



# Endogenous Regime Shifts in a New Keynesian Model with a Time-Varying Natural Rate of Interest

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Applications of Behavioural Economics,  
and Multiple Equilibrium Models to Macroeconomic

Bank of England, London – 3-4 July 2017

# Summary of the Paper

- ▶ Decline of the **natural real interest rate** (Laubach and Williams, 2016, Del Negro et al, 2017, ...)  
  
⇒ **ZLB** episodes are likely to be **more frequent** (Reifschneider and Williams, 2000)
- ▶ NK 'Standard Model' has two steady states: **targeted equilibrium (TE)**, **deflation equilibrium (DE)** (Benhabib, Schmitt-Grohé and Uribe, 2001a,b)

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- ▶ Large shocks can push the economy at the ZLB
- ▶ Agent places higher probability on the deflation equilibrium – self-fulfilling
- ▶ Even outside ZLB the agent can assign a nontrivial probability to the deflation equilibrium

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## **This discussion:**

- ▶ Is it a good description of the US economy?
- ▶ Is a standard NK model the right framework?

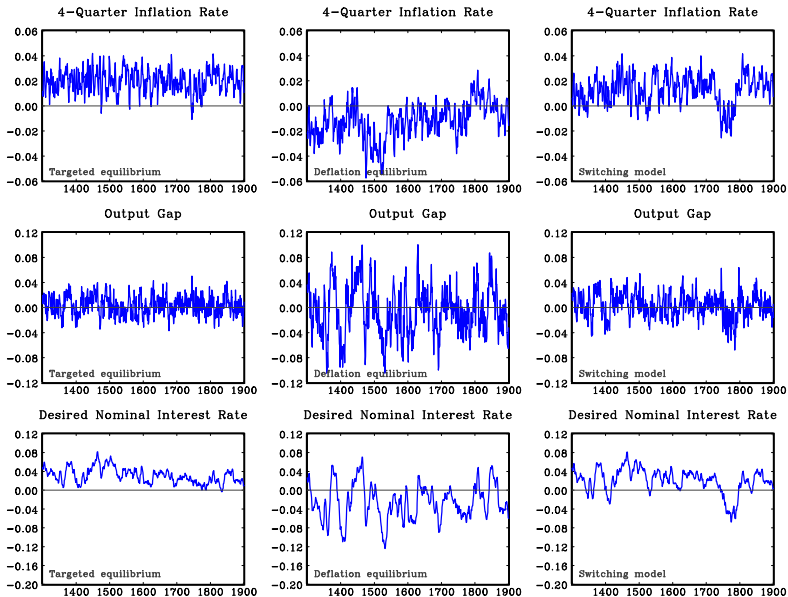
# Deflationary equilibrium

- ▶ **Targeted equilibrium:** inflation on the target, nominal interest rates are positive
- ▶ **Deflation equilibrium:** nominal interest rates are zero and inflation rates are (usually) negative

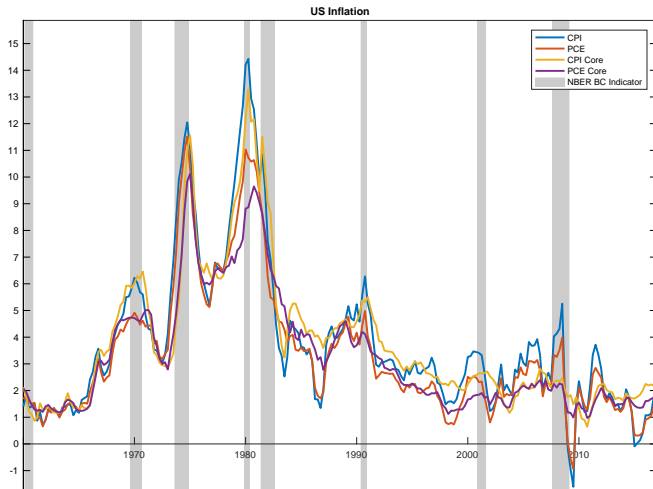
Table 1. Long-run Endpoints

Targeted equilibrium	Deflation equilibrium
$\pi_t = \pi^*$	$\pi_t = -r_t^*$
$y_t = y^* \equiv \pi^* (1 - \beta) / \kappa$	$y_t = -r_t^* (1 - \beta) / \kappa$
$i_t^* = r_t^* + \pi^*$	$i_t^* = (r_t^* + \pi^*) [1 - g_\pi - g_y (1 - \beta) / \kappa]$
$\dot{i}_t = r_t^* + \pi^*$	$\dot{i}_t = 0$

# Deflationary equilibrium

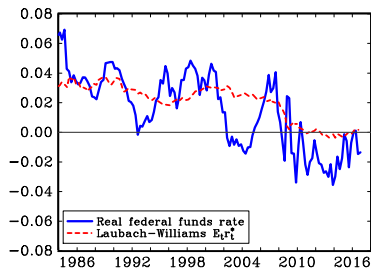


# Missing disinflation?

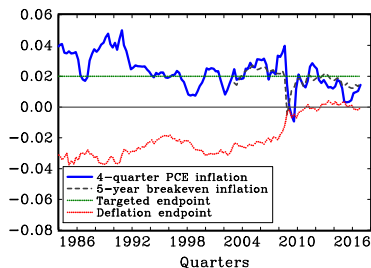


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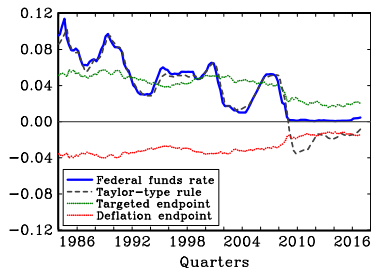
U.S. Real Interest Rate



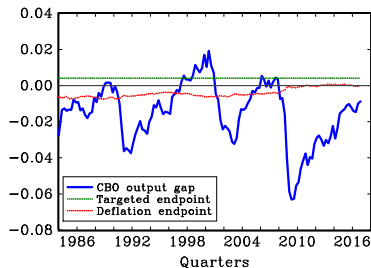
U.S. Inflation Rate



U.S. Nominal Interest Rate



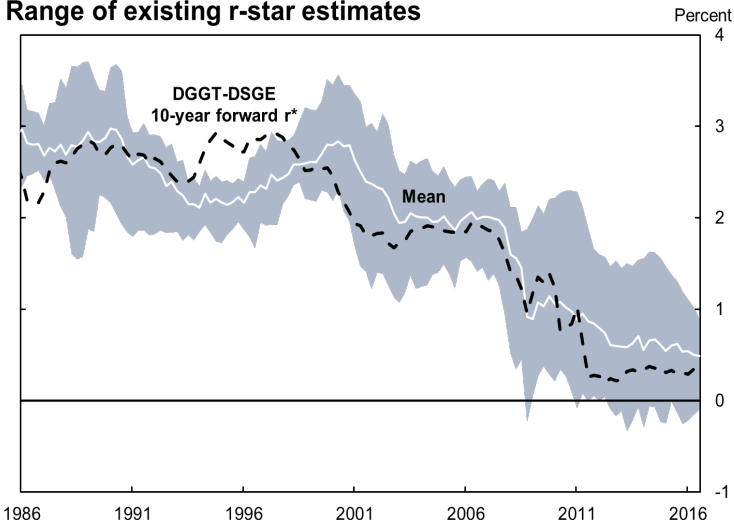
U.S. Output Gap



# How low is the real natural interest rate?

William (2017)

## Range of existing r-star estimates



Estimates from Laubach and Williams (2003), Kiley (2016), Lubik and Matthes (2016), Johanssen and Mertens (2016), Holston, Laubach, and Williams (2016), Crump, Eusepi, and Moench (2016), and Christensen and Rudebusch (2017) [estimates begin 1998q2].



# How low is the real natural interest rate?

Laubach and Williams, 2016

**Why is  $r^* < 0$ ?**

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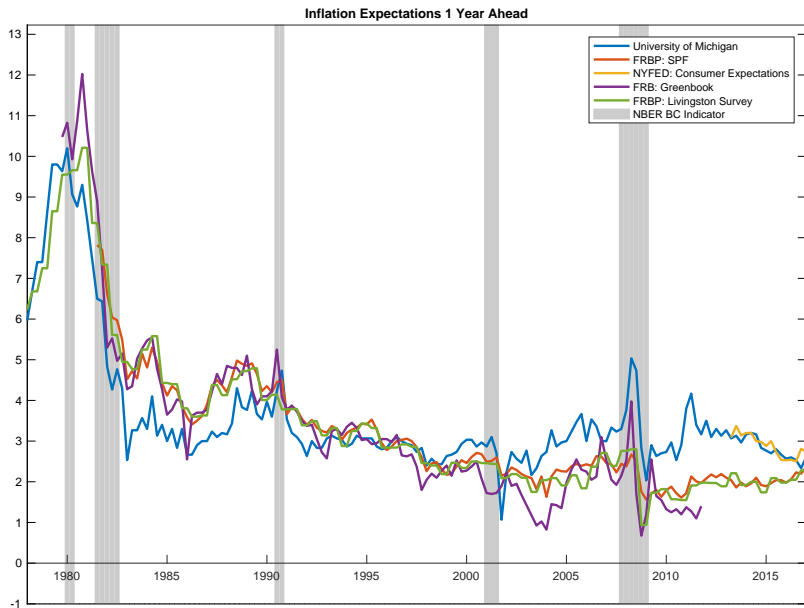
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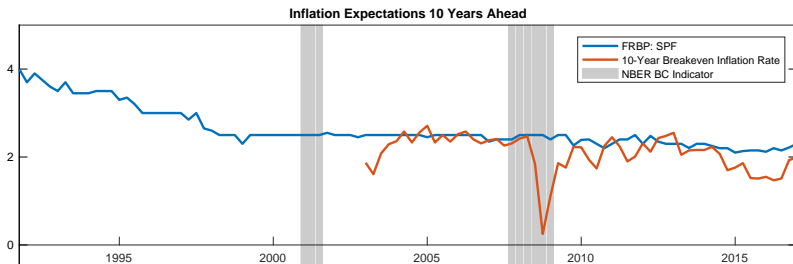
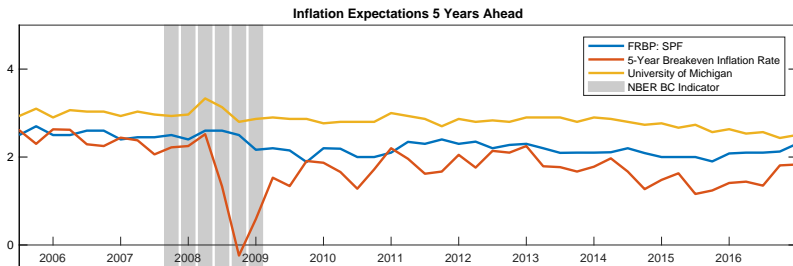
“With **core inflation** remaining surprisingly stable in the face of **sharp declines of real GDP** below the trend [...], the model assigned some of the unexpected output declines to the output gap, but also a large share to declines in potential output and its trend growth rate. [...]

While the **output gap began to narrow** gradually beginning in mid-2009, [...] the **IS curve, would have predicted a much faster return** of the output gap to zero if the estimate of  $r^*$  had remained at its pre-recession value near 2 percent. [...] **The (one-sided) estimate of  $r^*$  therefore fell rapidly** to 0.5 percent in mid-2009, and then continued to decline to around zero by the end of 2010, cutting the implied real rate gap to about **-0.5 percent.** ”

# Did inflation expectations shift?

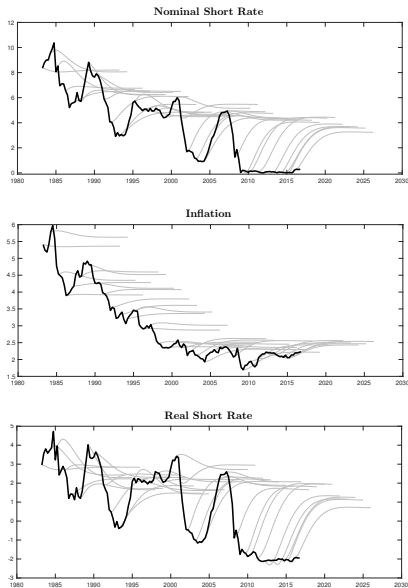


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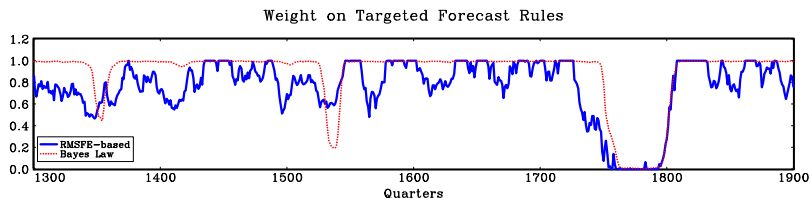


# Did inflation expectations shift?

Universal consensus term structure of expectations – Crump et al (2017)

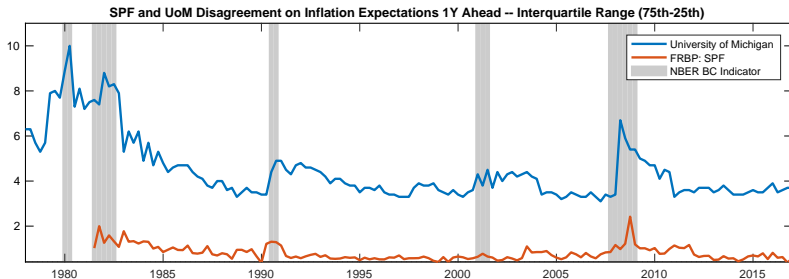
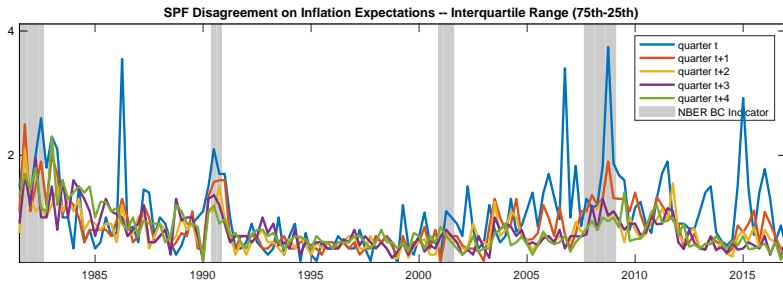


# Bimodal or divergent expectations?



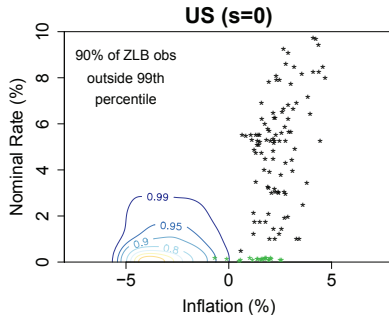
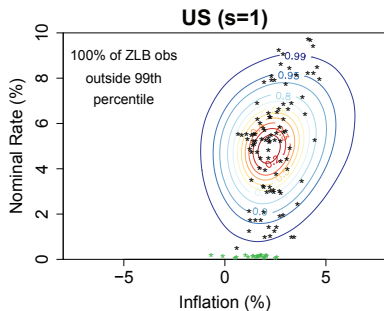
- ▶ Sudden shifts of expectations?
- ▶ Implication of the model – representative agent has a bimodal forecast distribution
- ▶ Is there any evidence of this? Look at aggregate uncertainty in SPF inflation forecast (bins).
- ▶ Maybe disagreement in population?

# Disagreement about the steady state?



# How would the model fit the data?

Arouba et al (2016)





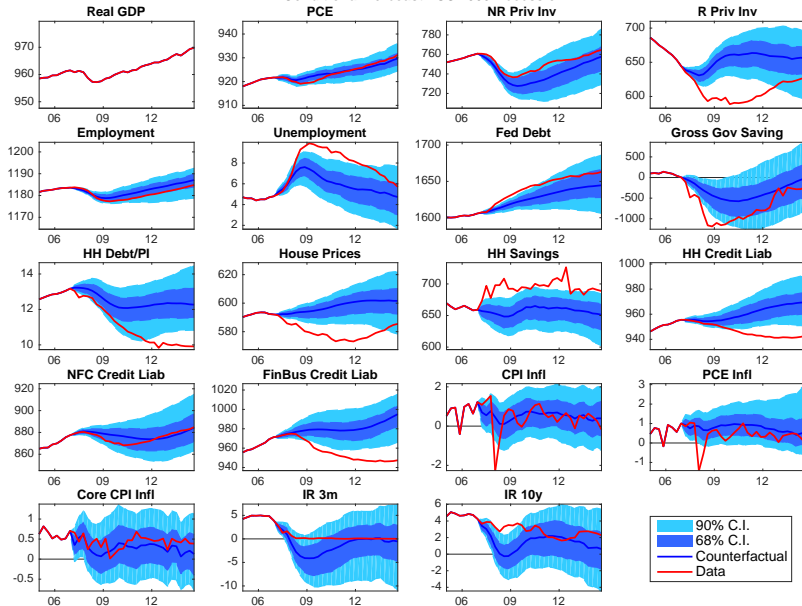
# What was different in the Great Recession?

**Conditional projections** (Bańbura et al, 2015):

- ▶ Think of data as Y's and Z's
- ▶ The object of interest is the **density of future Y's** conditional on **past Y's and Z's** as well as on **future Z's**
- ▶ E.g. **given past recessions, what inflation would we have forecast in 2008Q1 if we had known the subsequent paths of GDP?**
- ▶ If the actual data different from the forecast  $\implies$  the actual data are '**unusual**' (what modellers may want to focus on)

# Spot the differences?!

Conditional Forecast - US 2008 Recession



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- ⑦ Path of  $r^*$  is assumed
- ⑧ Not fully consistent with Laubach, Williams model for  $r^*$

# Conclusions

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## Open Questions:

- ▶ Is the standard NK model the right framework?
- ▶ How should we model the expectation formation?
- ▶ How to model the macro-financial interaction?
- ▶ Are the decline of the natural interest rate and the Great Recession just separate albeit interacting phenomena?