The Dynamic Effects of Forward Guidance Shocks

Brent Bundick & A. Lee Smith
Federal Reserve Bank of Kansas City

July 9, 2017

The opinions expressed herein are those of the authors and do not reflect the views of the Federal Reserve Bank of Kansas City or Federal Reserve System.
Forward guidance became key policy tool at zero lower bound

Yellen (2016) suggests continued use in policy toolkit
Forward guidance became key policy tool at zero lower bound

Yellen (2016) suggests continued use in policy toolkit

What are macroeconomic effects of forward guidance shocks?

Focus on economic activity & prices at the zero lower bound
Forward guidance became key policy tool at zero lower bound

Yellen (2016) suggests continued use in policy toolkit

What are macroeconomic effects of forward guidance shocks?

Focus on economic activity & prices at the zero lower bound

Can a standard model reproduce the estimated effects?
Disconnect Between Theory & Empirical Evidence

Standard models with nominal rigidities imply large effects
⇒ Lower expected rates imply significant expansion
Disconnect Between Theory & Empirical Evidence

Standard models with nominal rigidities imply large effects
⇒ Lower expected rates imply significant expansion

Previous work argues forward guidance is too powerful in models
Del Negro, Giannoni, & Patterson (2012), Kiley (2014)
McKay, Nakamura, Steinsson (2016)
Disconnect Between Theory & Empirical Evidence

Standard models with nominal rigidities imply large effects

⇒ Lower expected rates imply significant expansion

Previous work argues forward guidance is too powerful in models
Del Negro, Giannoni, & Patterson (2012), Kiley (2014)
McKay, Nakamura, Steinsson (2016)

Empirical work suggests announcements may be contractionary
Campbell, Evans, Fisher, & Justiniano (2012)
Our Findings

In the Data

Exogenous decline in expected path of rates

⇒ Higher economic activity & inflation

⇒ Output increases by about 0.1% at its peak
Our Findings

In the Data

Exogenous decline in expected path of rates

⇒ Higher economic activity & inflation

⇒ Output increases by about 0.1% at its peak

A Standard Model of Nominal Price Rigidity

Estimated model replicates empirical results

Generate model-implied futures curve to map to empirical results
Identify Macroeconomic Effects in the Data

Combine event-study approach with traditional monetary VAR

Isolate unexpected component of monetary policy

Measure change in expectations around FOMC meetings

Daily change in monthly federal funds futures contracts

Use change in 12-month ahead futures rates as policy measure
The Macroeconomic Effects of Forward Guidance Shocks

Input policy surprises into a monthly VAR

December 2008 – December 2015 sample period

Macroeconomic Data: GDP, GDP deflator, investment, & capacity utilization

Monetary Policy: Funds rate implied by 12-month ahead futures

Order policy last using Cholesky identification

Robust to alternative ordering & policy indicators
Empirical Responses to Forward Guidance Shock

Output

Investment

Capacity Utilization

Price Level

12-Month Ahead Futures Rates
Robustness of Empirical Findings

Output

Investment

Capacity Utilization

Price Level

12-Month Ahead Futures Rates

Baseline Model
Policy Indicator Ordered First

Output

Investment

Capacity Utilization

Price Level

12-Month Ahead Futures Rates

Baseline Model
Policy Ordered First
Longer-Horizon Futures Contracts

- **Output**
- **Investment**
- **Capacity Utilization**
- **Price Level**
- **Monetary Policy Indicator**

Graphs showing the impact of baseline model, policy ordered first, and longer-horizon eurodollar futures on various economic indicators over different time horizons.
Measure Output Using Industrial Production

---

**Output**

![Graph of Output](image)

**Investment**

![Graph of Investment](image)

**Capacity Utilization**

![Graph of Capacity Utilization](image)

**Prices**

![Graph of Prices](image)

**Monetary Policy Indicator**

![Graph of Monetary Policy Indicator](image)

---

- **Baseline Model**
- **Policy Ordered First**
- **Longer-Horizon**
- **Eurodollar Futures**
- **Industrial Production**
Can Model Reproduce Empirical Findings?

Standard New-Keynesian sticky price model with capital

Household consumes, works, & receives firm dividends
   Habits in consumption

Firms employ labor & produce
   Investment adjustment costs, variable capital utilization

Constant probability of adjusting nominal price each period
Monetary Policy

\[ r_t^d = \phi_r r_{t-1}^d + (1 - \phi_r) \left( r + \phi_\pi (E_{t-1}\pi_t - \pi) + \phi_x E_{t-1}x_t \right) + \nu_t \]

\[ r_t = \max(0, r_t^d) \]

\[ \nu_t = \rho_\nu \nu_{t-1} + \sigma_\nu \varepsilon_t^\nu \]

Away from ZLB: Conventional monetary policy shock

At ZLB: Forward guidance shock
Mapping Model to Empirical Evidence Using Futures

Use stochastic discount factor to price futures in the model

Determine price of 1-month ahead futures contract:

\[ f_t^1 = E_t \left\{ \left( \beta \frac{\lambda_{t+1}}{\lambda_t} \right) (1 - 12r_{t+1}) \right\} \]

\( n \)-month contract at \( t \) becomes an \( n - 1 \) contract at \( t + 1 \):

\[ f_t^n = E_t \left\{ \left( \beta \frac{\lambda_{t+1}}{\lambda_t} \right) (f_{t+1}^{n-1}) \right\} \]
Solve nonlinear model using piecewise-linear solution

Examine forward guidance shock at zero lower bound:

1. Use demand shock to simulate zero lower bound episode
2. Simulate an exogenous decline in expected rates

Estimate model using impulse response matching

Pick shock so futures in model generate same movement as in data
Empirical & Model-Implied Responses

Output

Investment

Capacity Utilization

Price Level

12-Month Ahead Futures Rates

Impulse Response

90% Probability Interval
Empirical & Model-Implied Responses

Output

Investment

Capacity Utilization

Price Level

12-Month Ahead Futures Rates

Model Impulse Response

Data Impulse Response

90% Probability Interval
Empirical Response of Output to Expected Rates

We find no disconnect between empirical evidence & model

Prior work argues output is too responsive to expected rates in models

Is our empirical elasticity of output with respect to expected future rates implausibly large?

Compare elasticity to estimates in the policy shock literature
    Christiano, Eichenbaum, & Evans (2005)
    Romer & Romer (2004)
Elasticity of Output with Respect to Expected Policy Rates

Baseline VAR

Output

12-Month Ahead Futures Rates

Percent

Annual Percentage Points

Christiano, Eichenbaum, & Evans (2005)

Output

Federal Funds Rate

Percent

Annual Percentage Points
Comparison with Conventional Monetary Policy Shocks

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Output</th>
<th>Price Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Christiano et al. (2005)</td>
<td>4.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Romer &amp; Romer (2004)</td>
<td>3.9</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Quantitative Easing & Forward Guidance

Asset purchases often accompanied policy announcements

No need to disentangle effects if purchases reflect signaling

Bias results under significant portfolio-rebalancing channel

Difficult to disentangle during zero lower bound period

Examine forward guidance announcements before & after 2009
Use Gurkaynak, Sack, & Swanson (2005) path factor
Path Factor Shock During Zero Lower Bound

GDP
Core Capital Goods
Capacity Utilization
GDP Deflator
GSS Path Factor

Zero Lower Bound Period
Impulse Response
Zero Lower Bound Period
90% Credible Set
Conclusions

Forward guidance shocks that lower expected path of rates
⇒ Modest increase in economic activity & inflation

Consistent with standard model of monetary policy

Discipline forward guidance process in model using futures data
Additional Details
Where is the Forward Guidance Puzzle?

Previous work argues these models overestimate effects
Del Negro, Giannoni, & Patterson (2012), Kiley (2014)

Simulate one-year extension of zero policy rates
Implies very large movements in activity & prices
“Forward Guidance Puzzle”

We estimate a significantly smaller forward guidance shock
Extends zero lower bound duration by one month

Discipline shock process in model using futures data
The Forward Guidance Puzzle?

### One-Month Extension of Zero Lower Bound Duration

- **Consumption**
- **Price Level**
- **Nominal Interest Rate**

### One-Year Extension of Zero Lower Bound Duration

- **Consumption**
- **Price Level**
- **Nominal Interest Rate**
Longer-Horizon Eurodollar Futures

GDP

Core Capital Goods

Capacity Utilization

GDP Deflator

9 Quarter EDD

Impulse Response

90% Credible Set
Industrial Production

- Industrial Production
- Core Capital Goods
- Capacity Utilization
- Core PPI
- Funds Rate After 7th Meeting

Impulse Response
90% Credible Set
No High-Frequency Identification or Cumulative Sum
## Estimated Model Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Distribution</th>
<th>Prior</th>
<th>Posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mode</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>$b$</td>
<td>Habit Persistence</td>
<td>Beta</td>
<td>0.50</td>
<td>0.25</td>
</tr>
<tr>
<td>$\omega$</td>
<td>Calvo Probability</td>
<td>Beta</td>
<td>0.93</td>
<td>0.02</td>
</tr>
<tr>
<td>$\chi$</td>
<td>Degree of Lagged Indexation</td>
<td>Beta</td>
<td>0.50</td>
<td>0.25</td>
</tr>
<tr>
<td>$\phi_r$</td>
<td>Policy Rate Smoothing</td>
<td>Beta</td>
<td>0.75</td>
<td>0.25</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Investment Adjustment</td>
<td>Gamma</td>
<td>2.48</td>
<td>60.0</td>
</tr>
<tr>
<td>$\sigma_\delta$</td>
<td>Capacity Utilization Curvature</td>
<td>Gamma</td>
<td>0.01</td>
<td>60.0</td>
</tr>
<tr>
<td>$\rho_\nu$</td>
<td>Policy Shock Persistence</td>
<td>Beta</td>
<td>0.50</td>
<td>0.25</td>
</tr>
<tr>
<td>$1200 \times \sigma_\nu$</td>
<td>Std. Dev. of Policy Shock</td>
<td>Gamma</td>
<td>25.0</td>
<td>1200</td>
</tr>
</tbody>
</table>
Global Solution and OccBin Solution

![Graphs showing consumption, price level, nominal interest rate, 1-month, 6-month, and 12-month ahead futures for nonlinear global solution and piecewise linear OccBin.](image-url)
Responses of Additional Variables

- **Consumption**
- **Price Level**
- **Real Interest Rate**
- **1-Month Ahead Futures**
- **6-Month Ahead Futures**
- **12-Month Ahead Futures**

The graphs illustrate the responses of additional variables over time, showing trends and changes in consumption, price levels, real interest rates, and futures prices.
High-Frequency Policy Surprises

-0.8 -0.8
-0.6 -0.6
-0.4 -0.4
-0.2 -0.2
-0.0 -0.0
0.2 0.2
0.4 0.4

7th Next FOMC Meeting
GSS Path Factor
36 Month USD OIS
How Important are Forward Guidance Shocks?

Examine variance decompositions of forecast errors

**Forward Guidance Shocks**

<table>
<thead>
<tr>
<th>Variable</th>
<th>1 Year</th>
<th>2 Year</th>
<th>5 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>9</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Price Level</td>
<td>19</td>
<td>35</td>
<td>45</td>
</tr>
</tbody>
</table>

*Source: Christiano, Eichenbaum, Evans (2005)*
How Important are Forward Guidance Shocks?

Examine variance decompositions of forecast errors

**Forward Guidance Shocks**

<table>
<thead>
<tr>
<th>Variable</th>
<th>1 Year</th>
<th>2 Year</th>
<th>5 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>9</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Price Level</td>
<td>19</td>
<td>35</td>
<td>45</td>
</tr>
</tbody>
</table>

**Conventional Policy Shocks***

<table>
<thead>
<tr>
<th>Variable</th>
<th>1 Year</th>
<th>2 Year</th>
<th>5 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>15</td>
<td>41</td>
<td>26</td>
</tr>
<tr>
<td>Price Level</td>
<td>1</td>
<td>1</td>
<td>14</td>
</tr>
</tbody>
</table>

*Source: Christiano, Eichenbaum, Evans (2005)*
Baseline Assumption - Policy Ordered Last

Output

Investment

Capacity Utilization

Price Level

12-Month Ahead Futures Rates

Impulse Response

90% Probability Interval
Alternative Assumption - Policy Ordered First

- **Output**: Percent
- **Investment**: Percent
- **Capacity Utilization**: Percentage Points
- **Price Level**: Percent
- **12-Month Ahead Futures Rates**: Annual Percentage Points

Each graph shows the impulse response over time, with shaded areas indicating the 90% probability interval.