# Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events?

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Monetary Policy at the Zero Lower Bound
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# Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events?

- Yes …
- … unless you think we were hit by a once-a-century event

# Goal: Address Three Questions

1. How surprising have recent events been?

2. Has the estimated probability of hitting the ZLB changed over time?

3. How severely did the ZLB bind during the crisis?
   - What might unconstrained policy have done?
   - Did asset purchases significantly ease the constraint?

# Past as Prologue: Estimated Incidence of the Zero Lower Bound: 2 Percent Inflation Target

| | FRB/US | |
|---|---|---|
| | Original Taylor Rule | Henderson-McKibbon Rule |
| Frequency of ZLB episodes | 5 | 17 |
| Mean duration of ZLB episodes | 4 | 4 |
| Frequency of deep recessions (output gap < -6 percent) | 2 | 1 |

Source: Reifschneider and Williams (2000)

- Others were even more sanguine:

*In light of the finding that the Ramsey-optimal inflation rate is negative, it is puzzling that most inflation-targeting countries pursue positive inflation goals. We show that the zero bound on the nominal interest rate, which is often cited as a rationale for setting positive inflation targets, is of no quantitative relevance in the present model.*

Schmitt-Grohe and Uribe (2007)

# Methodology

- Re-examine the probability of hitting the ZLB and the duration of such episodes using a broad set of estimated structural macro models and atheoretical statistical models.

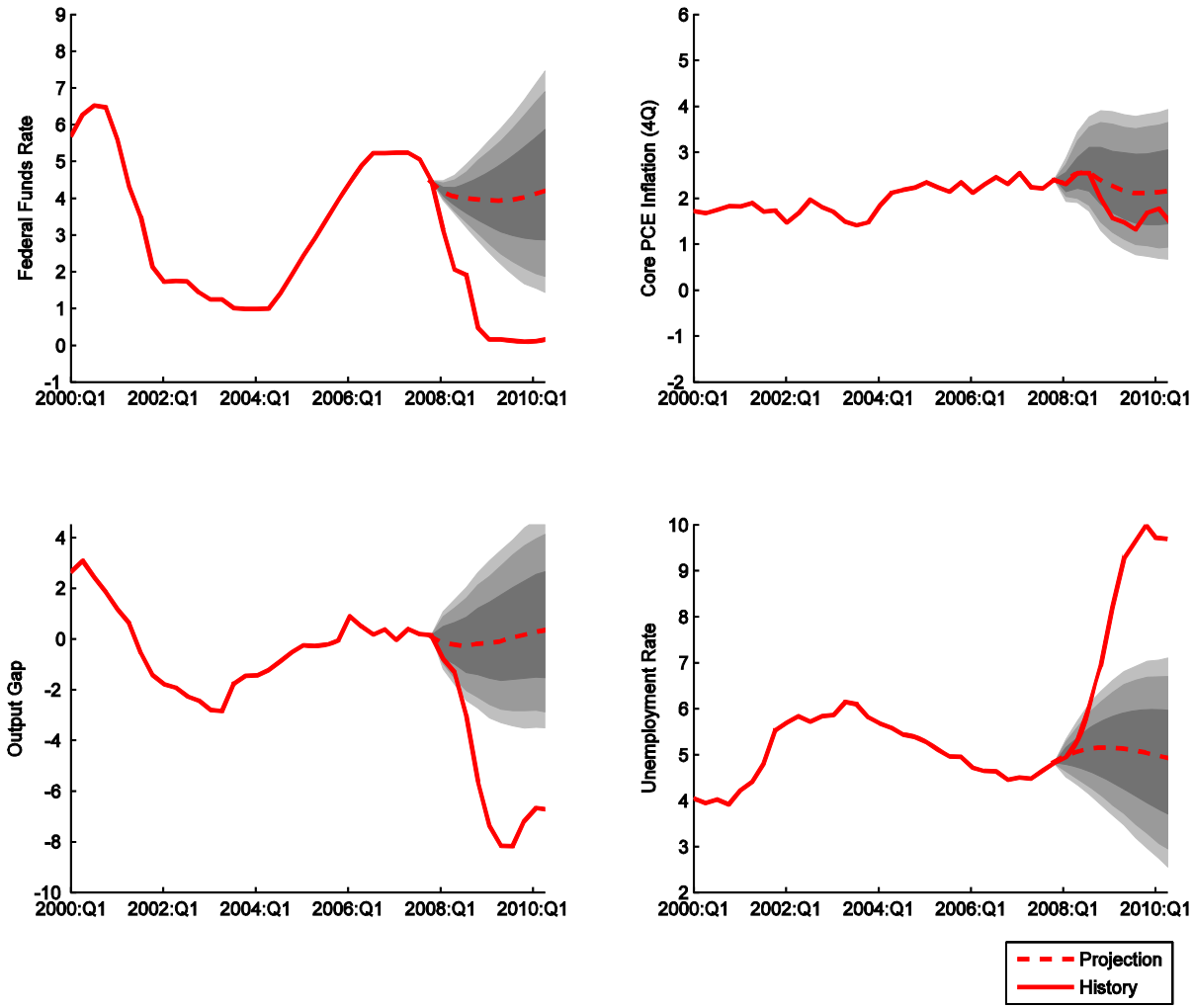
- Include models that allow for time-varying:
  - Parameters
  - Neutral real interest rate (r*)
  - Variances

- Incorporate uncertainty about:
  - Shocks
  - Parameters
  - Latent variables (output gap, r*)

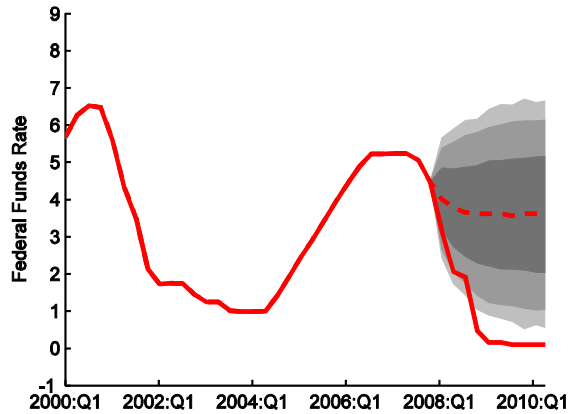
# Model Summary

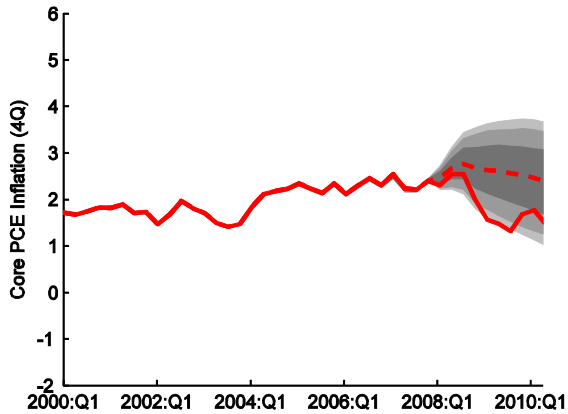
| | EDO (DSGE) | Smets-Wouters (DSGE) | FRB/US | TVP-VAR | Laubach-Williams | GARCH |
|---|---|---|---|---|---|---|
| Estimation sample size | 1984 | 1968 | 1968 | 1964 | 1961 | 1968 |
| Estimation method | Bayes | Bayes | OLS | Bayes | ML | ML |
| Estimated equations | 28 | 13 | 56 | 3 | 8 | 3 |
| Time-varying R* | No | No | No | Yes | Yes | No |
| Time-varying parameters | No | No | No | Yes | No | No |
| Time-varying variances | No | No | No | Yes | No | Yes |

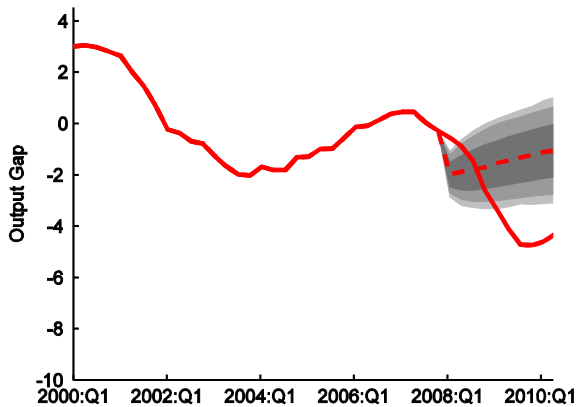
# Decline in Output, Rise in Unemployment, and Hitting the ZLB Were Huge Surprises to FRB/US



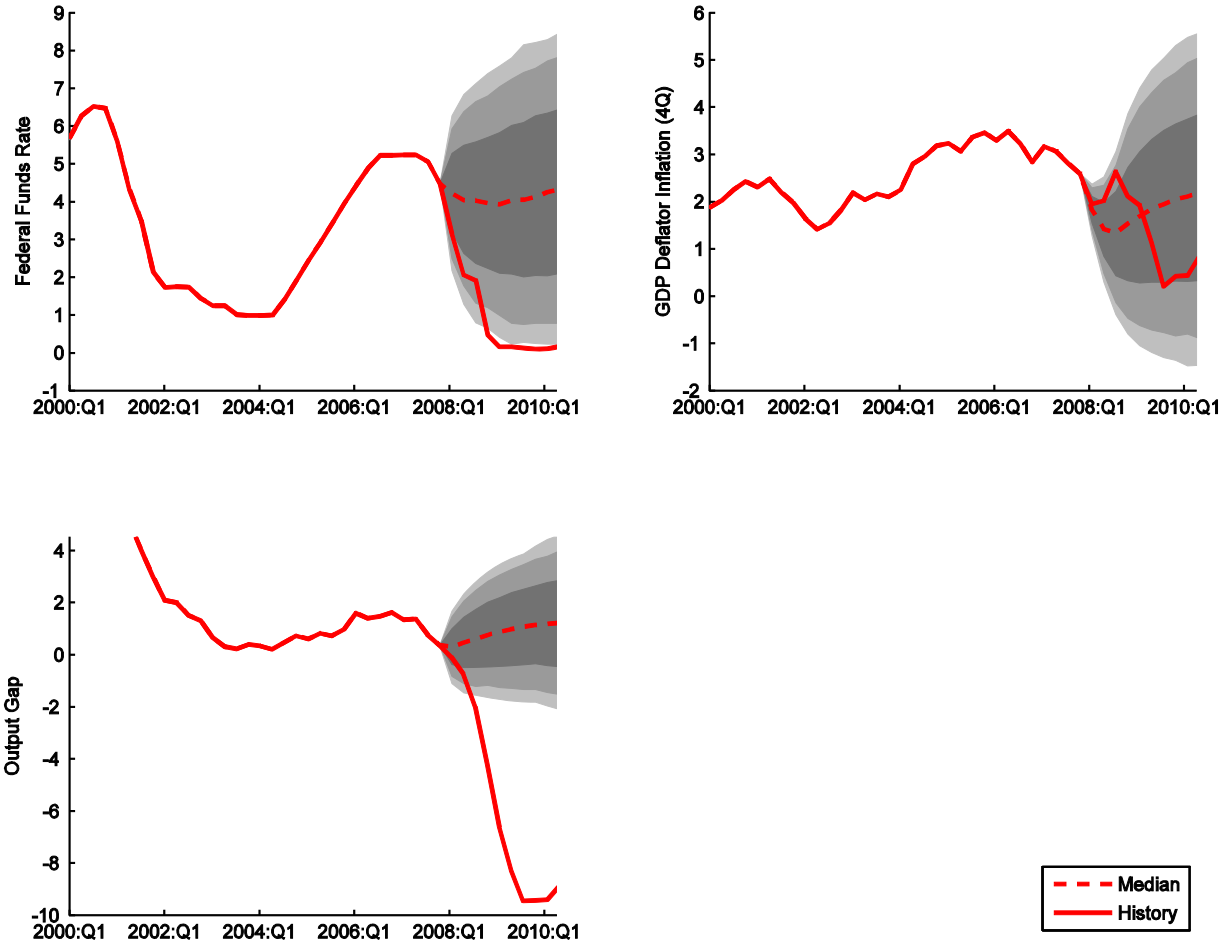
# EDO Was Also Quite Surprised



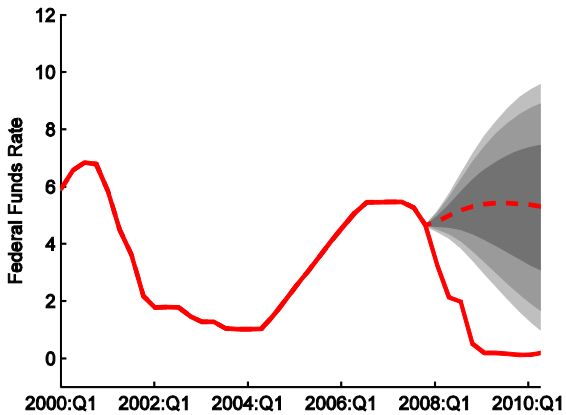




# Smets-Wouters, Too

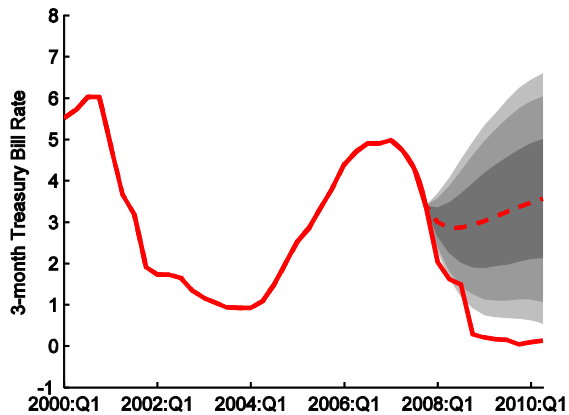


# Most Statistical Models Were Also Surprised if We Ignore Uncertainty About Parameters and Latent Variables

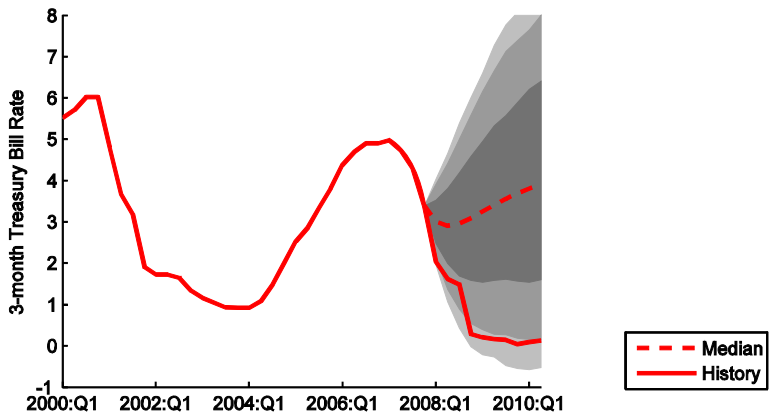
LW




TVP-VAR




GARCH



# Influence of the Shock Process Sample Period to Estimated Probabilities of a ZLB Event Occurring Within 20 Quarters After 2007Q4, Ignoring P/LV Uncertainty

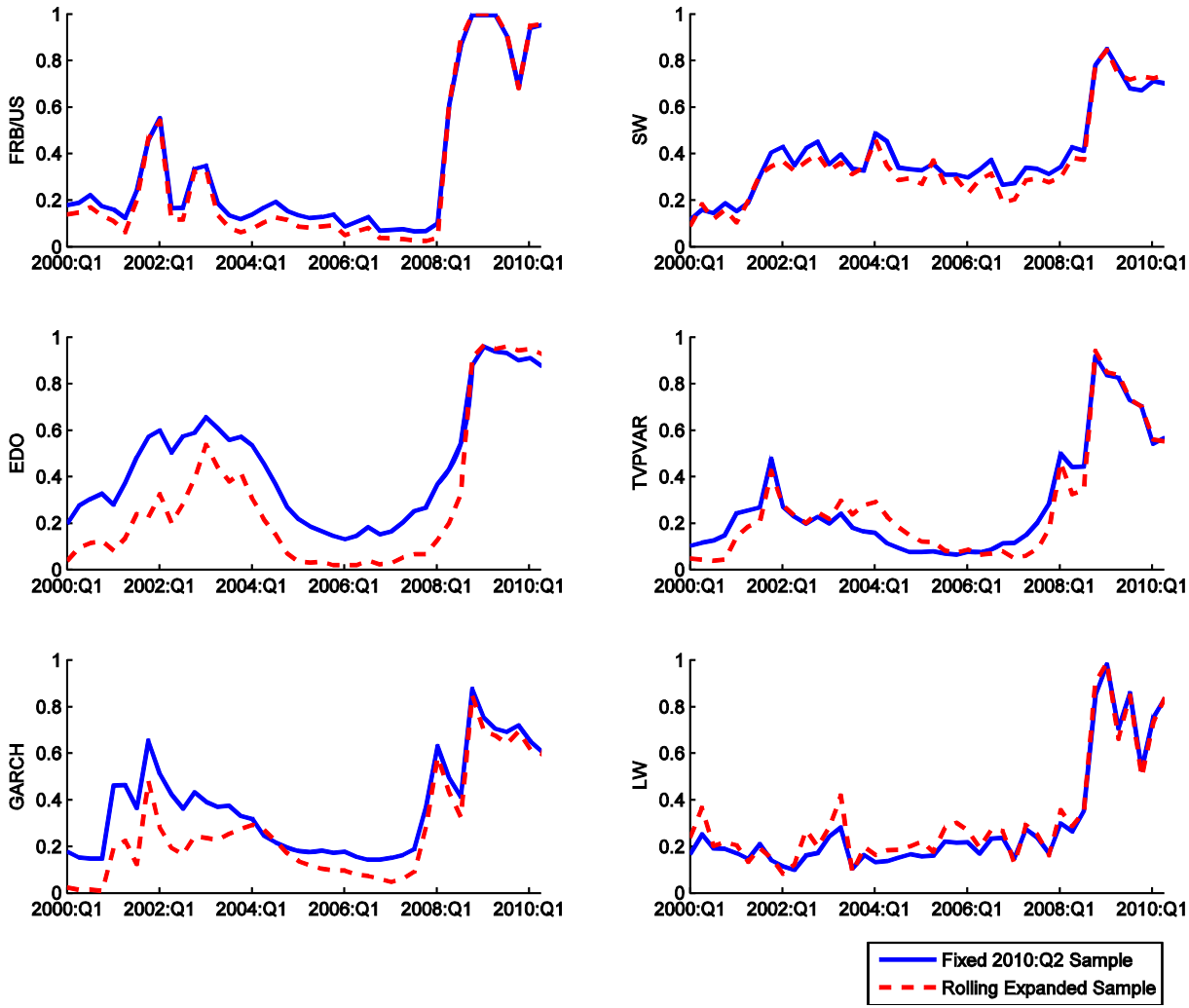
| | FRB/US | EDO | SW | LW | TVP-VAR | GARCH |
|---|---|---|---|---|---|---|
| Probability of a ZLB event | | | | | | |
| long sample ending in 2007 | .03 | .10 | .19 | .09 | .09 | .29 |
| long sample ending in 2010 | .09 | .23 | .25 | .09 | .24 | .36 |
| 1984-2007 sample | .01 | .02 | .02 | .05 | | |
| | | | | | | |
| Probability of a persistent (eight quarter) ZLB event | | | | | | |
| long sample ending in 2007 | <.01 | <.01 | <.01 | .01 | .01 | .03 |
| long sample ending in 2010 | .01 | <.01 | <.01 | .01 | .03 | .05 |
| 1984-2007 sample | <.01 | <.01 | <.01 | <.01 | | |

# Influence of Uncertainty About Parameters and Latent Variables on Estimated Probabilities of a ZLB Event Occurring Within 20 Quarters After 2007Q4

| | EDO | SW | LW | TVP-VAR |
|---|---|---|---|---|
| Probability of a ZLB event | | | | |
| excl. P/LV uncertainty (sample ends in 2007) | .02 | .19 | .09 | .09 |
| incl. P/LV uncertainty (sample ends in 2007) | .09 | .22 | .16 | .18 |
| incl. P/LV uncertainty (sample ends in 2010) | .17 | .27 | .17 | .29 |
| | | | | |
| Probability of a persistent (8-quarter) ZLB event | | | | |
| excl. P/LV uncertainty (sample ends in 2007) | <.01 | <.01 | .01 | .01 |
| incl. P/LV uncertainty (sample ends in 2007) | <.01 | .01 | .05 | .03 |
| incl. P/LV uncertainty (sample ends in 2010) | <.01 | <.01 | .06 | .06 |

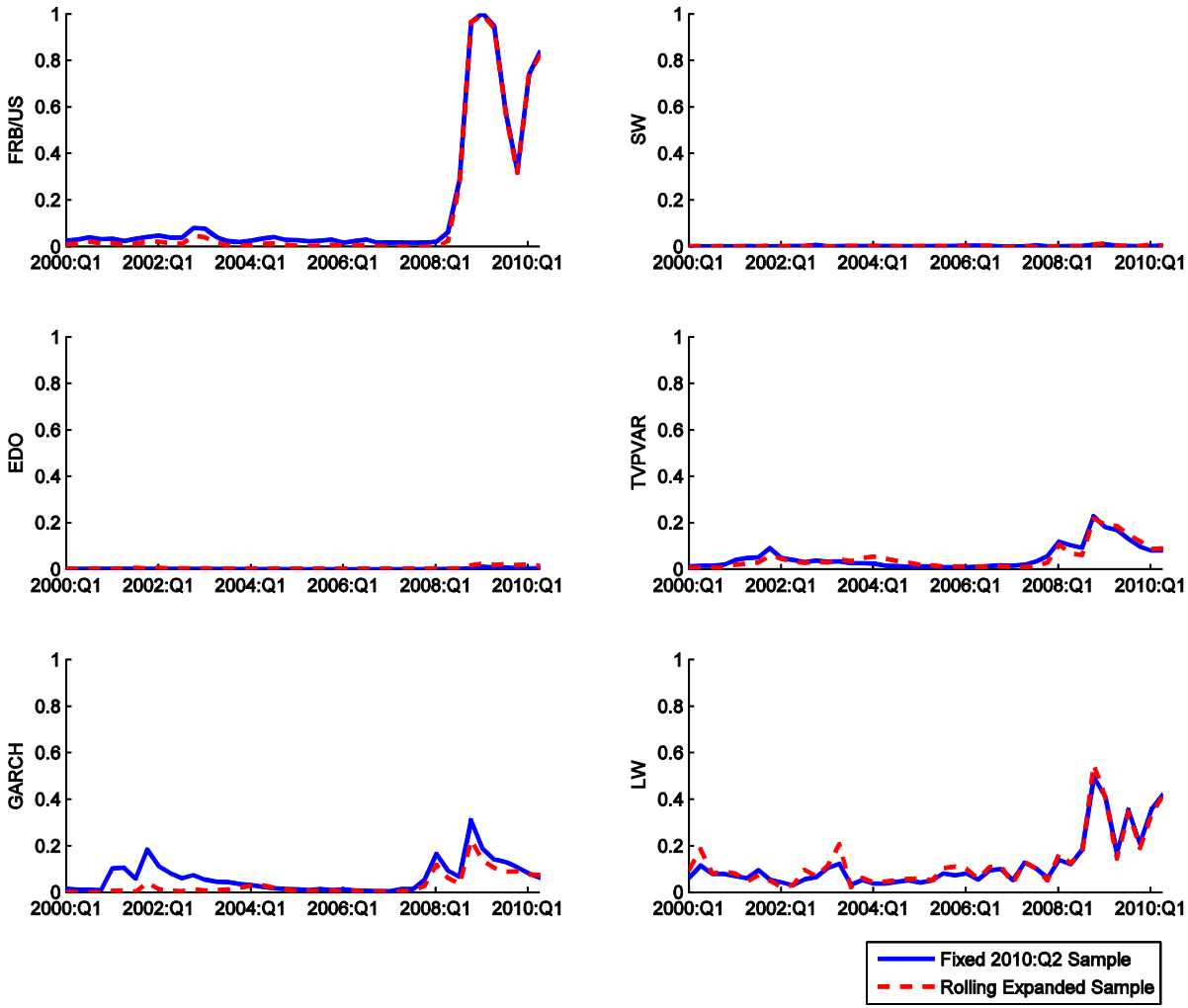
Has the Probability of Hitting the ZLB Changed Much Over Time?

# Rolling Estimates of the Probability of a Future ZLB Event Within the Next 20 Quarters Vary Considerably Over Time



Has the Probability of Hitting the ZLB Changed Much Over Time?

# But the Probability of a *Persistent* ZLB Event Varies Much Less



# Summary of Part A

- Pre-crisis, structural models were fairly sanguine about macro risks
  - Saw almost no chance of a persistent ZLB event in the medium term
  - Saw little risk of unemployment rising above 7 percent

- During the crisis, the DSGE models remained optimistic
  - Anticipated quick rebound in real activity (low intrinsic persistence)
  - Thus saw no persistent ZLB problem

- Going forward, researchers assessing ZLB risks should …
  - Use a broader range of models
  - Take account of P/LV uncertainty
  - Put less weight on short periods, such as the Great Moderation
  - Make greater allowance for tail risks & low-frequency dynamics

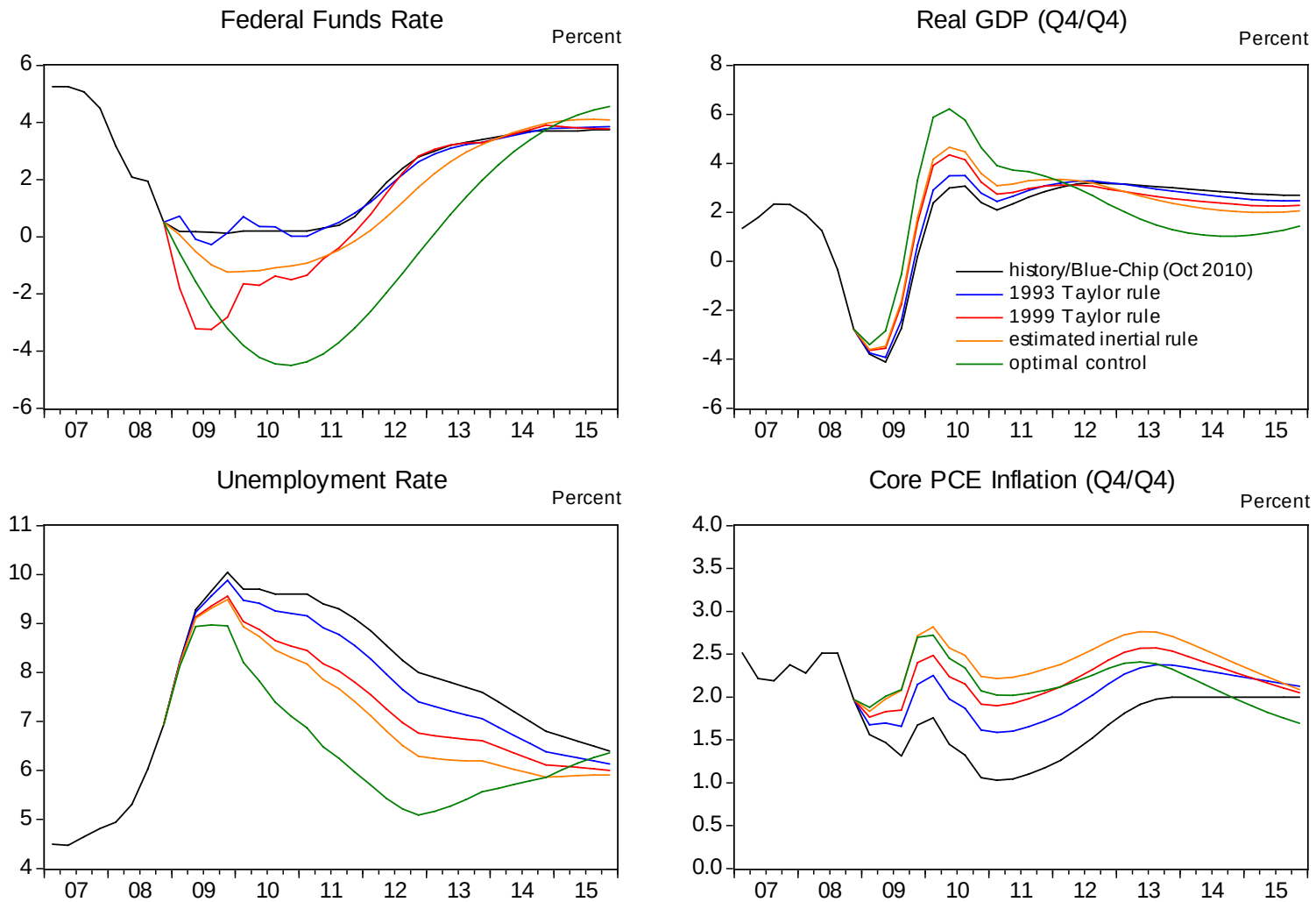
# Gauging the Severity of the ZLB Constraint

- Run counterfactual simulations from 2009Q1 on using FRB/US & history/Blue Chip baseline (Oct '10)
- Funds rate follows unconstrained prescriptions of:
  - Taylor (1993) rule
  - Taylor (1999) rule
  - Est. rule $R_t = .82R_{t-1} + .18\left[R_t^* + \pi_t + .65\left(\pi_t - \pi_t^*\right) + 1.04Y_t\right]$
  - Optimal-control path

$$L = E_t \sum_{j=0}^{m} .99^j \left[\left(U_{t+j} - U_{t+j}^*\right)^2 + \left(\pi_{t+j} - 2\right)^2 + \Delta R_{t+j}^2\right]$$

# How Severely Did the ZLB Bind During the Crisis?

## Counterfactual FRB/US Simulations of the Evolution of the Economy If Monetary Policy Had Not Been Constrained by the ZLB

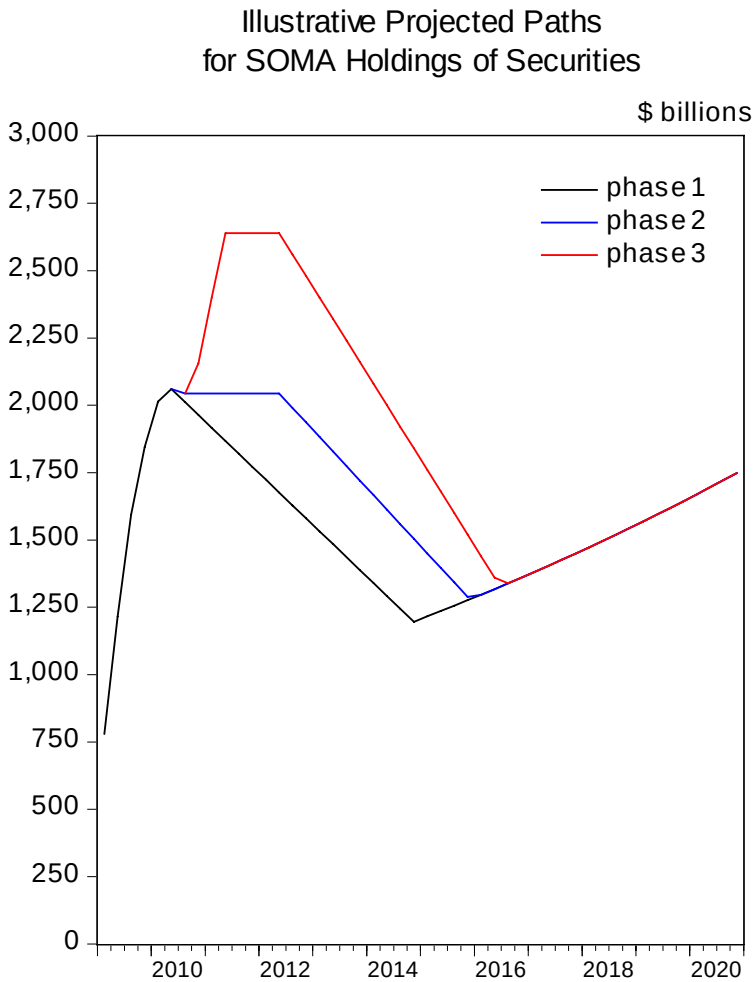


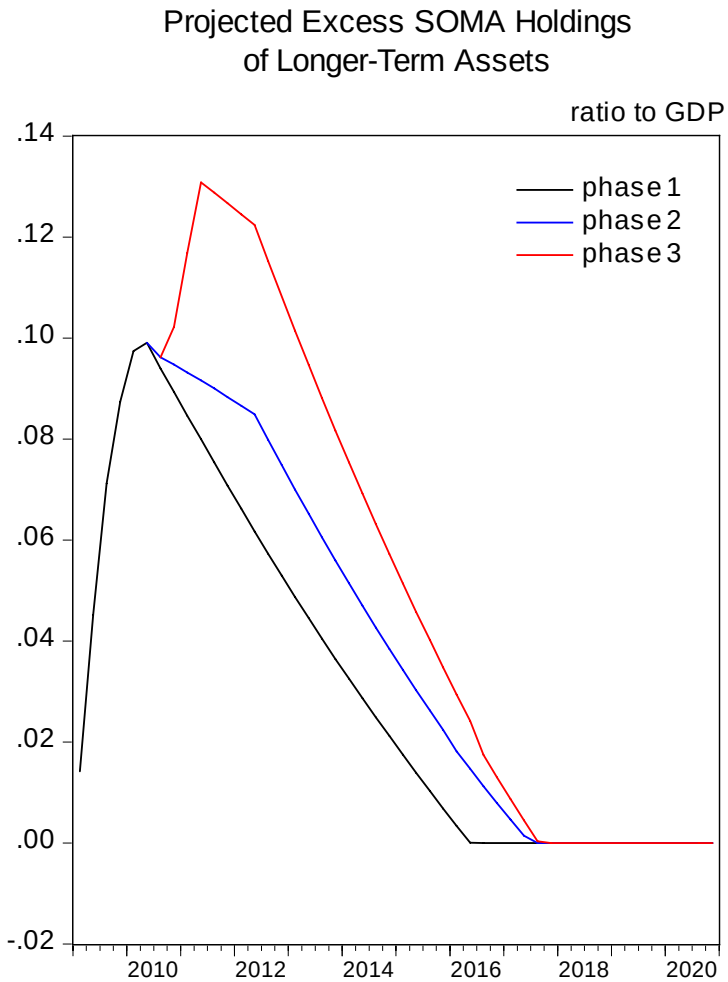
# Counterfactual FRB/US Simulations: Caveats

- Results are model dependent
  - EDO & S&W suggest ZLB constraint was less binding
  - DSGE results hinge on large effects of anticipated policy shocks
- Results are sensitive to slack estimates
  - Simulations assume peak GDP gap = 8 percent
  - IMF/OECD estimates would imply less binding ZLB constraint
- Results understate the overall severity of the ZLB constraint because baseline incorporates actual and projected effects of large-scale asset purchases

How Severely Did the ZLB Bind During the Crisis?

# Phases of the Expansion of Federal Reserve Holdings of Longer-Term Securities in the System Open Market Account



# Transmission Channels for Asset Purchases

- Asset purchases can reduce long-term interest rates …
  - Through portfolio-balance, duration, and other effects that reduce term premiums
  - Through lower risk premiums (reduced adverse tail risks)
  - By improving market functioning
  - By altering expectations for future short-term interest rates
- As a result …
  - Financial conditions improve
  - Real activity stimulated through lower cost of capital, increased wealth, and lower value of the dollar
  - Deflationary pressures checked

# Calibrating Financial Effects of Asset Purchases

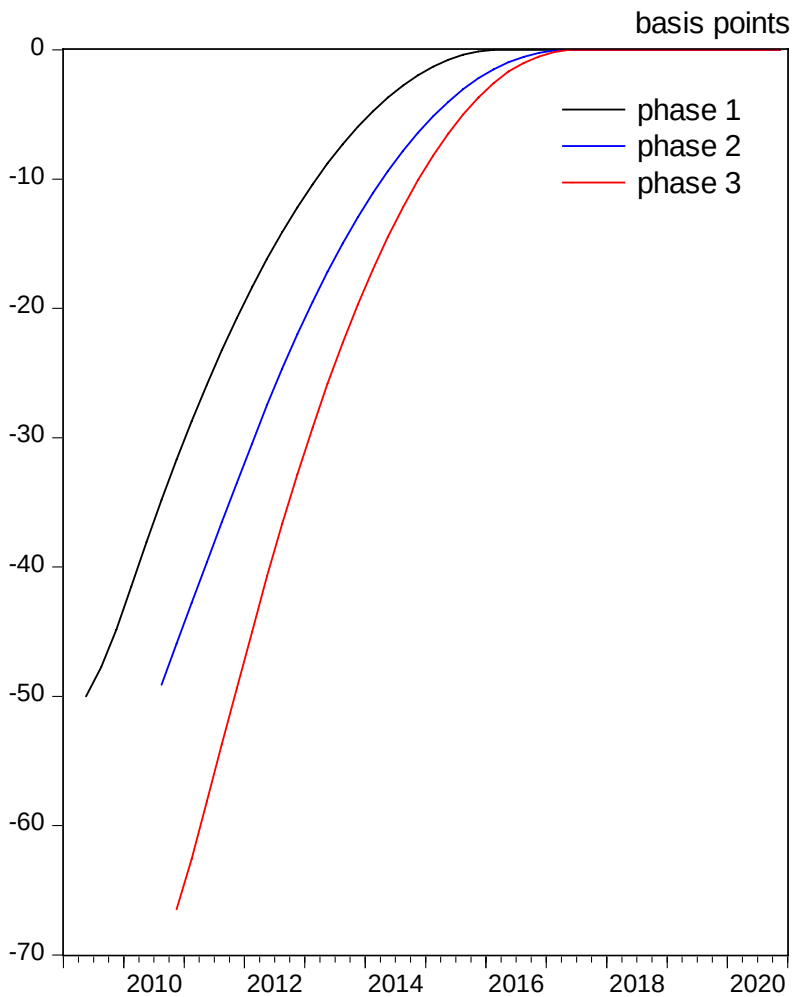
- Treasury bond term premium effects:

$$\theta_t = \lambda E_t \sum_{j=0}^{\infty} \beta^j \left[ \frac{A_{t+j}}{X_{t+j}} - \phi_{t+j} \right]$$

- Projecting $\Theta_t$ :
  - $\Theta_0$ = -50 b.p. (Gagnon et al, 2010)
  - Generate $\Theta_t$ based on path of $A_{t+j}$

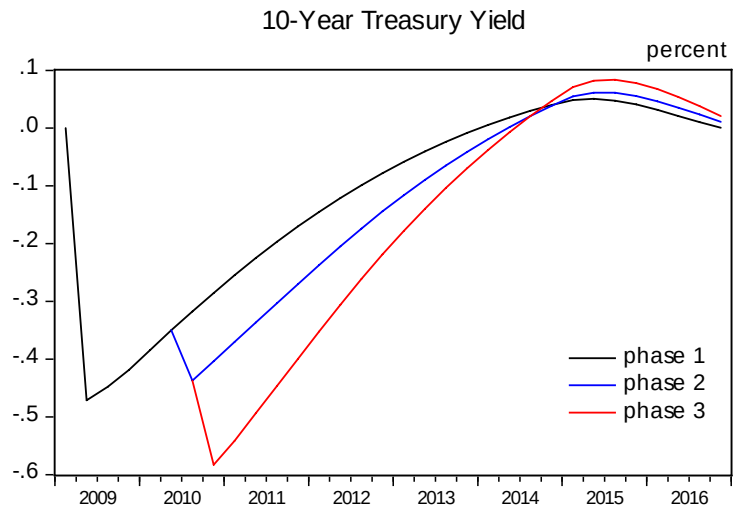
- Simulating macro effects in FRB/US:
  - Shock T-bond premiums by $\Theta_t$
  - Shock mortage rate spreads -50 b.p. in 2009 and early 2010
  - Assume endogenous spillovers to other asset prices, conditional on "neutral" response of conventional monetary policy

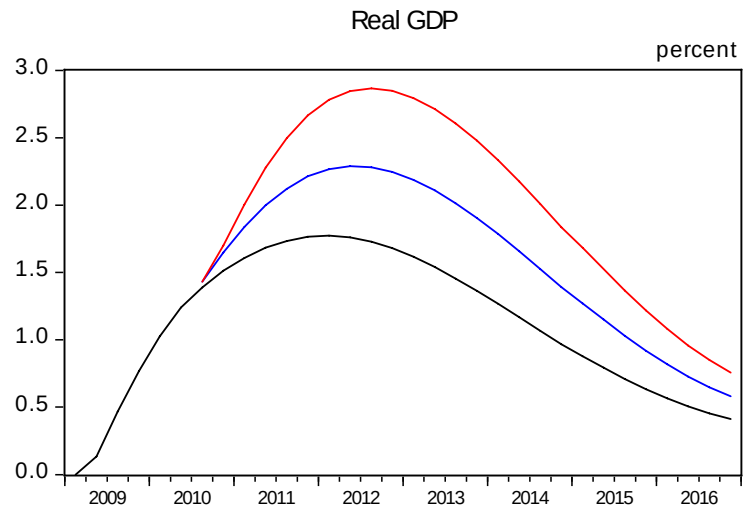
Effect of Large-Scale Asset Purchases on Treasury Term Premiums

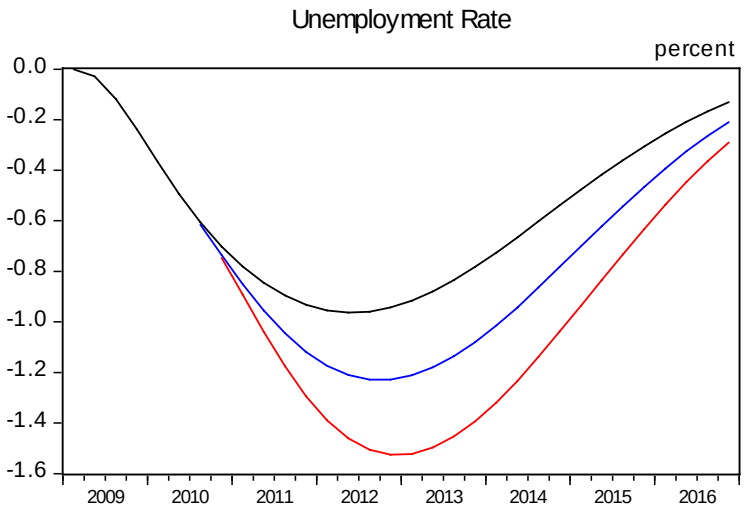


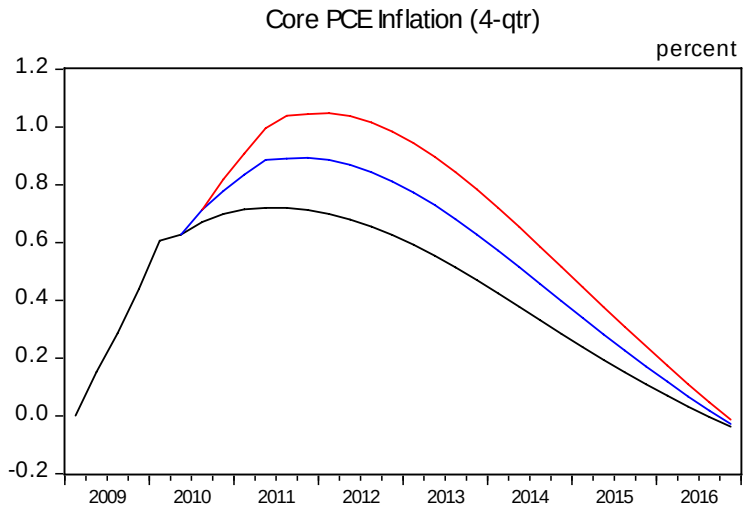
How Severely Did the ZLB Bind During the Crisis?

# Macroeconomic Effects of the Three Phases of the Asset-Purchase Program Under Basecase Assumptions



# Estimated Effects of Asset Purchases: Caveats

- Considerable uncertainty about financial effects
  - Theory at preliminary stage
  - Empirical evidence limited
- FRB/US may overstate macro response to financial effects
  - Inflation may be more inertial
  - Real activity may be less responsive under current conditions
  - Agents may expect future trade-off in conventional monetary policy
- Other models could yield different effects
  - Research hindered by lack of channels in most DSGE models
  - Early work with Smets-Wouters and EDO suggests sizeable spending effects
  - Baumeister and Benati (2010) also find significant effects
- More research needed on …
  - Macro benefits of asset purchases
  - Costs and complications of use