>$\sigma_{\varepsilon r} = 0.24%$</td>
</tr>
<tr>
<td>s.d. mark-up shock innovation</td>
<td>$\sigma_{\varepsilon u} = 0.30%$</td>
</tr>
<tr>
<td>AR(1)-coefficient of real-rate shock</td>
<td>$\rho_{r} = 0.8$</td>
</tr>
<tr>
<td>AR(1)-coefficient of mark-up shock</td>
<td>$\rho_{u} = 0.1$</td>
</tr>
<tr>
<td>Inflation Target (w/o inflation measurement bias)</td>
<td>$\pi^* = 1.0%$ per year</td>
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<tr>
<td>(Optimal) Interest-rate response to inflation, or</td>
<td>$\phi_{\pi} = 1.0$</td>
</tr>
<tr>
<td>(Optimal) Interest-rate response to the price level</td>
<td>$\phi_{p} = 0.4$</td>
</tr>
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<td>Interest-rate response to the output gap</td>
<td>$\phi_{x} = 0.0$</td>
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## Preview of main findings (table 1)

<table>
<thead>
<tr>
<th>Policy Framework*</th>
<th>Loss%</th>
<th>Fr((i = 0))%</th>
<th>Skew.((\pi))</th>
<th>Kurt.((\pi))</th>
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<tbody>
<tr>
<td>Optimal Policy</td>
<td>-0.13</td>
<td>0.4</td>
<td>0.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Optimal Simple IT Rule(^A)</td>
<td>-0.17</td>
<td>0.0</td>
<td>0.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Optimal Simple PLT Rule(^A)</td>
<td>-0.18</td>
<td>0.0</td>
<td>0.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Aggressive Simple IT Rule(^B)</td>
<td>-0.18</td>
<td>1.0</td>
<td>-0.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Aggressive Simple PLT Rule(^B)</td>
<td>-0.19</td>
<td>0.0</td>
<td>0.0</td>
<td>3.0</td>
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* PCE-price inflation in the long run is 1.5 percent per year for each framework.

\(^A\) \(\phi_{\pi}^{op} = 1.0\) or \(\phi_{p}^{op} = 0.4\)

\(^B\) \(\phi_{\pi}^{op} = 2.5\) or \(\phi_{p}^{op} = 1.0\)
Moderate Inflation Is Very Costly (figure 1).
PLT protects against hitting the ZLB (figure 2).
PLT protects against tail risk of deflation (figure 3).
Responding to output is not a good idea (figure 4).

Graphs showing:
- Simple IT Rule: \( \pi^* = 1\% \) with Perm. Consumption Loss
  - Optimal Simple Response = 0.2
- Simple PLT Rule: \( \pi^* = 1\% \) with Perm. Consumption Loss
  - Optimal Simple Response = 0.2
- Std. Dev. of Output Gap
- Frequency of Bind

Graph legends:
- Optimal Policy
- Simple IT Rule
- Simple PLT Rule
PLT protects against tail risk of recession (figure 5).
Robustness of PLT.

- The risk management property of PLT is a robust finding to:
  - greater uncertainty about the state of the economy (table 3);
  - and a wide range of alternative model calibrations (table 4).
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- In a standard macro model, PLT is effective for risk management:
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  - and it costs little in forgone consumption by agents.
- Case for PLT is even stronger if consider also tail risks due to:
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