Risk Management with a Simple Monetary Policy Rule*

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*The views expressed herein are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Cleveland or the Federal Reserve System.
Motivation

The FOMC made three rate cuts in 2019, totaling 75 basis points

- Associated statements: “the labor market remains strong and that economic activity has been rising at a moderate rate”

- Jerome Powell said the motivation for the cut was “to insure against downside risks from weak global growth and trade policy uncertainty, to help offset the effects these factors are currently having on the economy, and to promote a faster return of inflation to our symmetric 2 percent objective” [emphasis added]

- Powell also said “the Committee still sees a favorable baseline outlook” [emphasis added].
Motivation

Risk management approach to monetary policy:

- Anticipate different scenarios for the economy
- Take action that may not be optimal in most likely scenario in order to guard against bad outcomes in less likely scenarios
  - Tolerate slightly higher inflation to reduce unemployment risk
  - Tolerate slightly higher unemployment to reduce inflation risk
- Long been a feature of Fed decision-making (Greenspan, 2004)

Criticism of risk management (Greenspan, 2004):

- “too undisciplined – judgmental, seemingly discretionary, and difficult to explain”
- Critics often recommend “the prescriptions of a simple policy rule”
Introduction

This project:

1. Incorporate risk management into simple policy rule
2. Compare this rule to Fed’s historical policy changes

Why?

- Address some criticism of risk management approach
  - Add discipline, facilitate communication
- Link risk management to specific forecasting models and policy rules
  - Not intended to replace scenario analysis or judgment
- Assess if such a rule gives reasonable policy prescriptions
Introduction

This project:

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2. Compare this rule to Fed’s historical policy changes

How?

- Use forward-looking policy rule where forecasts of unemployment and inflation determine current policy rate
- Forecast densities of unemployment and inflation
  - Modal forecasts reflect “baseline” outlook
  - Mean forecasts incorporate (density-weighted) risk
- Use modal or mean forecasts in policy rule depending on which risks one wants to address
Introduction

Some details:

- Density forecasts follow Adrian, Boyarchenko & Giannone (2019)
  - Use quantile regression to forecast quantiles
  - Include recession indicators in regression: oil prices, stock prices, term spread, corporate yield spreads
  - Fit asymmetric Student-\(t\) distribution to forecasted quantiles
  - Allows for skew so that mean and modal forecasts differ

- Policy rule is first difference rule

Caveats:

- These details are examples used to highlight the methodology
- Many different forecasting approaches and policy rules can be used
Results

- Mean forecasts usually above or equal to modal forecast for both unemployment and inflation
  - Unemployment and inflation often have upside risk
  - Risks often associated with oil prices
- Fed seems to prioritize different risks at different times
  - Risk of high inflation prioritized late in expansions
  - Risk of high unemployment prioritized at other times
- Rate cuts in 2019 consistent with prioritizing risks to unemployment
Literature Review

- Risk Management in Monetary Policy

- Monetary Policy Rules

- Recession Forecasting

- Quantile Regression/Density Forecasting
Outline

- Policy Rule and Forecasting Models
- Density Forecasts
- Policy Rule Prescriptions and Historical Comparisons
- Narrative Account of Fed Risk Concerns
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Policy Rule

Timing of the variables:

- Unemployment rate and core CPI inflation both monthly
- Assume in month $t$, we know unemp rate and CPI for month $t - 1$
- One-year forecasts: $\pi_{t+11|t}^{\text{core}} = p_{t+11|t}^{\text{core}} - p_{t-1}^{\text{core}}, u_{t+11|t} - u_{t-1}$

First difference rule:

$$i_t = i_{t-1} + 0.25(\pi_{t+11|t}^{\text{core}} - \pi^*) - 0.25(u_{t+11|t} - u_{t-1})$$

- $\pi^*$ is target inflation rate
  - 3.25% core CPI inflation from 1994 to 1997
  - 2.75% core CPI inflation from 1998 to 2001
  - 2.3% core CPI inflation from 2002 to present
  - “opportunistic disinflation”
  - 2% PCE price inflation target beginning in 2012
Forecasting Model for Unemployment

Variables used in forecasting:

- **Business cycle variables:**
  - Current unemployment rate
  - Geometric trend of changes in unemployment
    \[ \Delta \ddot{u}_t = 0.4 \Delta u_t + 0.6 \Delta \ddot{u}_{t-1} \]

- **Recession risk variables:**
  - 3-month average oil prices less average over previous 33 months
    \[ \text{oil}_t = \frac{(x_t + x_{t-1} + x_{t-2})}{3} - \frac{(x_{t-3} + \cdots + x_{t-35})}{33} \]
    - In spirit of Hamilton (2003)
  - \(sp500_t\): 6-month percent change in S&P 500
  - \(tspread_t\): 6-month average of term spread between 10-year and 3-month Treasuries
  - \(baspread_t\): Difference of Moody’s Baa and Aaa corporate yield
Forecasting Model for Unemployment

Direct forecasting model:

\[ u_{t+11} - u_{t-1} = \beta_0 + \beta_1 u_{t-1} + \beta_2 \Delta \tilde{u}_{t-1} + \beta_3 oil_{t-1} \]
\[ + \beta_4 sp500_{t-1} + \beta_5 tspread_{t-1} + \beta_6 baspread_{t-1} + e_{u,t+11} \]

- Information set runs through month \( t - 1 \)
- Estimate model with quantile regression
- Use 19 quantiles: 0.05, 0.1, \ldots, 0.95
Forecasting Model for Inflation

Variables used in forecasting:

- Geometric trend of core CPI inflation
  - \( \Delta \tilde{p}_{t}^{\text{core}} = 0.1 \Delta p_{t}^{\text{core}} + 0.9 \Delta \tilde{p}_{t-1}^{\text{core}} \)
  - Motivated by Faust & Wright (2013)

- Geometric trend of headline CPI inflation
  - \( \Delta \tilde{p}_{t}^{\text{head}} = 0.1 \Delta p_{t}^{\text{head}} + 0.9 \Delta \tilde{p}_{t-1}^{\text{head}} \)
  - To capture potential pass through of energy prices to core prices

- Recent 3-month average of unemployment rate
  - To capture potential Phillips curve effects
Forecasting Model for Inflation

Direct forecasting model:

\[
p_{t+11}^{\text{core}} - p_{t-1}^{\text{core}} = \alpha_0 + \alpha_1 \Delta \tilde{p}_{t-1}^{\text{core}} + \alpha_2 \Delta \tilde{p}_{t-1}^{\text{head}} \\
+ \alpha_3 (u_{t-1} + u_{t-2} + u_{t-3})/3 + e_{p,t+11}
\]

- Information set runs through month \( t - 1 \)
- Estimate model with quantile regression
- Use 19 quantiles: 0.05, 0.1, \ldots, 0.95
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Density Forecasts

I follow Adrian, Boyarchenko & Giannone (2019):

1. Estimate forecasting models with quantile regression
   - Quantiles are 0.05, 0.1, . . . , 0.95

2. Use estimated quantile functions to produce forecasts

3. Fit asymmetric Student-\(t\) distribution to quantile forecasts
   - Asymmetry allows modal and mean forecasts to be different

Alternative: Bayesian VAR with stochastic volatility

- Carriero, Clark & Marcellino (2020)

- Intuition: Simultaneous shifts in conditional means and variances create asymmetry in unconditional distributions
Compute Forecast Density

- Denote quantile function with $Q(\tau|z)$
  - $\tau$ is quantile of interest
  - $z$ is vector of conditioning variables

- Estimated quantile forecasts:
  - 19 forecasts for each variable
  - Unemployment forecasts: $\hat{Q}_u(0.05|z_{u, t-1}), \ldots, \hat{Q}_u(0.95|z_{u, t-1})$
  - Inflation forecasts: $\hat{Q}_\pi(0.05|z_{\pi, t-1}), \ldots, \hat{Q}_\pi(0.95|z_{\pi, t-1})$

- Fit asymmetric Student-$t$ distribution to the forecasted quantiles
  - Narrow purpose: A fitted distribution allows for computing the mode
  - Broader purpose:
    - A fitted distribution allows for computing a variety of statistics associated with risk management
    - A fitted distribution allows for distribution forecast targeting (Svensson & Williams, 2005)
Asymmetric Student-\textit{-t} Distribution

Five-parameter density of Zhu & Galbraith (2010):

\[
f(y; \mu, \sigma, \alpha, \nu_1, \nu_2) = \begin{cases} 
\frac{1}{\sigma} \frac{\alpha}{\alpha^*} K(\nu_1) \left[ 1 + \frac{1}{\nu_1} \left( \frac{y-\mu}{2\alpha^*\sigma} \right) \right]^{-\frac{\nu_1+1}{2}} & \text{if } y \leq \mu \\
\frac{1}{\sigma} \frac{1-\alpha}{1-\alpha^*} K(\nu_2) \left[ 1 + \frac{1}{\nu_2} \left( \frac{y-\mu}{2(1-\alpha^*)\sigma} \right) \right]^{-\frac{\nu_2+1}{2}} & \text{if } y > \mu 
\end{cases}
\]

with

\[
K(\nu) = \frac{\Gamma((\nu + 1)/2)}{\sqrt{\pi\nu}\Gamma(\nu/2)}
\]

\[
\alpha^* = \frac{\alpha K(\nu_1)}{\alpha K(\nu_1) + (1 - \alpha) K(\nu_2)}
\]

Constraints on parameters:

- \( \mu \in \mathbb{R}, \sigma > 0, \alpha \in (0, 1), \nu_1 > 1, \nu_2 > 1 \)
Compute Forecast Density

- This distribution has the following quantile function

\[
F^{-1}(q) = \mu + 2\alpha^* \sigma F_t^{-1} \left( \frac{\min\{q, \alpha\}}{2\alpha}; \nu_1 \right) \\
+ 2(1 - \alpha^*) \sigma F_t^{-1} \left( \frac{\max\{q, \alpha\} + 1 - 2\alpha}{2(1 - \alpha)}; \nu_2 \right)
\]

where \( F_t^{-1} \) is the quantile function of the standard Student-\( t \).

- Choose \( \mu \in \mathbb{R}, \sigma > 0, \alpha \in (0, 1), \nu_1 > 1, \nu_2 > 1 \) to minimize

\[
\sum_{i=1}^{N} \left[ \hat{Q}(q_i | z_{t-1}) - F^{-1}(q_i) \right]^2
\]

where \( q_1, q_2, \ldots, q_N = 0.05, 0.1, \ldots, 0.95 \).
Compute Forecast Density

- Use expanding sample
  - Sample begins in 1967
  - Initial sample ends in 1993
  - Add one observation at a time through 2019

- With each sample
  1. Estimate quantile functions on historical data
  2. Put current data into quantile functions to make quantile forecasts
  3. Fit density to quantile forecasts

- Modal forecast is $\mu$

- Mean forecast is

$$\mu + 4\sigma \left[ \alpha K(\nu_1) + (1 - \alpha)K(\nu_2) \right] \left[ -\alpha^* 2 \frac{\nu_1}{\nu_1 - 1} + (1 - \alpha^*)^2 \frac{\nu_2}{\nu_2 - 1} \right]$$
Examples of Unemployment Forecast Densities

Density as of January 2001

Density as of January 2003

Density as of July 2008

Density as of January 2010
Results: Unemployment Rate Forecasts

Forecasts of Unemployment Rate

Mean Forecast less Modal Forecast

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Results: Core CPI Inflation Forecasts

Forecasts of Core CPI Inflation

Next year's core CPI inflation (percent)

Modal Forecast

Mean Forecast

Mean Forecast less Modal Forecast

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Density Forecast Counterfactuals

Recall the forecasting steps

1. Estimate quantile functions on historical data
2. Put current data into quantile function to make quantile forecast
3. Fit density to quantile forecasts

Instead, let’s consider

1. Estimate quantile functions on historical data
2. Put alternative data into quantile function to make counterfactual quantile forecast
3. Fit density to counterfactual quantile forecasts

What if there are no oil price fluctuations?

- Model for unemployment: set $oil_t = 0$
  
  $oil_t = (x_t + x_{t-1} + x_{t-2})/3 - (x_{t-3} + \cdots + x_{t-35})/33$

- Model for inflation: $\Delta \tilde{p}_t^{head} = \Delta \tilde{p}_t^{core}$
Unemployment Rate Counterfactual

![Graphs showing the change in unemployment rate over time in different modes.](image)

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Core CPI Inflation Counterfactual

- Baseline Mode
- Counterfactual Mode

- Baseline Mean
- Counterfactual Mean

- Baseline Difference
- Counterfactual Difference

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Outline

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4 types of policy rules that mix modal and mean forecasts:

1. No risk management: only use modal forecasts
2. Inflation risk management: use mean forecast for inflation
3. Unemp risk management: use mean forecast for unemp
4. Balanced risk management: use mean forecast for both
Results: Policy Rule Prescriptions

Modal Unemployment and Inflation Forecasts

Actual FFR Change
First Diff Rule

Mean Unemployment Forecast and Modal Inflation Forecast

Actual FFR Change
First Diff Rule

Mean Unemployment and Inflation Forecasts

Actual FFR Change
First Diff Rule
Policy Rule Priorities

What if different risks are prioritized at different times?

- When unemployment risk prioritized
  - Use mean forecast for unemployment
  - Use modal forecast for inflation
- When inflation risk prioritized
  - Use modal forecast for unemployment
  - Use mean forecast for inflation

How might the Fed prioritize risks?

- Unemployment risk prioritized when $u_t \geq 6$
- Unemployment risk prioritized in recessions
  - Recession: when $u_t - \min\{u_{t-1}, u_{t-2}, \ldots, u_{t-13}\} \geq 0.3$
  - Less strict Sahm (2019) recession rule
- Otherwise prioritize inflation risk
Results: Policy Rule Prescriptions with Changing Priorities

Indicator for when Unemployment Risks Take Priority

Policy Rule with Alternating Risk Priorities

Actual FFR Change
First Diff Rule

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Discussion

- My previous perception of risk management:
  - Tolerate slightly higher inflation
  - This is “insurance premium” to reduce risk of rising unemployment

- My new perception of risk management:
  - Late in expansions, tolerate slightly higher unemployment
  - This is “insurance premium” to reduce risk of rising inflation

- Rate cuts in 2019 are unusual
  - Happened late in an expansion with low unemployment
  - Comparable to 1995/96 or 1998?
Example 1: May 18, 1999

The post-meeting FOMC statement read

While the FOMC did not take action today to alter the stance of monetary policy, the Committee was concerned about the potential for a buildup of inflationary imbalances . . . Trend increases in costs and core prices have generally remained quite subdued . . . Against the background of already-tight domestic labor markets and ongoing strength in demand in excess of productivity gains, the Committee recognizes the need to be alert to developments over coming months that might indicate that financial conditions may no longer be consistent with containing inflation.
High energy prices appeared to be taking a toll on household and business confidence and might be beginning to crimp corporate profits. In some cases, firms seemed to be more successfully passing on energy costs to their customers. Indeed, some portion of recent elevated inflation readings probably represented, at least partly, such pass-through effects from higher energy costs. . . . Participants voiced concerns about recent price trends; they expected inflation to remain contained but also perceived that the risks to that inflation outlook now might be skewed somewhat to the upside. . . . Against the backdrop of the recent uptick in core inflation and in some measures of inflation expectations, members agreed that they should continue along the course of removing policy accommodation at a measured pace.
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Above examples of show that risk management can be about containing inflation risks

I want to be more systematic in documenting this

- Read FOMC minutes and count times inflation risks are discussed
- Read FOMC transcripts and count times the Chair discusses inflation risks in policy go-around
- Separate upside and downside inflation risks
Results: Upside Inflation Risks

Risks to Upside Inflation

Date

Recession
Minutes
Transcript

Times Discussed


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Conclusions

This project:

1. Propose incorporating risk management into simple policy rule
2. Compare a risk management rule to Fed’s historical policy changes

How?

- Use forward-looking policy rule where forecasts of unemployment and inflation determine current policy rate
- Forecast densities of unemployment and inflation to compute modal forecast and mean forecast
  - Modal forecasts reflect “baseline” outlook
  - Mean forecasts incorporate (density-weighted) risks
- Consider both modal and mean forecasts in first difference policy rule
Conclusions

Results:

- Mean forecasts usually above or equal to modal forecast for both unemployment and inflation
  - Unemployment and inflation often have upside risk
  - Upside risks often associated with oil prices

- Fed seems to prioritize different risks at different times
  - Risk of high inflation prioritized late in expansions
  - Risk of high unemployment prioritized at other times

- Rate cuts in 2019 consistent with incorporating risks to unemployment