# Fed's policy rule:

# A discrete-choice regime-switching approach

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# Reasons to model monetary policy decisions

*"What the market needs to know is the policy response function by which the central bank acts in a consistent way over time"*

— William Poole

*"Greater transparency reduces the lags and enhances the power of monetary policy"*

— Alan Blinder and Ricardo Reis

- Use the federal funds rate target as a measure of monetary policy instead of the effective federal funds rate.

*"Actual federal funds rate is a noisy and imprecise measure of the federal funds rate target actually set by the Federal Reserve."*

— Catherine Bonser-Neal and Gordon H. Sellon

*"Federal funds rate target is not the outcome of the interaction of supply and demand of the federal funds and it is not subject to technical fluctuations or extraneous sources of noise. Rather, it is an operational indicator of how the direction of monetary policy determined by the FOMC is translated into practice"*

— James D. Hamilton and Oscar Jorda

- Estimate the Fed's response to an information set available at a given FOMC scheduled meeting rather than the relationship between the monthly or quarterly averages of the Fed funds rate and explanatory macroeconomic variables.

- Accurately synchronize Fed's decisions with the historical real-time data available at each FOMC meeting rather than the latest version of the revised data.

"Estimated policy reaction functions obtained using the ex post revised data can yield misleading descriptions of historical policy."

— Athanasios Orphanides

- Address the discrete and censored nature of policy rate by a discrete-choice model.

*"The economic world ... is best described by a structure whose parameters are continuously changing. The channels of monetary policy, consequently, are changing in tandem"*

— Alan Greenspan

*"Indeed, I know of no research testing the structural stability of the Federal Reserve reaction function over the past few decades that has not rejected the null of structural stability."*

— Glenn Rudebusch

*"Overall, it appears that there have not been any great successes in modeling Federal Reserve behavior with a single, stable reaction function."*

- Use the federal funds rate target as a measure of monetary policy instead of the effective federal funds rate.
- Estimate the Fed's response to an information set available at a given FOMC scheduled meeting rather than the relationship between the monthly or quarterly averages of the Fed funds rate and explanatory macroeconomic variables.
- Accurately synchronize Fed's decisions with the historical real-time data available at each FOMC meeting rather than the latest version of the revised data.
- Address the discrete and censored nature of policy rate by a discrete-choice model.

- Allow switching among three latent policy regimes.

# Scheduled FOMC decisions on the federal funds rate target

## 11/1987 – 12/2018 period

| Change, bp | -75 | -50 | -25 | -12.5 | 0 | 6.25 | 12.5 | 25 | 31.25 | 50 | 75 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 2 | 12 | 17 | 1 | 174 | 2 | 1 | 35 | 1 | 4 | 1 |

## 11/1987 – 12/2018 period

| Change, bp | -75 | -50 | -25 | -12.5 | 0 | 6.25 | 12.5 | 25 | 31.25 | 50 | 75 |
|------------|-----|-----|-----|-------|-----|------|------|-----|-------|-----|-----|
| Frequency | 2 | 12 | 17 | 1 | 174 | 2 | 1 | 35 | 1 | 4 | 1 |

## 7/1989 – 12/2018 period

| Change, bp | -75 | -50 | -25 | 0 | 25 | 50 | 75 |
|------------|-----|-----|-----|-----|-----|-----|-----|
| Frequency | 2 | 11 | 17 | 168 | 34 | 4 | 1 |

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I classified these 250 FOMC decisions into the following five categories:

| Target rate change | large cut | small cut | no change | small hike | large hike |
|---|---|---|---|---|---|
| Frequency | 14 | 18 | 176 | 36 | 6 |

# Regime-switching ordered probit model

In the regime equation:

- An indicator derived from the "*policy bias*" or "*balance-of-risks*" statement made at the previous FOMC meeting that takes value $1$ if the statement was "tightening", $0$ if the statement was "symmetrical", and $-1$ if the statement was "easing";

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- Tealbook (formerly Greenbook) projection of the total number of new privately owned *housing units started* for current quarter.

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In the outcome equations:

- Tealbook (formerly Greenbook) projection of quarter-over-quarter core PCE (before 2000 – core CPI) *inflation rate* for four quarters ahead;

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In the outcome equations:

- Tealbook (formerly Greenbook) projection of quarter-over-quarter core PCE (before 2000 – core CPI) *inflation rate* for four quarters ahead;

- Tealbook (formerly Greenbook) projection of the *output gap* for four quarters ahead.

# Regime-switching ordered probit model
## Estimation results for 11/1987 – 12/2018 period

| Variables | Regime equation | Output equations | |
|---|---|---|---|
| | | Loose regime | Tight regime |
| *policy bias $_{t-1}$* | 1.42 (0.38)*** | | |
| *house starts $_t$* | 3.22 (0.69)*** | | |
| *output gap $_t$* | | 0.81 (0.23)*** | 0.89 (0.63) |
| *inflation $_t$* | | 1.44 (0.66)* | 2.15 (1.02)* |
| *threshold $_1$* | 5.1 (1.13)*** | -1.59 (0.18)*** | -0.42 (0.5) |
| *threshold $_2$* | 5.76 (1.05)*** | -0.96 (0.15)*** | 1.49 (0.26)*** |

Sample size: 250 observations.

***/**/* denote the statistical significance at the 0.1/1/5 percent level. The asymptotic standard errors are shown in parentheses.

Percentage correctly predicted (accuracy): 75.2%.

Mean absolute error (MAE): 7.7 basis points.

| Model: | Switching ordered probit |
|---|---|
| Forecast without re-estimation | |
| MAE, basis points | 5.3 |
| Accuracy, % | 83.8 |

MAE is the mean absolute difference between the observed and predicted choices (the predicted choice is that with the highest predicted probability).

Accuracy is the percentage of correct predictions.

# Comparison of competing models
## Out-of-sample forecast of 80 FOMC decisions in 1/2009-12/2018 period

| Model: | Ordered probit | Switching ordered probit |
|---|---|---|
| Forecast without re-estimation | | |
| MAE, basis points | 22.8 | 5.3 |
| Accuracy, % | 48.8 | 83.8 |

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Accuracy is the percentage of correct predictions.

# Comparison of competing models
## Out-of-sample forecast of 80 FOMC decisions in 1/2009-12/2018 period

| Model: | Linear regression | Ordered probit | Switching ordered probit |
|---|---|---|---|
| Forecast without re-estimation | | | |
| MAE, basis points | 18.4 | 22.8 | 5.3 |
| Accuracy, % | 27.5 | 48.8 | 83.8 |

MAE is the mean absolute difference between the observed and predicted choices (the predicted choice is that with the highest predicted probability).

Accuracy is the percentage of correct predictions.

# Comparison of competing models
## Out-of-sample forecast of 80 FOMC decisions in 1/2009-12/2018 period

| Model: | Linear regression | Ordered probit | Switching ordered probit |
|--------|-------------------|----------------|--------------------------|
| Forecast without re-estimation | | | |
| MAE, basis points | 18.4 | 22.8 | 5.3 |
| Accuracy, % | 27.5 | 48.8 | 83.8 |
| | | | |
| Forecast with recursive re-estimation | | | |
| MAE, basis points | 11.3 | 6.9 | 3.4 |
| Accuracy, % | 56.3 | 80.0 | 87.5 |

MAE is the mean absolute difference between the observed and predicted choices (the predicted choice is that with the highest predicted probability).

Accuracy is the percentage of correct predictions.

- The studies that predict target changes report that the Taylor-rule variables do not provide the best forecasting performance.

# Forecasting federal funds rate target

- The studies that predict target changes report that the Taylor-rule variables do not provide the best forecasting performance.

- Despite an extensive literature relating Fed policy to such macroeconomic variables as inflation, output gap, capacity utilization, the term spread appears to be a far more important predictor of the Fed's target rate.

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- The term spread can be seen as a low-dimension market-based precursor of future inflation and economic activity.

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- The studies that predict target changes report that the Taylor-rule variables do not provide the best forecasting performance.

- Despite an extensive literature relating Fed policy to such macroeconomic variables as inflation, output gap, capacity utilization, the term spread appears to be a far more important predictor of the Fed's target rate.

- The term spread can be seen as a low-dimension market-based precursor of future inflation and economic activity.

- The term spread can be very useful in estimating monetary policy regimes.

In the regime equation:

- An indicator derived from the "*policy bias*" or "*balance-of-risks*" statement made at the previous FOMC meeting that takes value $1$ if the statement was "tightening", $0$ if the statement was "symmetrical", and $-1$ if the statement was "easing";

- Tealbook (formerly Greenbook) projection of the total number of new privately owned *housing units started* for current quarter.

In the outcome equations:

- Term *spread* — the difference between the one-year treasury constant maturity rate and effective federal funds rate, three-business-day moving average;

- Tealbook (formerly Greenbook) projection of the *output gap* for four quarters ahead.

# Using term spread to improve the policy rule
## Estimation results for 11/1987 – 12/2018 period

| Variables | Regime equation | Output equations | |
|---|---|---|---|
| | | Loose regime | Tight regime |
| *policy bias $_{t-1}$* | 1.86 (0.32)*** | | |
| *house starts $_t$* | 4.18 (0.75)*** | | |
| *output gap $_t$* | | 0.9 (0.22)*** | 0.24 (0.82) |
| *term spread $_t$* | 1.94 (0.53)*** | 1.62 (0.31)*** | 3.44 (0.81)*** |
| *threshold $_1$* | 6.14 (1.22)*** | -1.89 (0.22)*** | -0.15 (0.55) |
| *threshold $_2$* | 8.11 (1.29)*** | -1.02 (0.17)*** | 3.28 (0.62)*** |

Sample size: 250 observations.

***/**/* denote the statistical significance at the 0.1/1/5 percent level. The asymptotic standard errors are shown in parentheses.

Percentage correctly predicted (accuracy): 82.0%.

Mean absolute error (MAE): 5.3 basis points.

| Model: | with inflation rate | with term spread |
|---|:---:|:---:|
| | In-sample fit (11/1987-12/2008) | |
| Log likelihood | -184.9 | -130.8 |
| AIC | 393.7 | 298.9 |
| BIC | 436.0 | 341.1 |
| MAE, bp | 7.7 | 5.3 |
| Accuracy, % | 75.2 | 82.0 |

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| In-sample fit (11/1987-12/2008) | | |
| Log likelihood | -184.9 | -130.8 |
| AIC | 393.7 | 298.9 |
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| MAE, bp | 7.7 | 5.3 |
| Accuracy, % | 75.2 | 82.0 |
| Out-of-sample forecast without re-estimation (1/2009-12/2018) | | |
| MAE, bp | 5.3 | 4.1 |
| Accuracy, % | 83.8 | 85.0 |

| Model: | with inflation rate | with term spread |
|---|---|---|
| In-sample fit (11/1987-12/2008) | | |
| Log likelihood | -184.9 | -130.8 |
| AIC | 393.7 | 298.9 |
| BIC | 436.0 | 341.1 |
| MAE, bp | 7.7 | 5.3 |
| Accuracy, % | 75.2 | 82.0 |
| Out-of-sample forecast without re-estimation (1/2009-12/2018) | | |
| MAE, bp | 5.3 | 4.1 |
| Accuracy, % | 83.8 | 85.0 |
| Out-of-sample forecast with recursive re-estimation (1/2009-12/2018) | | |
| MAE, bp | 3.4 | 3.1 |
| Accuracy, % | 87.5 | 88.8 |

# Concluding remark

*"The model is often smarter than you are."*

*— Paul Krugman*

I took the values of policy bias indicator up to 1999 from Thornton and Wheelock (2000) and derived them after 1999 from the FOMC statements and minutes.

## Policy bias indicator

For example, the "policy bias" directive released on May 18, 1999 was "tightening":

> "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 that could undermine the favorable performance of the economy and therefore adopted a directive that is tilted toward the possibility of a firming in the stance of monetary policy."

By contrast, the "balance-of-risks" statement released on January 31, 2001 was "easing":

*"Nonetheless, the Committee continues to believe that against the background of its long-run goals of price stability and sustainable economic growth and of the information currently available, the risks are weighted mainly toward conditions that may generate economic weakness in the foreseeable future."*

The "balance-of-risks" statement released on January 29, 2003 was "symmetrical":

*"In these circumstances, the Committee believes that, against the background of its long-run goals of price stability and sustainable economic growth and of the information currently available, the risks are balanced with respect to the prospects for both goals for the foreseeable future."*