Measures and Policy Applications of the Equilibrium Neutral Real Interest Rate

FRBNY DSGE Team

2016 PBOC-FRBNY Joint Symposium

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Outline

This presentation will focus on one specific definition of "neutral real interest rate", namely the so-called *natural rate of interest* r^* featured in New Keynesian models, and will discuss estimates of r^* from one such model – the FRBNY DSGE model – and their use in policy analysis.

1. The FRBNY DSGE Model
2. r^* – What is it, and what is it for?
3. Estimates of r^* for the US, or why are interest rates so low?
4. r^* as a Benchmark for Monetary Policy

Commentary

- In spite of the broad title, this presentation will focus on one specific definition of "neutral real interest rate", namely the so-called *natural rate of interest* r^* featured in New Keynesian models, and will discuss estimates of r^* from one such model – the FRBNY DSGE model.
- We start by quickly introducing the FRBNY model, and discussing its main features.
- We continue by elaborating on why the New Keynesian *natural rate of interest* r^* is a conceptually useful measure of the "neutral real interest rate".
- Next, we discuss empirical estimates of r^* obtained from the FRBNY DSGE model, and focus on the question - Why have interest rates been so low for so long in the US?
- We conclude with some policy applications, discussing the pace of interest rate renormalization from the perspective of r^*.

FRBNY DSGE Model

- **New Keynesian DSGE** model á la Smets-Wouters (2007)
- Stochastic growth model + ...

real rigidities	**nominal rigidities**
investment adjustment costs	price stickiness (ζ_p)
variable capital utilization	wage stickiness (ζ_w)
	partial indexation to lagged inflation

+ habit persistence

- Model is estimated on the several **observables**: output (both GDP and GDI), consumption, investment, and wage growth, total hours worked, inflation (both headline and core PCE), the federal funds rate, TFP, 10-year rate

- Many **shocks**: TFP .. .

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- Many **shocks**: TFP .. .

Commentary

- We start by briefly describing the FRBNY DSGE model because this is the model used to extract our measure of r^*, hence it is important to understand its main features.
- The FRBNY DSGE model is based on the seminal work of Smets and Wouters (2007) with a number of additions: shocks/observables/features that are in our model but not in Smets and Wouters (2007) are in blue in the previous slides. The most important addition is financial frictions (next slide).
- The FRBNY DSGE model is broadly discussed in the Liberty Street post "A Bird's Eye View of the FRBNY DSGE Model" (De Paoli et al.) LINK and its most recent version in "The FRBNY DSGE Model Forecast April 2015" (Del Negro et al.) LINK.

Financial Frictions

- Modeled along the lines of Bernanke, Gertler, and Gilchrist (1999), Christiano, Motto, and Rostagno (2003, 2014).
- No arbitrage condition between safe assets and risky investment implies that

$$\begin{array}{c}\text{spread in the return}\\ \text{between risky and safe assets}\end{array} = f(\underbrace{\text{leverage}}_{\text{endogenous}}, \underbrace{\text{shock}}_{\text{exogenous}})$$

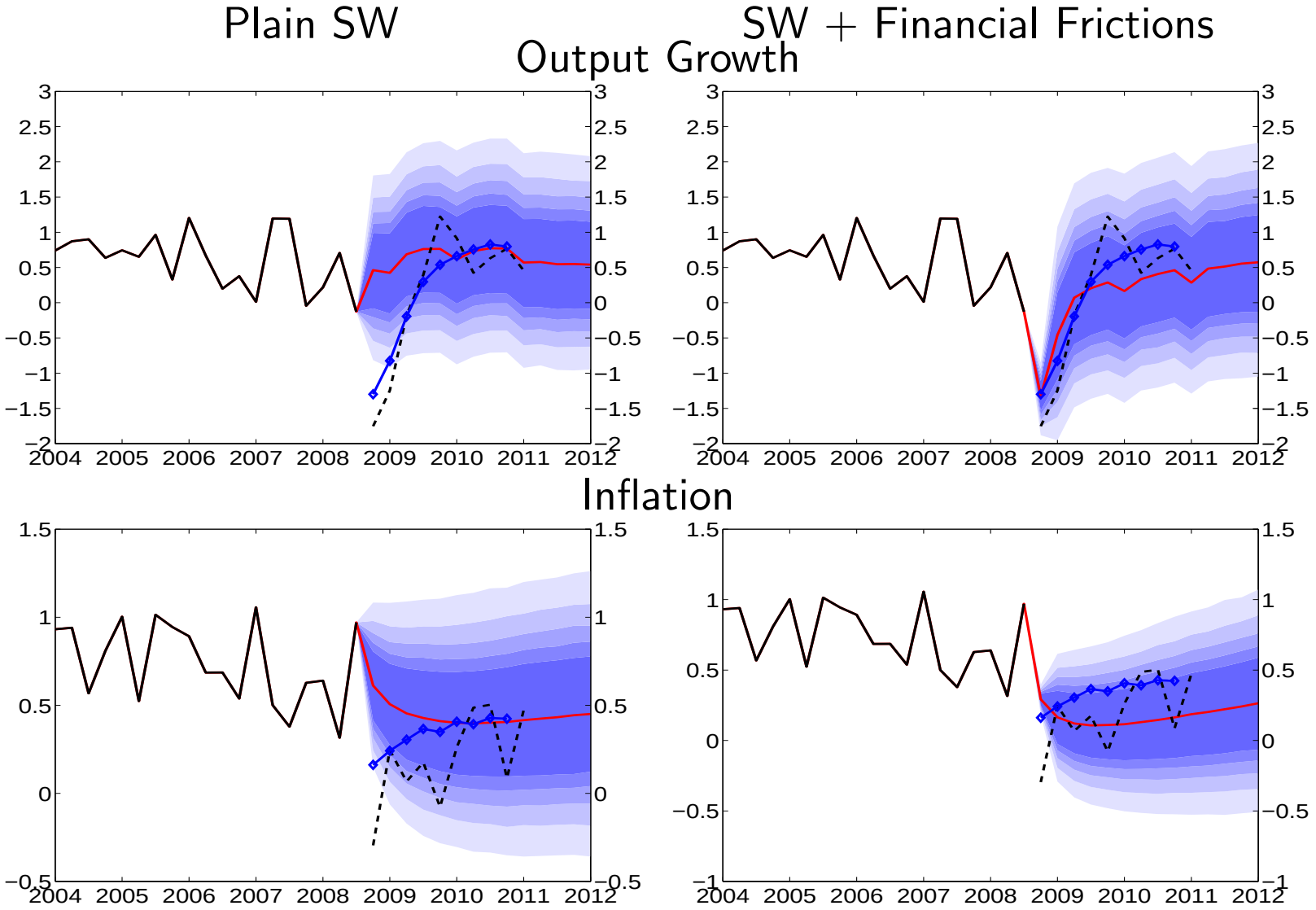
- Spread is treated as observed and measured as the difference between the Baa Corporate rate and the 10 year Treasury
- Del Negro, Giannoni, and Schorfheide (2015)

Commentary

- Financial frictions are introduced as in Del Negro, Giannoni, and Schorfheide (2015) LINK.
- They are very important both in terms of the model's dynamics (propagation of financial shocks) and the information set (BAA-Treasury spread contains information about the state of the economy, and specifically of financial conditions).
- They are key in terms of forecasting performance (next slide).
- Financial frictions also play an important role in terms of estimates of r^*: financial shocks are the key drivers of r^* in our model.

Why Financial Frictions?

Forecasts of the Great Recession: 2008Q3 Data (Del Negro and Schorfheide 2014)



Commentary

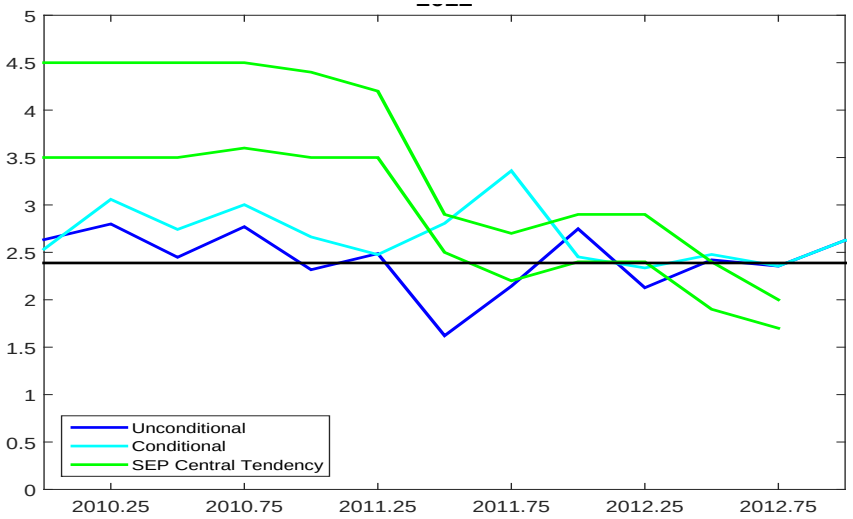
- The figure is from Del Negro and Schorfheide, 2014 Handbook of Economic Forecasting, section 7.2 LINK, and is commented in detail therein.
- The two models are identical except for the inclusion of financial frictions. The figure shows that financial frictions, and the inclusion of spreads in the information set, change the forecasts dramatically using pre-Lehman (2008Q3) data.
- *Figure description*: The panels show for each model the available real GDP growth/core PCE inflation data as of Jan 10 2009 (black line), the DSGE model's multi-step mean forecasts (red line) and bands of its forecast distribution (shaded blue areas; these are the 50, 60, 70, 80, and 90 percent bands, in decreasing shade), the Jan 10 2009 Blue Chip forecasts (blue diamonds), and the actual realizations according to the May 2011 vintage (black dashed line). All the data are in percent, Q-to-Q.

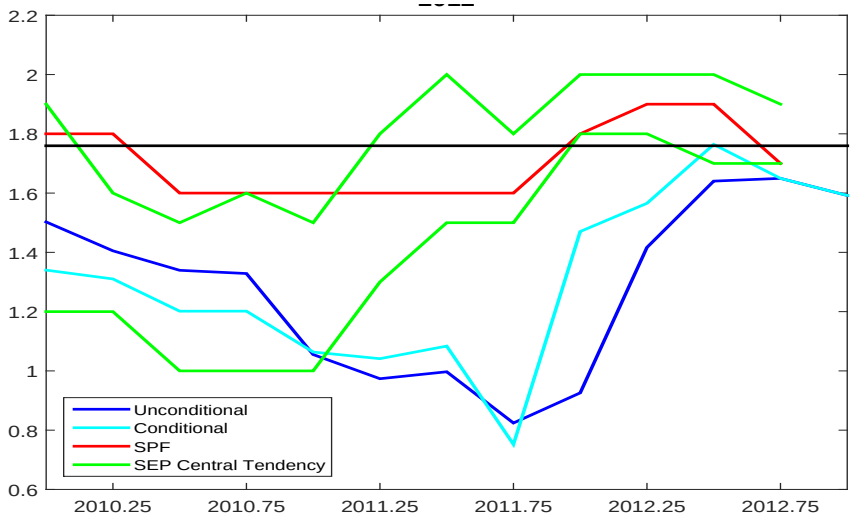
"Real" Real Time Forecasts from FRBNY-DSGE Model

Forecasts evolution over time: FRBNY DSGE vs SEP

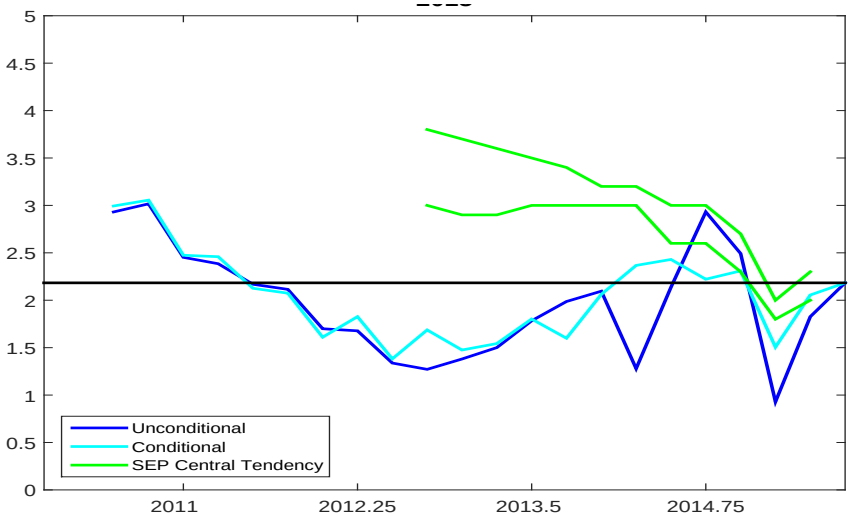
Output Growth (Q4/Q4) | Core PCE Inflation (Q4/Q4)

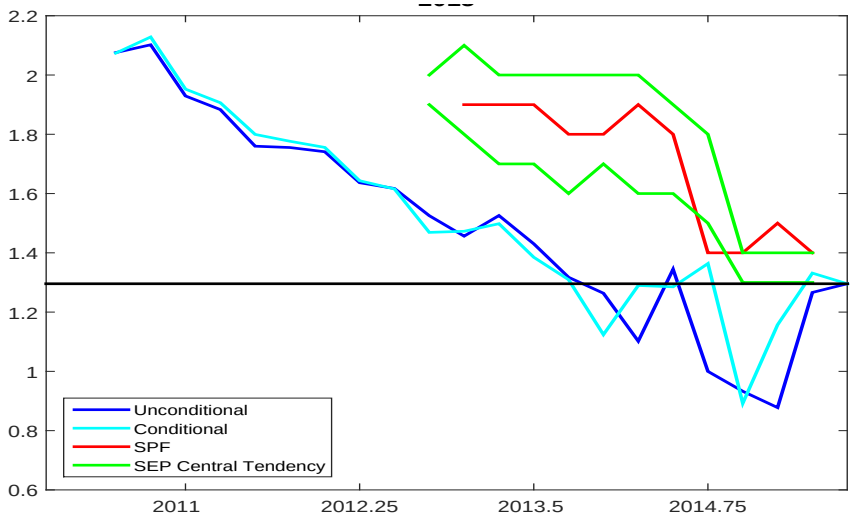
2012





2015





Commentary

- r^* estimates from the FRBNY DSGE model are credible only to the extent that the model has some empirical validity. Real (as opposed to pseudo) real-time assessment of forecasting accuracy from the model may provide some.
- The FRBNY model from the beginning (mid-2010) predicted a meek recovery and inflation below the long run objectives. The forecasts in the Summary of Economic Projections were substantially more optimistic. This is because it believed that the headwinds from the financial crisis would dissipate only slowly. The FRBNY model was broadly correct in terms of output growth. It under-predicted inflation in 2012 (Arab spring) but did well for 2015 inflation.
- *Figure description*: The plots show the **evolution over time** of the forecasts for 2012 (top panels) and 2015 (bottom panels) for output growth (Q4/Q4, left panels) and core PCE inflation (Q4/Q4, right panels). The forecasts are the FRBNY DSGE forecast (dark blue), the FRBNY DSGE forecast conditional on the judgmental nowcast for output and inflation (light blue), the upper and lower bounds of the "central tendency" of the FOMC's Summary of Economic Projections (green), and the Survey of Professional Forecasters' forecasts (red). These plots are update versions of the charts shown in the Liberty Street post "An Assessment of the FRBNY DSGE Model's Real-Time Forecasts" (Cocci et al.) LINK

Caveats

- Long run trends misspecified (balanced growth path)
- No external sector (only exogenously captured via "demand shocks")
- No term premia

Commentary

- The FRBNY DSGE model – in spite of arguably being at the frontier – is still badly misspecified and misses important features of the US economy.
- Among the sources of misspecification are the long run trends (e.g., the balanced growth path assumed in the model implies that output and consumption grow at the same pace)
- Among the (many) missing features are the lack of an external sector, term premia, a banking sector, non-linearities ...

What is r^*?

(in New Keynesian DSGE Models)

- r^* is the short term **real rate of return** in an **hypothetical economy without nominal (price and wage) rigidities**, but otherwise identical to the one we live in.
- In this economy monetary policy **cannot** affect real rates of return ...
- ... nor should it try to. The level of output (y^*) is the optimal one – given the environment.

Commentary

- r^* in New Keynesian models in general and in the FRBNY DSGE model in particular is discussed in the Liberty Street post "Why Are Interest Rates So Low?" (Del Negro et al.) LINK. See also the literature cited therein.

What is r^* for?

1) Provide **information on real rates of return – <u>net</u> of monetary policy**. (Positive)

- What would the real rate be in a parallel universe where monetary policy had no effects?

- Real rates of return in the US are currently very low, and have been so for many years. According to the model, monetary policy has very little to do with this.

What is r^* for?

2) Provide a **benchmark for setting the short term rate**. (Normative)

- Why? A simple New Keynesian economy can be described by an AD curve resulting from the interaction of monetary policy (the LM) and the IS relationship:

$$y_t = \sigma r_t + \boldsymbol{E}_t[y_{t+1}] + \text{IS shifters}$$

or

$$(y_t - y_t^*) = \sigma(r_t - r_t^*) + \boldsymbol{E}_t[(y_{t+1} - y_{t+1}^*)]$$

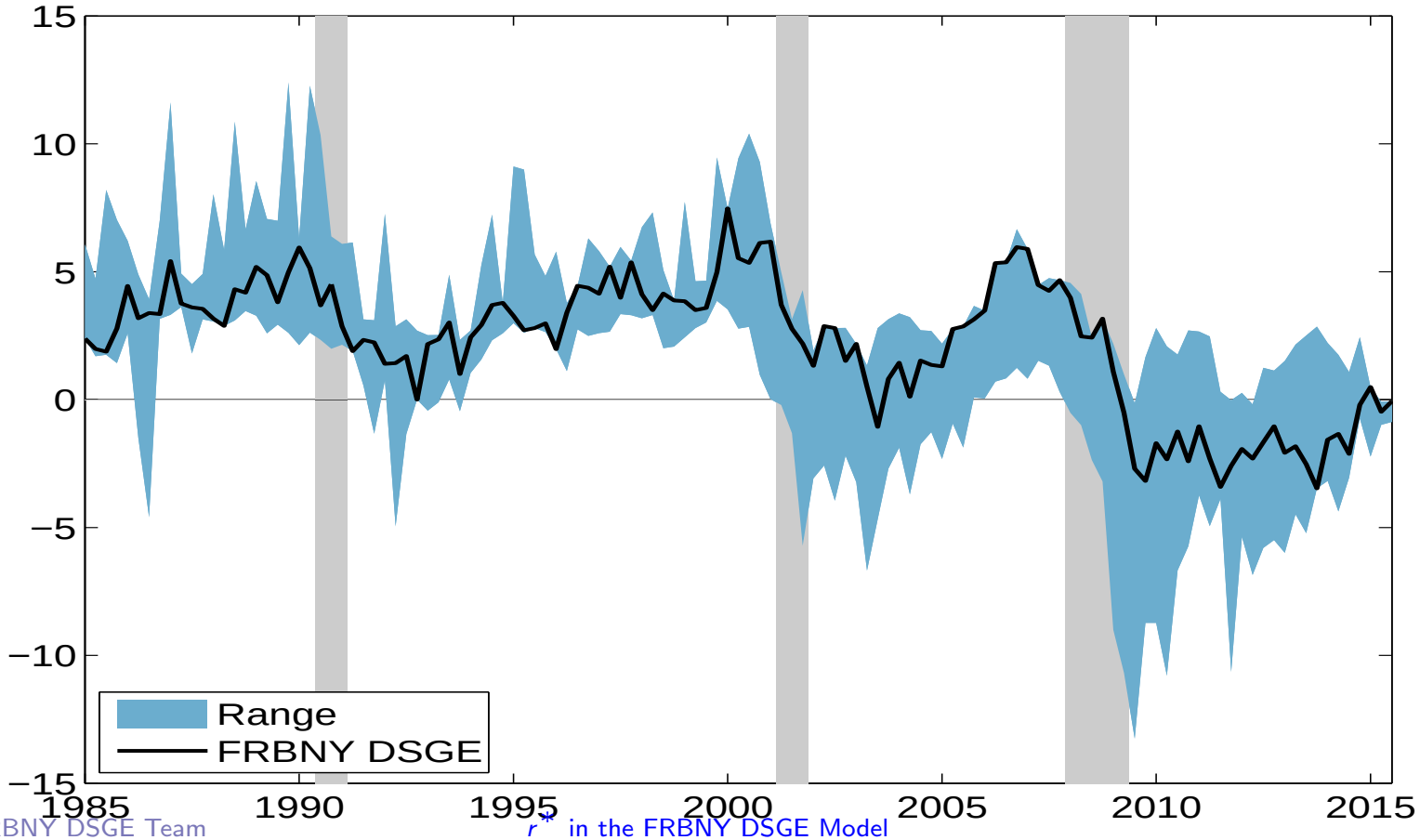
and by an AS curve

$$\pi_t = \kappa(y_t - y_t^*) + \beta \boldsymbol{E}_t[\pi_{t+1}]$$

- In this simple economy setting r equal to r^* kills two birds with one stone: 1) it closes the output gap ($y = y^*$) and 2) stabilizes inflation ($\pi = 0$).

A Time Series of r^*

- r^* varies greatly over time and is pro-cyclical $\rightarrow$ Assumption of constant r^* does not appear to be supported by the data.
- r^* fell in the Great Recession; it has been low ever since and only recently started to rise.

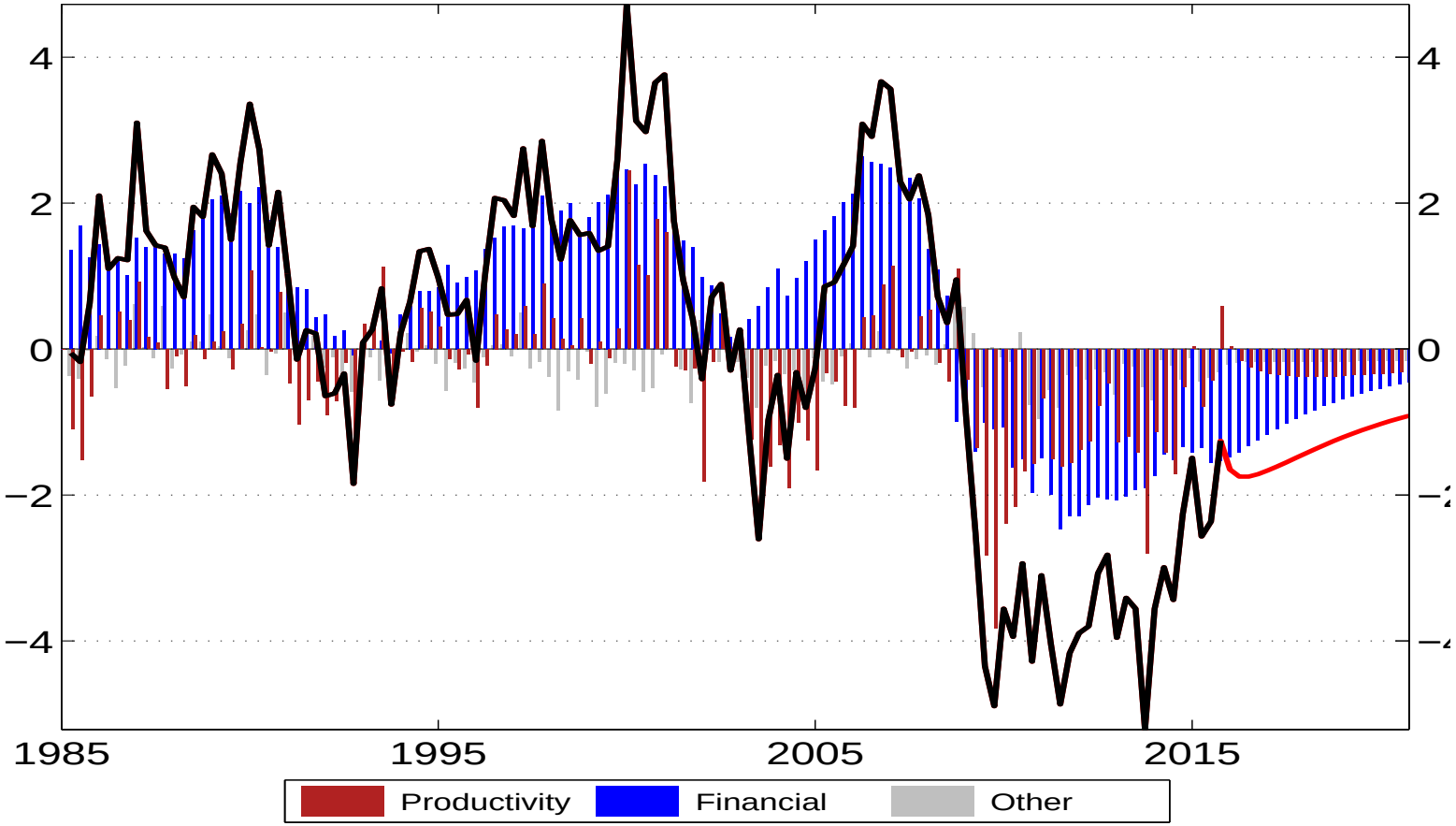


Commentary

- *Figure description*: The black line shows r^* (in real terms, quarterly annualized) in the FRBNY DSGE model. The shaded areas show the range of estimates of r^* from various DSGE models used across the Federal Reserve System and shown in a December 2015 speech by Chair Yellen LINK.
- Estimates of r^* in the FRBNY DSGE model are discussed in the Liberty Street posts "Why Are Interest Rates So Low?" (Del Negro et al.) LINK and more recently in "The FRBNY DSGE Model Forecast November 2015" (Del Negro et al.) LINK. The current estimates are based on data up to 2015Q4.
- Since model misspecification is a serious issue, it may not be wise to rely on a single model. Hence we look at estimates of r^* across different DSGE models (although, in fairness, all these model share some of the same sources of misspecification).
- Note that quarterly estimates of r^* tend to be quite volatile.

What Drives r^*?

- The main forces driving r^* in the US in the recent period have been *financial headwinds*, which lower investment and increase savings, and *productivity* shocks, which affect the marginal product of capital.
- Financial headwinds are expected to dissipate over time, but slowly.



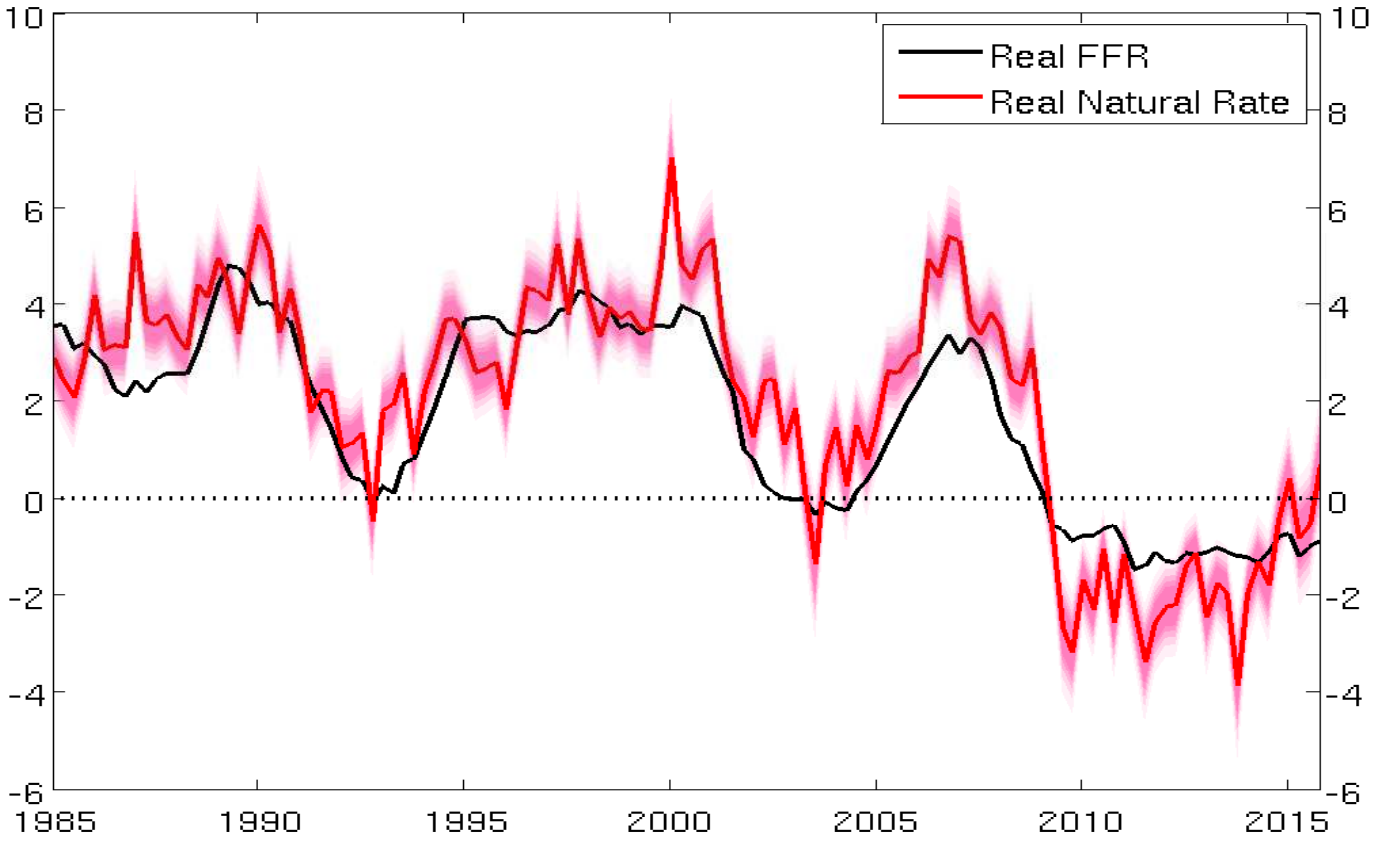
Commentary

- *Figure description*: The black line shows r^* in deviations from its long run mean. The red line shows the model's forecast for r^*. The colored bars show the contribution of various shocks to the evolution of the natural rate.
- The DSGE model allows us to trace the evolution of the natural rate back to the original shocks perturbing the economy.
- Financial and (to a lesser extent) productivity shocks are the main drivers of r^* – both in the recent period and throughout the entire sample.

The Monetary Policy Stance Through the Lenses of r^*

- r (actual real rate of return) $> r^*$ $\rightarrow$ monetary policy is "*restrictive*"
- $r > r^*$ $\rightarrow$ monetary policy is "*accommodative*"

- Caveat: r^* is not necessarily optimal in outside of simple models

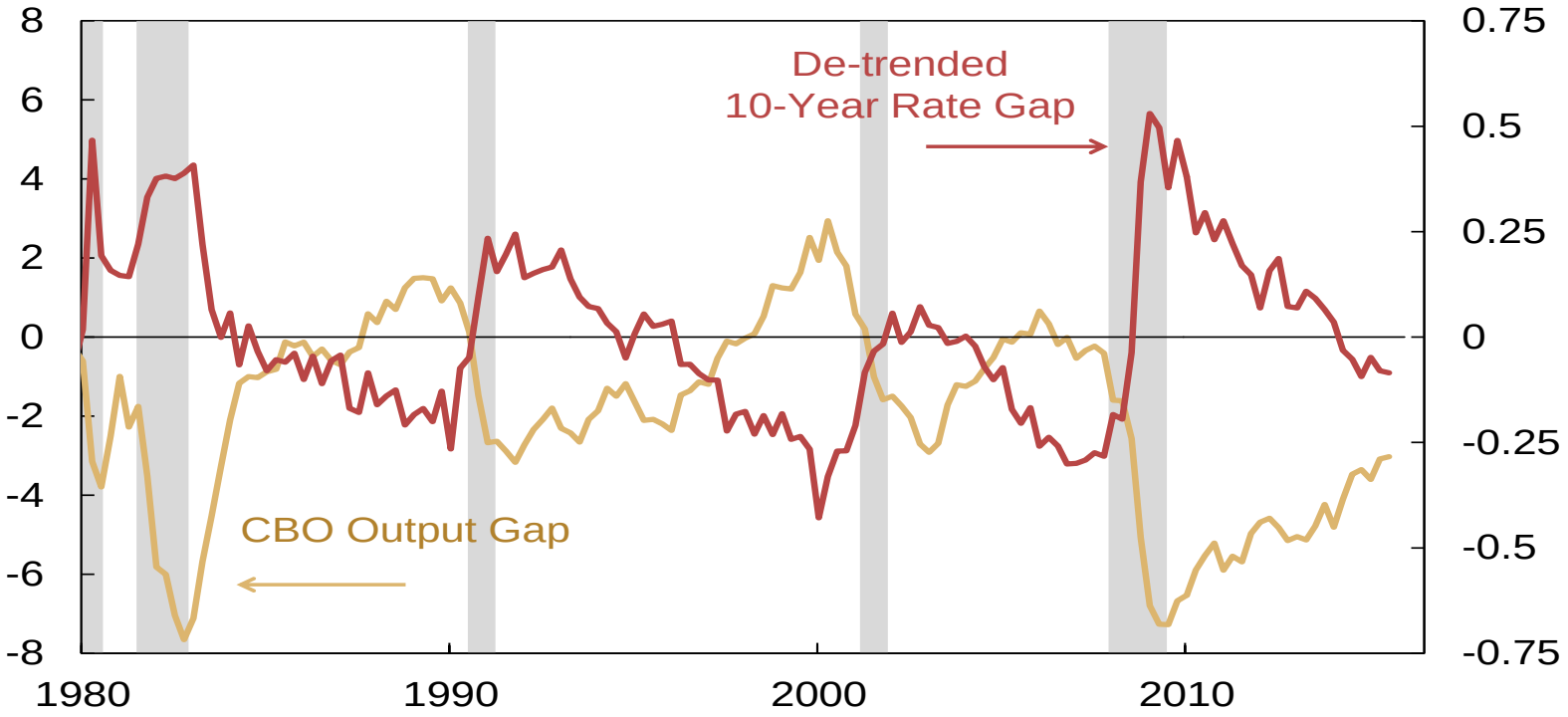


Commentary

- *Figure description*: The figure shows the actual real short term interest rate (black, computed as the federal funds rate minus expected inflation), and r^* (red, 90% bands characterize estimation uncertainty).
- r^* – rather than the absolute level of interest rates – can serve as a gauge as to whether policy is accommodative or not.
- According to this measure, policy was accommodative in the mid-2000's, but restrictive in the aftermath of the Great Recession. Currently, r^* and the actual real rate are close to one another, indicating that policy is close to "neutral."

The r^* Gap and Business Cycles in the US

- The gap between r and r^* is strongly countercyclical (negatively correlated with CBO output gap).
- This does not mean the monetary policy "caused" recessions and booms; only that it could have responded more forcefully – according to the model

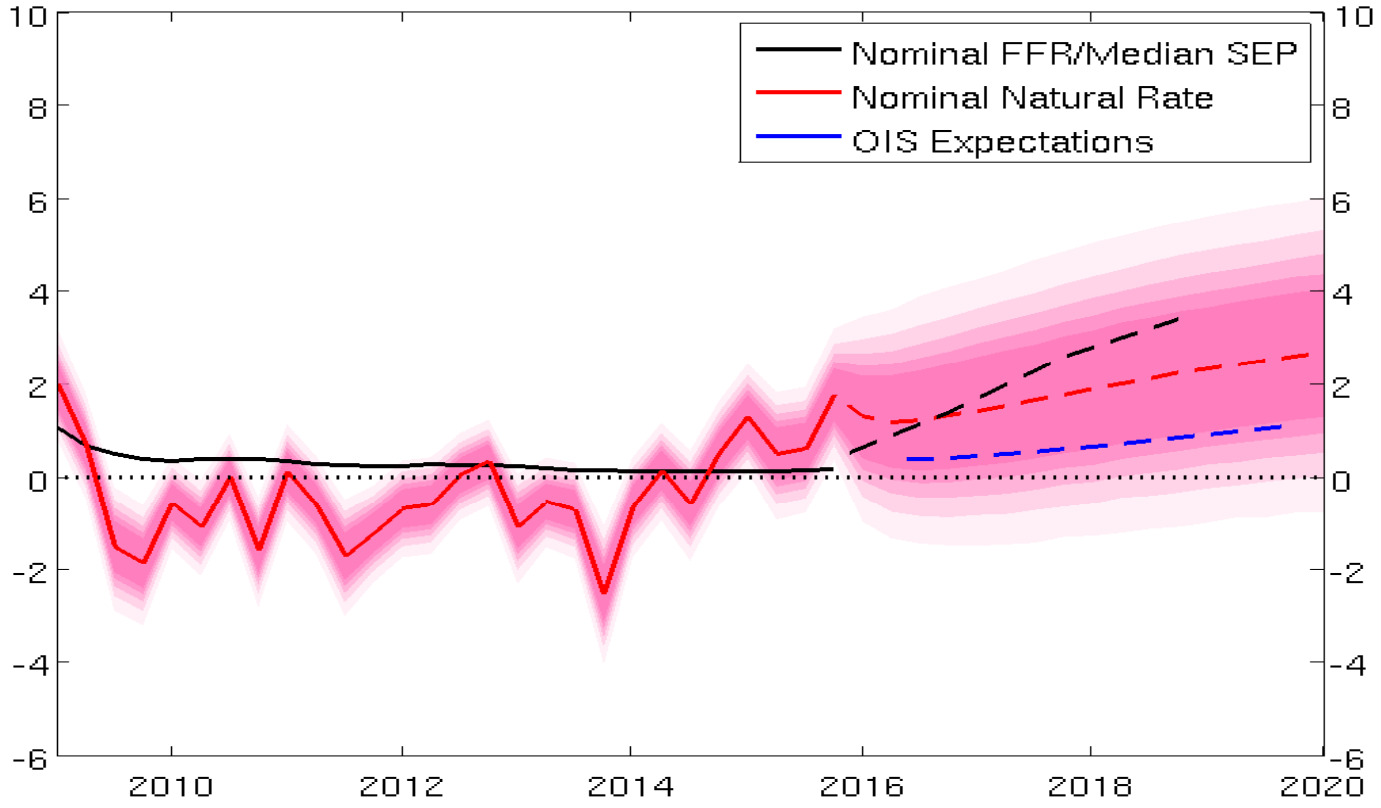


Commentary

- *Figure description*: The figure shows the gap between the 10-year r^* and the 10-year real rate (red line), both computed using the expectation hypothesis. This r^* gap is detrended using the HP filter. The orange line shows the CBO output gap.
- Does the r^* gap matter? The figure shows that the r^* gap and the CBO output gap are strongly *negatively* correlated. This does not mean the monetary policy "caused" recessions and booms; only that it could have responded more forcefully – at least, according to the model (see Justiniano et al. 2013 LINK for a similar finding).
- Why do we use the 10-year rate gap? Because it is the long rate, rather than the short rate, that affects economic conditions in New Keynesian models (as can be seen by iterating the Euler/IS equation). We use the HP filter to address the long run trends issues discussed before, but the negative correlation is there even with non-detrended data, if slightly weaker.

Interest Rate Renormalization and Nominal r^* in the US

- r^* set to renormalize quite slowly
- The chances that nominal r^* become negative are not small $\rightarrow$ asymmetric risks



Commentary

- *Figure description*: The figure shows the federal funds rate and the median forecast for the federal funds rate from the December Summary of Economic Projections (black line), the nominal natural rate (defined as r^* plus expected inflation, red lines), and the OIS (Overnight Interest Swaps, blue line, as of February 9 2016).
- The figure makes two points. First, the nominal natural rate is currently slightly higher than the federal funds rate, but renormalizes very slowly (because of financial headwinds discussed before). The median SEP forecast foresees a faster renormalization which, according to the model, may change the stance of US policy from being mildly accommodative to being restrictive.
- Second, there are non negligible chances that the nominal natural rate may become negative $\rightarrow$ the risks are asymmetric, as negative nominal rates are harder to achieve.

Conclusions

- The FRBNY DSGE model has a reasonable forecasting track record so far
- r^* is the real rate of interest "net" of monetary policy influences
  - It varied widely in the US over the past 30 years, mostly driven by financial shocks
  - It provides a useful benchmark for monetary policy
- The gap between r and r^* is countercyclical
- r^* is expected to normalize slowly in the US