Forward Guidance as a Monetary Policy Rule, Zero Lower Bound on Interest Rates and the Cost Channel

LASITHA R.C. PATHBERIYA, PHD
ECONOMIC RESEARCH DEPARTMENT
CENTRAL BANK OF SRI LANKA

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Disclaimer: Views expressed in this presentation and corresponding paper (Interest Rate Rules, Forward Guidance Rules and the Zero Lower Bound on Nominal Interest Rates in a Cost Channel Economy) belong solely to the author, and not necessarily to the author’s employer
Zero Lower Bound on Nominal Interest Rates (ZLB) is no longer a theoretical concept...

- Short-term nominal interest rates were at zero levels in the recent past in many economies around the world.
... and ZLB was accompanied by Deflation and Recession

**Deflation:** Selected Countries

- Monetary policy is restricted by the ZLB constraint and prompted unconventional monetary policies
  - **Forward guidance** and Balance sheet (quantitative easing - QE) policies

**Recession:** USA (GDP)

Source: FRED
Forward Guidance is...

- Central bank's public announcement of its near future policy plan
  - Central bank provides information about its future monetary policy intentions, based on its assessment of the outlook for price stability
  - Odyssean and Delphic Forward Guidance
  - Threshold based and Calendar based Forward Guidance
- Exercised to shape inflationary expectations of economic agents

How does it work?

- Central bank clearly and credibly announces its near term policy path
  - eg. keeping interest rate low for a specific time
- Commercial banks set long term interest rates low, trusting central bank announcement
- Businesses and households get cheaper loans stimulating investments and spending
- Increases inflationary expectations and facilitates growth

A permanent Forward Guidance rule?
... and Cost Channel of Monetary Policy is ...

- the transmission mechanism of the supply-side effect of monetary policy.
  - It is generally assumed that the supplied side effect is transmitted through the Cost Channel of Monetary Policy

- Economists agree monetary policy changes affect the real economy, at least in the short run

- Demand-side effects of monetary policy are well established

Wright Patman – A USA Congressman once said (1970):

... raising interest rates to fight inflation is similar to throwing gasoline on fire to put out the flames...

Wright Patman discussed an extreme case of supply-side effects of monetary policy, which is less examined
and the Cost Channel received considerable attention since 1990s

- Scholars renewed interest of supply side effects with the emergence of *price puzzle* – *rise in price level due tight monetary policy* - in VAR analysis in 1990s.

- A Cost Channel exists in an economy, if changes in nominal interest rates affect firms' costs of production directly - *by way of cost of working capital* - and thereby inflation and output.
  - In this study, I consider firms borrow money to pay wage bill, within the period.

- Cost Channel is empirically validated using:
Outline for the Rest of the Presentation

• Motivation and Objective
• Literature Review
• The Model and Simulation
• Analysis and Results
• Conclusion
Motivation and Objective

Motivation

- Zero lower bound on nominal interest rates restricts monetary policy and worsens recession
- Can a permanent forward guidance rule help increase inflation expectations and revive the economy
- How different would be the impact on Cost Channel economies

Objective

- To examine an endogenous threshold-based forward guidance policy rule at ZLB in a Cost Channel economy
Outline

• Motivation and Objective
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Monetary Policy at ZLB

- **Optimal monetary policy with credible commitment (by managing expectations) improves conditions of recession (perfect foresight):**
  - With Cost Channel: Chattopadhyay and Ghosh (2016), Pathberiya (2016)

- **Occasionally binding ZLB constraint can affect even steady state values (stochastic setting):**
  - **Deflation bias** at (risky) steady state:
    - Optimal monetary policy [Adam and Billi (2006, 2007), Nakov (2008)]
    - Taylor type interest rate rules [Nakov (2008), Hills, Nakata and Schmidt (2016)]
    - No study with Cost Channel

- **Implications of Taylor type interest rate rules at ZLB:**
  - Truncated Taylor rule (TTR)
  - Multiple steady states [Benhabib, Schmitt-Grohé and Uribe (2001)]
Forward Guidance (FG)

- **Odyssean and Delphic Forward guidance** [Campbell, Evans, Fisher and Justiniano (2012)]
  - **Applications (Odyssean):**
    - *Exogenous extension to zero interest rate regime* [Chattopadhyay and Daniel (2015)]
    - *Transitory unanticipated endogenous rule* [Boneva, Harrison and Waldron (2015)]

Forward Guidance rule in this study is closest to latter one -transitory endogenous rule-, but the rule examine in this study is anticipated and permanent
Outline

• Concepts
• Introduction to the Study
• Literature Review
• The Model and Simulation
• Analysis and Results
• Conclusion
The Model

- New Keynesian forward looking inter-temporal model

- Incorporate Cost Channel assuming firms borrow within the period to pay wage bill

- Model economy consists of four main agents: households, firms, monetary authority, financial intermediaries

- ZLB binds occasionally
The Model - Supply and Demand Side Blocks

- Dynamic IS Curve:
  \[ x_t = E_t x_{t+1} - \sigma^{-1} \left( \hat{R}_t - E_t \hat{\pi}_{t+1} - \hat{r}^n_t \right) \]

- New Keynesian Phillips Curve adjusted for Cost Channel:
  \[ \pi_t = \beta E_t \pi_{t+1} + \kappa (\sigma + \eta) x_t + \kappa J \hat{R}_t \]

where \( x_t \) is the output gap, \( \pi_t \) is the rate of inflation between time \( t - 1 \) and \( t \). \( \hat{R}_t \) and \( \hat{r}^n_t \) are the percentage point deviation of nominal interest rate and natural interest rate from their corresponding zero inflation steady state values, respectively. \( \beta \in (0, 1) \) is a subjective rate of discount, \( \sigma > 0 \) is the coefficient of relative risk aversion and \( \eta > 0 \) is the elasticity of labour supply. The slope parameter of the NKPC: \( \kappa = \frac{(1-\omega)(1-\omega \beta)}{\omega} \), where \( \omega \) is share of firms that cannot adjust prices optimally. The parameter \( J \in [0, 1] \) in the NKPC represents the cost channel of monetary policy.

- Economy is prone to hit by a stochastic shock to natural interest rate
  \[ \hat{r}^n_t = \rho \hat{r}^n_{t-1} + \epsilon_t \]

where \( \epsilon_t \) is i.i.d. \( N(0, \sigma^2_{\epsilon}) \), \( \sigma^2_{\epsilon} \) is the variance of the shock and \( \rho \in (0, 1) \) is the persistence parameter.
The Model – Monetary Policy Block

- Baseline: Truncated Taylor Rule (CTTR):

\[ R_t = \max[1, r^* + \pi^* + \phi_\pi (\pi_t - \pi^*) + \phi_x x_t] \]

where \( R_t \) is the gross nominal interest rate, \( r^* \) is the equilibrium real gross interest rate, \( \pi^* \) is the target inflation rate, \( \phi_\pi \) is the inflation response coefficient and \( \phi_x \) is the output gap response coefficient.
The Model – Monetary Policy Block

• **Forward Guidance Rule:** Central bank credibly announces a permanent Forward guidance rule at time zero:

> “We will not increase interest rates until output gap recovers to X in a liquidity trapped recession”

\[
R_t = 1 \quad \text{if} \quad \left[ R_t^{\text{Taylor}} \leq 1 \right] \quad \text{or} \quad \left[ R_{t-1} = 1 \text{ and } x_{t-1} < a \right]
\]

\[
R_t = R_t^{\text{Taylor}} \quad \text{otherwise}
\]

where \( a < 0 \) is a value chosen by the central bank. If the central bank chooses a large value for \( a \), that is considered as strict forward guidance, while if the central bank chooses a small value for \( a \), that is considered as weak forward guidance.
Solution Method

- Since the non-linear rational expectation model is stochastic in nature and ZLB binds occasionally, no analytical solution is possible.
- A numerical approximation method: the collocation method.
- Widely used to solve models with occasionally binding ZLB constraint:

*Advantages:*
  - A global solution technique
  - Flexible and numerically efficient [Miranda and Fackler (2003)]

*Disadvantages:*
  - Non-convergence in certain regions in parameter space
  - Curse of dimensionality
Baseline Calibration

- Calibrated to the US economy. Time period: Quarterly

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Baseline Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Discount rate in the utility function</td>
<td>0.993</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Coefficient of relative risk aversion</td>
<td>4</td>
</tr>
<tr>
<td>$J$</td>
<td>Share of working capital to be financed externally</td>
<td>[0, 1]</td>
</tr>
<tr>
<td>Net Natural rate of interest</td>
<td>Max. depth of the large negative shock (per annum)</td>
<td>$\frac{1}{\beta} - 1 = 3%$</td>
</tr>
<tr>
<td></td>
<td>Standard deviation [per annum, $\sigma(r^n)$]</td>
<td>−6%</td>
</tr>
<tr>
<td></td>
<td>Shock persistence ($\rho$)</td>
<td>0.65</td>
</tr>
<tr>
<td>Taylor Rule</td>
<td>Inflation Target (per annum)</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Coefficient on Inflation ($\phi_\pi$)</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Coefficient on Output ($\phi_\xi$)</td>
<td>1</td>
</tr>
</tbody>
</table>

- Simulations: 20,000 simulations in each case examined with 4,000 periods per simulation
Outline

- Motivation and Objective
- Literature Review
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Baseline Analysis with Truncated Taylor Rule

- Compare and contrast implications of Cost channel and no-Cost Channel economies with ZLB constraint
  - Relationship between std. deviation of shock and pr. of hitting ZLB
  - Dynamic paths of variables
  - Probability of persistence of Zero interest rate regimes
• Natural interest rate remain 10 quarters at the minimum value due to the shock.
The relationship between the standard deviation of shock and the probability of hitting the Zero Lower Bound (ZLB) is depicted in the graph. The graph shows that as the standard deviation of the shock (measured in percentage points) increases, the probability of hitting the ZLB also increases.

Key takeaway:
- The higher the uncertainty, the higher the probability of hitting the ZLB.
Relationship between Std. Deviation of Shock and Probability of Hitting ZLB ctd.

- The higher the uncertainty, the higher the pr. of hitting ZLB
- Pr. of hitting ZLB is higher in Cost Channel economies
Dynamic paths of variables - Baseline

- No deflation bias at deterministic case

- Deflation bias at stochastic steady state in both Cost Channel and no-Cost Channel economies
  - Asymmetry in expected production costs at risky steady state

- Cost Channel economy is more deflationary and recession is deeper

- Higher deflation bias in Cost Channel economies
  - Cost Channel amplifies asymmetry of expected production costs – Agents expect more recessions in Cost Channel economies

Note: Baseline calibration. In the deterministic setting, standard deviation of the natural interest rate has been set to zero.
Probability of Persistence of the Zero Interest Rate Regime

- Persistent ZLB regimes in Cost Channel economies

- The stronger the Cost Channel, the higher the persistence of ZLB

Note: Persistence of ZLB regimes Conditional on Int. Rates Being Binding in Q1
Paths of Variables under Forward Guidance rule

Recall the forward guidance rule...

\[ R_t = 1 \quad \text{if} \quad \left[ R_t^{Taylor} \leq 1 \right] \quad \text{or} \quad \left[ R_{t-1} = 1 \text{ and } x_{t-1} < a \right] \]

\[ R_t = R_t^{Taylor} \quad \text{otherwise} \]
Paths of Variables under Forward Guidance

- Inflation bias under FG due to management of expectations
  - Higher inflation expectations at ZLB
  - Lower real int. rates at ZLB.
  - Ultimately, increases exp. prod. Costs (asymmetric) at steady state
- Cost Channel amplifies inflation bias
- Recession is milder under FG, irrespective of Cost Channel
Outline

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Conclusion

• Liquidity trapped recession due to a large demand shock is milder and welfare increasing under Forward Guidance Rule
• An appropriate Forward Guidance Rule can avoid deflation bias
• Cost Channel economy:
  • Is more likely to hit ZLB and remain longer
  • Has amplified inflation bias under Forward guidance

Policy implications:

  An endogenous Forward guidance rule increases welfare
  Central banks should pay careful attention on Cost Channel when they set policies at the ZLB
Thank you
Annex
Deflation Bias

• If inflation is lower than the target rate in the steady state, we call that a Deflation bias “risky” steady state.

• The risky steady state is the point where economic agents choose to stay at a given date if they expect future risk (asymmetry).

• Lower inflation observed in many countries including the USA following the Great Recession can be explained by deflation bias risky steady state.
Figure 5.8: Paths of Variables to a Large Positive Shock to the Economy under CTTR

Note: Path of the natural interest rate to a positive shock is symmetric to the negative shock. Accordingly, the maximum value of the net natural interest rate during the liquidity trap is 12%.
3.4 Welfare Calculation

The welfare calculation is based on the procedure used by Adam and Billi (2007, p.748). Accordingly, the utility equivalent percentage loss of consumption in the steady state is given by, \( p = 100 \times \frac{1}{\sigma} \left( -1 + \sqrt{1 + \frac{2(1-\beta)L'}{1/\sigma}} \right) \). Here, \( L' = \frac{1}{2} \frac{\omega\theta(1+\zeta\theta)}{(1-\omega)(1-\omega\beta)} \sum_{i=0}^{\infty} \beta^i (\pi_{t+i}^2 + \lambda x_{t+i}^2) \), where, \( \lambda \) is the weight assigned to the output gap in the monetary authority’s objective function,\(^{11}\) \( \zeta \) is elasticity of a firm’s real marginal cost and \( \theta \) is the elasticity of substitution among production varieties.\(^{12}\)
# Macroeconomic Performance under Forward Guidance

<table>
<thead>
<tr>
<th>Measure</th>
<th>J=0</th>
<th>J=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of time nominal interest rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bounded by Zero</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTTR</td>
<td>-0.25 - 0.5 - 0.75 - 1 - 10</td>
<td>-0.25 - 0.5 - 0.75 - 1 - 10</td>
</tr>
<tr>
<td>%Nominal Interest Rate</td>
<td>5.92 2.29 4.56 5.76 5.91 5.92</td>
<td>9.86 3.06 7.76 9.52 9.83 9.86</td>
</tr>
<tr>
<td>Additional periods i binding</td>
<td>0 3 2 1 1 1</td>
<td>0 3 2 1 1 1</td>
</tr>
<tr>
<td>Lowest value (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Nom. Interest Rate</td>
<td>0.00 0.00 0.00 0.00 0.00 0.00</td>
<td>0.00 0.00 0.00 0.00 0.00 0.00</td>
</tr>
<tr>
<td>Inflation</td>
<td>-1.59 -1.21 -1.37 -1.54 -1.57 -1.59</td>
<td>-2.16 -1.40 -1.91 -2.11 -2.14 -2.16</td>
</tr>
<tr>
<td>Output Gap</td>
<td>-1.07 -0.91 -0.98 -1.04 -1.05 -1.07</td>
<td>-1.11 -0.93 -1.03 -1.09 -1.09 -1.11</td>
</tr>
<tr>
<td>Steady state value (%) of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Nom. Interest Rate</td>
<td>2.87 3.04 3.02 2.90 2.88 2.87</td>
<td>2.60 3.27 2.81 2.64 2.60 2.60</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.08 0.01 0.01 -0.06 -0.08 -0.08</td>
<td>-0.29 0.21 -0.14 -0.26 -0.29 -0.29</td>
</tr>
<tr>
<td>Output Gap</td>
<td>-0.003 0.005 -0.001 -0.002 -0.003 -0.003</td>
<td>0.009 -0.009 0.005 -0.008 0.009 0.009</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Nom. Interest Rate</td>
<td>1.706 x 0.93 x 0.99 x 1.00 x 1.00 x 1.00</td>
<td>1.810 x 0.98 x 1.00 x 1.00 x 1.00 x 1.00</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.453 x 0.85 x 0.96 x 1.00 x 1.00 x 1.00</td>
<td>0.590 x 0.90 x 0.97 x 0.99 x 1.00 x 1.00</td>
</tr>
<tr>
<td>Output Gap</td>
<td>0.290 x 0.91 x 0.97 x 1.00 x 1.00 x 1.00</td>
<td>0.290 x 0.89 x 0.96 x 0.99 x 1.00 x 1.00</td>
</tr>
<tr>
<td>Welfare Loss</td>
<td>0.0156 x 0.46 x 0.59 x 0.89 x 0.97 x 1.00</td>
<td>0.0600 x 0.41 x 0.47 x 0.88 x 1.00 x 1.01</td>
</tr>
</tbody>
</table>

1/ Relative to the value of CTTR.