Monetary Policy Surprises, Credit Costs

and

Economic Activity

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Conventional Monetary Policy Transmission

1. Aggregate spending depends on current and expected future real interest rates

2. Central bank controls nominal short rate i_t

3. Nominal rigidities imply control over current and expected future short real rates, at least for some horizon.

4. Expectations hypothesis $\Rightarrow$ policy transmitted via yield curve

Loglinear approx of m period zero-coupon gov't bond $\Rightarrow$

$$i_t^m = E_t \frac{1}{m} \{ \sum_{j=0}^{m-1} i_{t+j} \} + \phi_t^m$$

$\phi_t^m \equiv$ term premium

Two Elaborations

1. Forward Guidance:

   (a) CB affects yield curve by managing expectations of future path of i_t.

2. Credit Channel(e.g., Bernanke and Gertler 1995)

   (a) With credit market frictions, to a first order

$$i_t^b = i_t + x_t$$

   $i_t^b \equiv$ private borrowing rate; $x_t \equiv$ external finance premium (credit spread)

   (b) Monetary policy affects credit spreads as well as risk free rate

      i. $i_t \uparrow \Rightarrow$ tightening of credit frictions $\Rightarrow x_t \uparrow$

      ii. vice versa for $i_t \downarrow$

What We Do

- Analyze joint response of economic activity and various credit cost measures to "exogenous" monetary policy surprises

- To do so, we combine:
  - Traditional "money shock" VAR analysis (e.g. BB 1991, CEE 1996)
  - High frequency identification (HFI) of policy surprises on interest rates (e.g, Kuttner, 2001, GSS, 2005)
    * Policy surprises: Unexpected changes in interest rate futures on FOMC dates

$\Longrightarrow$

- Use HFI measures of policy surprises as "external instruments" in monthly VARs:

Why We Do It This Way

- Two problems with identification of policy shocks in standard VARs
  - Simultaneity between policy indicator and other financial variables
  - Measure of policy shocks do not incorporate shocks to foward guidance:

- HFI addresses both simultaneity and forward guidance issues
  - Policy shocks are surprises in interest rate futures on FOMC dates
    - Dependent variables are same-day responses of various asset returns.
  - Permits incorporating use of forward guidance in policy action (GSS 2005)
    - Innovation in non-current futures rates reflects revision in beliefs about future path of rates

Why We Do It This Way (cont)

- Limitations to HFI
  - With daily data difficult to identify the persistence of the effects of policy shocks on financial variables
  - Can't identify joint response with economic activity
- Our approach: combines strengths of VAR and HFI methodologies
  - By using futures rate surprises as external instruments, exploits HFI approach to identify exogenous policy surprises
  - Uses VAR to trace out full dynamic response of real and financial variables.

Preview of Main Findings

1. FF futures surprises $\Rightarrow$ responses in output and inflation consistent conventional monetary transmission mechanism and with existing VAR literature.

2. "Modest" movements in short rates $\Rightarrow$ "large" movements in real credit costs

   (a) Due mainly to reaction of term premia and credit spreads

   (b) Evidence against baseline model of monetary policy transmission.

      i. Still evidence for sticky prices: real rates move one for one with nominal

      ii. Need to adjust model to account for term premia and credit spread responses.

3. Forward guidance important to strength of policy transmission.

Methodology

- VAR with external instruments (Stock-Watson (2012), Mertens-Ravn 2013).

- Structural autoregressive model

$$AY_t = \sum_{j=1}^{p} C_j Y_{t-j} + \varepsilon_t$$

- Reduced form model

$$Y_t = \sum_{j=1}^{p} B_j Y_{t-j} + u_t$$

$$u_t = S\varepsilon_t$$

with $B_j = A^{-1}C_j$; $S = A^{-1}$

Methodology (cont')

$y_t^p \, \epsilon \, Y_t \equiv$ monetary policy indicator; $\varepsilon_t^p \equiv$ structural policy shock

$s \equiv$ column in S corresponding to impact on each element of u_t of ε_t^p

- To compute the impulse response to a monetary shock, need to estimate

$$Y_t = \sum_{j=1}^{p} B_j Y_{t-j} + s\varepsilon_t^p$$

- B_j obtained via least squares; need restrictions to identify s

- Standard restriction: elements of s are zero except the one corresponding to the reduced form residual for the policy instrument.

External Instruments

$Z_t \equiv$ vector of instrumental variables

$\varepsilon_t^{-p} \equiv$ vector of structural shocks not including policy shock

- Z_t must satisfy

$$E[\varepsilon_t^p Z_t] = \phi$$

$$E[\varepsilon_t^{-p} Z_t] = 0$$

External Instruments (con't)

$u_t^p \equiv$ reduced form residual from equation for policy indicator

$u_t^q \equiv$ reduced form residual for variable $q \neq p$.

$s^q \varepsilon_t^p \equiv$ response of u_t^q to ε_t^p.

- Goal: Identify s^q which gives responses of u_t^q to the policy shock ε_t^p

- Use 2SLS: Three steps:
  - Obtain u_t from OLS regression of reduced form VAR
  - To identify variation in u_t^p due to ε_t^p,regress u_t^p on Z_t
  - To obtain estimates of s^q, regress u_t^q on u_t^p, using the fitted values $\widehat{u_t^p}$ from the first stage regressions as instruments for u_t^p.

Daily Fed Funds Futures Surprises as Instruments

$f_{t+j} \equiv$ settlement price on FOMC day in month t for FF futures expiring in $t+j$

$f_{t+i,-1} \equiv$ settlement price on day prior to FOMC meeting

$i^u_{t+i} \equiv$ surprise in target rate expected for month $t+j$ on FOMC day in month t .

$$i^u_{t+j} = f_{t+j} - f_{t+j,-1}$$

- $i^u_t \equiv$ shock to current funds rate target (Kuttner, 2011)
- for $j \geq 1$, $i^u_{t+j} \equiv$ shock to target expected at $t+j$. (GSS, 2005)
- i^u_{t+j} measured within 30 minute window of FOMC decision
  - Isolates FOMC news (GSS, 2005).

Policy Indicator (vs. Policy Instrument)

- Monthly VARs with IP, CPI, various interest rates and a policy indicator
- Policy indicator (i.e., the "policy relevant" interest rate)
  - Reflects stance of monetary policy, encompassing forward guidance.
  - Residual incorporates policy shocks, including shocks to forward guidance
- Conceptually preferred indiciator: two year government bond rate
  - View that FOMC operates with 2 yr horizon for Funds rate, (e.g. Swanson-Williams, 2012, Hanson-Stein, 2012)
- We use one year government bond rate as policy indicator for pragmatic reasons
  - Avoids potential weak instruments problem
  - Results robust to using two year rate as a policy indicator

Policy Indicator and Exogenous Policy Surprises

- Given monthly frequency, return on 1yr govt bond rate $\equiv i_t^{12}$

$$i_t^{12} = \frac{1}{12} E_t \{ \sum_{j=0}^{11} i_{t+j} \} + \phi_t^{12}$$

- Reduced form VAR residual for i_t^{12} equivalent to:

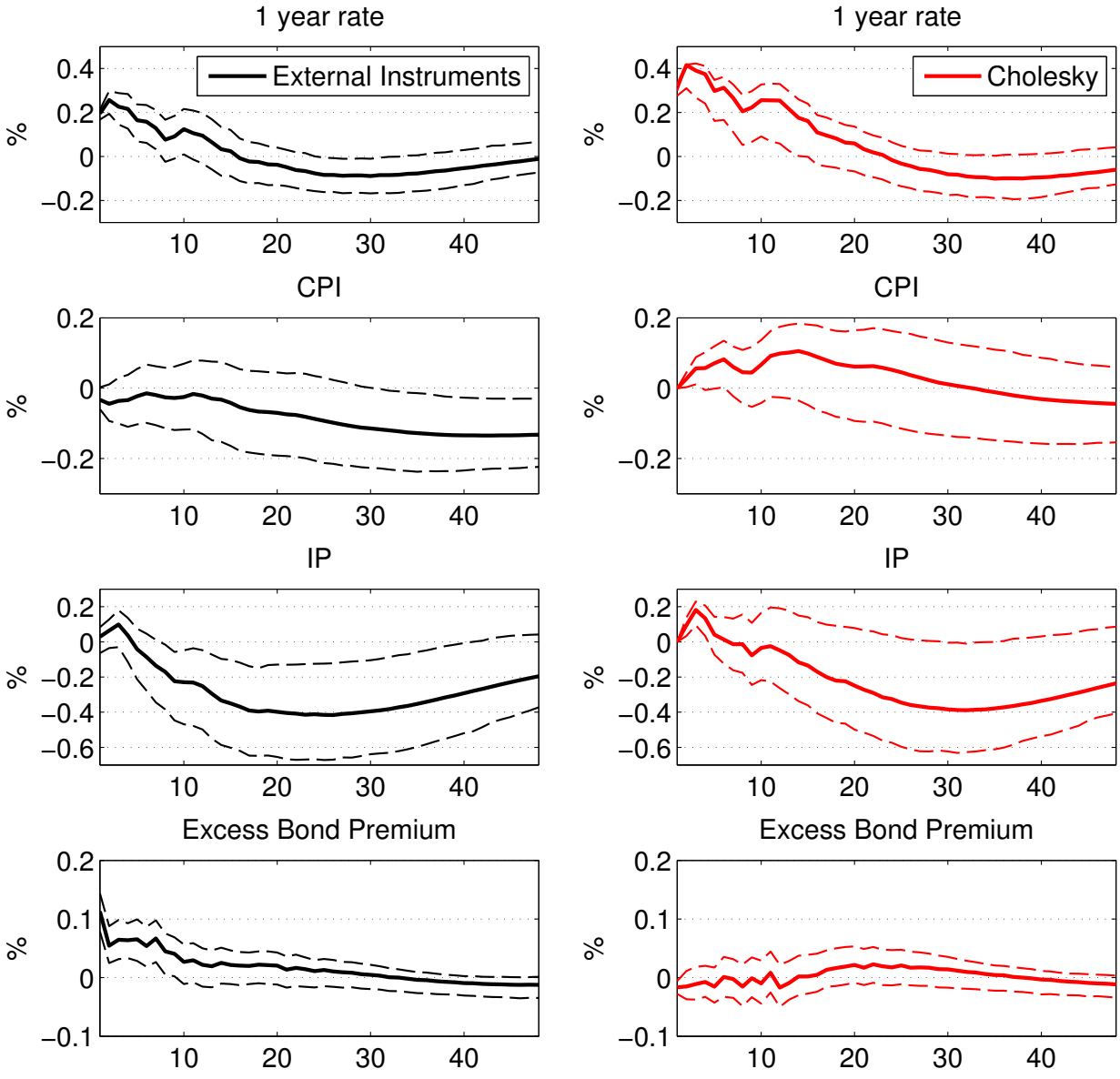
$$i_t^{12} - E_{t-1} i_t^{12} = \frac{1}{12} \sum_{j=0}^{11} \{ E_t i_{t+j} - E_{t-1} i_{t+j} \} + \phi_t^{12} - E_{t-1} \phi_t^{12}$$

- Instrumenting with FF, ED rate surprises isolates orthogonal movements
  - i.e, Isolates orthogonal surprises in current and expected future short rates.
  - Policy shock is linear combination of surprises in different FF and ED futures

Data Description

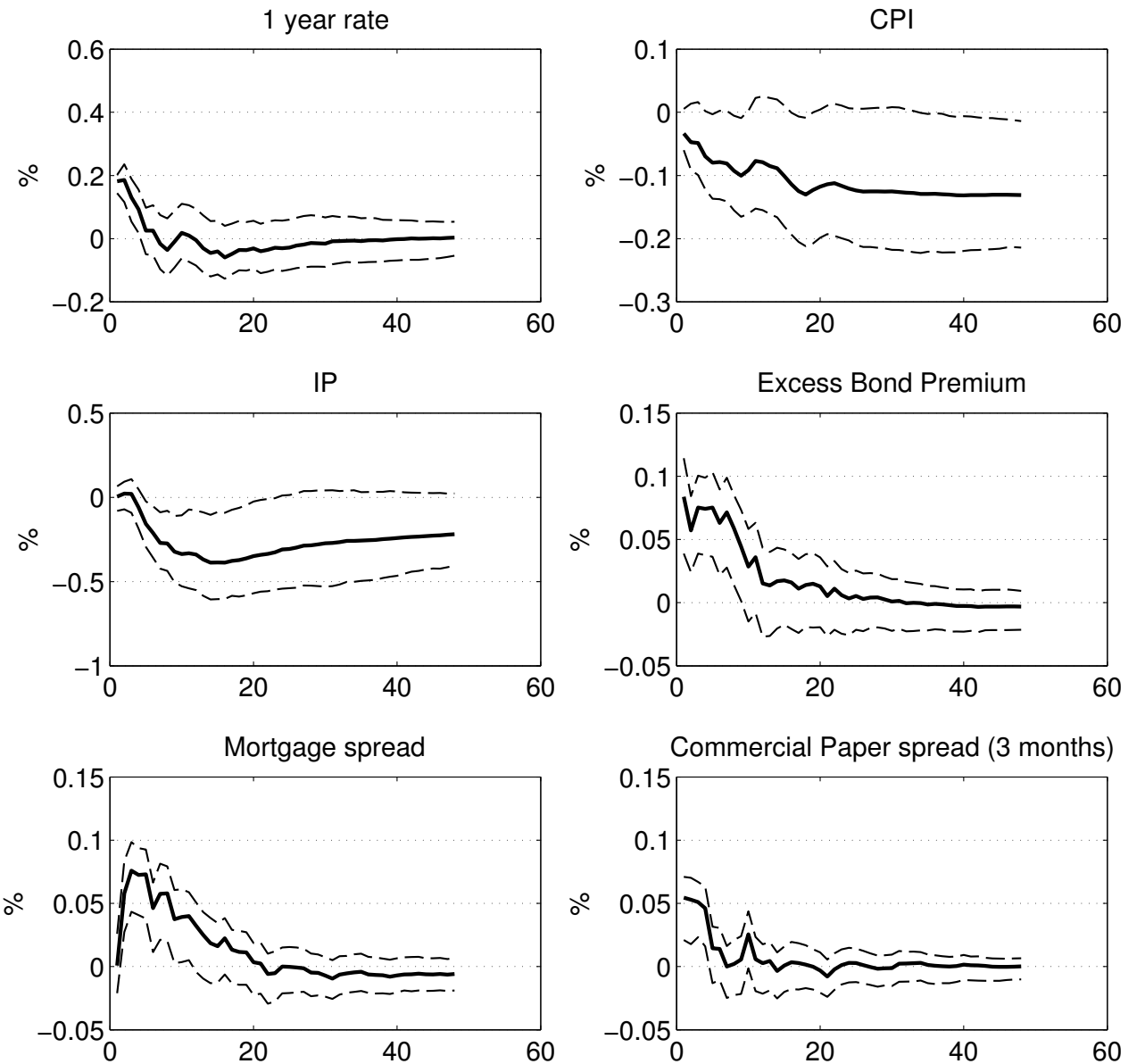
- Sample: 1979:09 - 2012:06
- Economic variables: IP, CPI
- Interest rates
  - Gov't bond yields: 1yr (policy indicator), 2yr, 5 yr, 10 yr; 1m FF rate
  - Baa spread, Gilchrist/Zakrasjek excess bond premium
  - Mortgage.spread, commercial paper spread
- Instruments: available 1991:01 through 2012:06
  - 1m, 3m ahead FF futures; 6m, 9m, year ahead 3 month ED futures
  - We use 3m ahead FF futures as baseline (best instrument choice)
    - Results robust to other instrument combinations

Figure 1: 1 year rate shock with excess bond premium



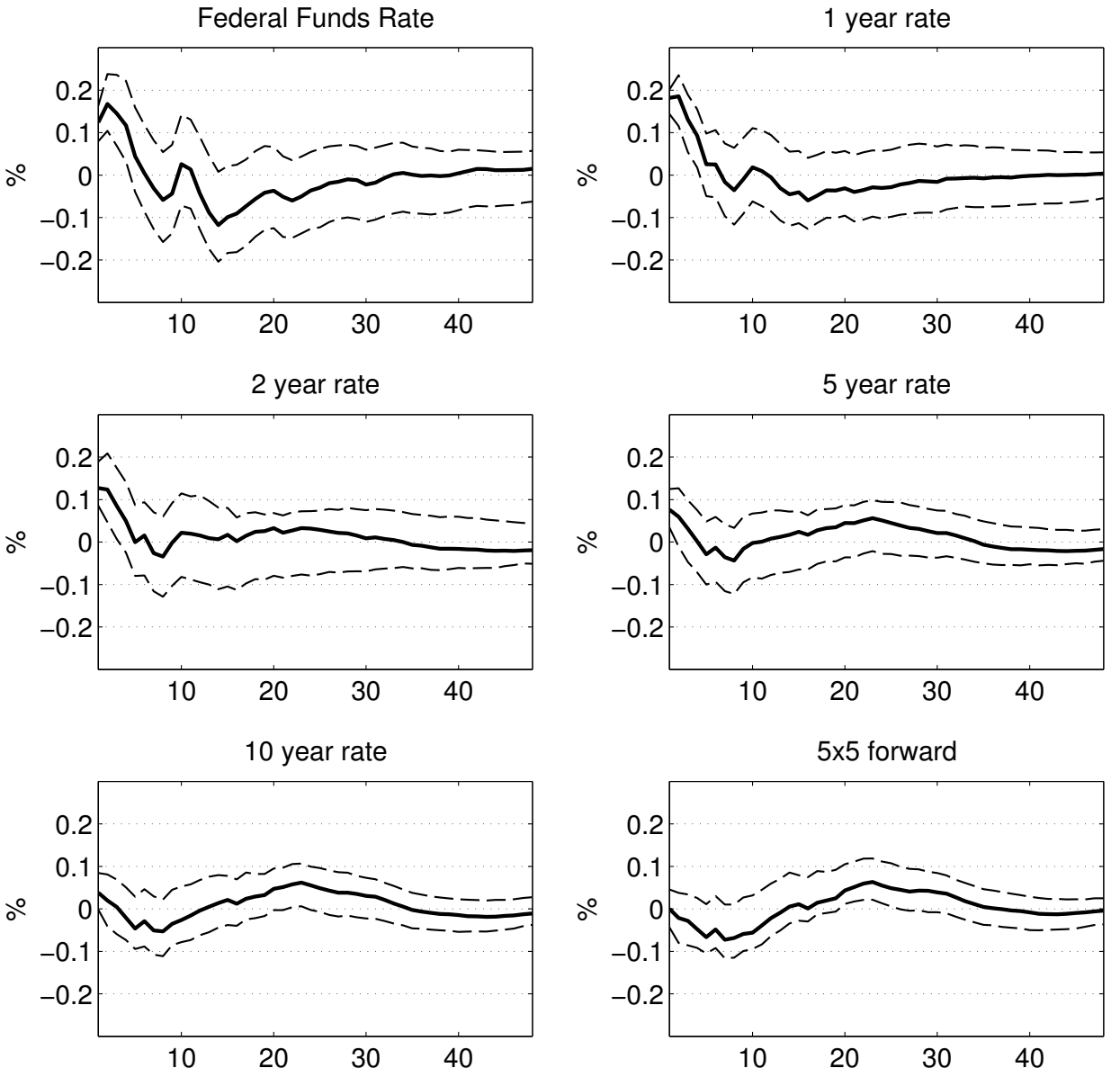
First stage regression: F: 21.55 robust F: 17.64 R2: 7.76% Adjusted R2: 7.40%

Figure 2: 1 year rate shock with corporate and mortgage premia



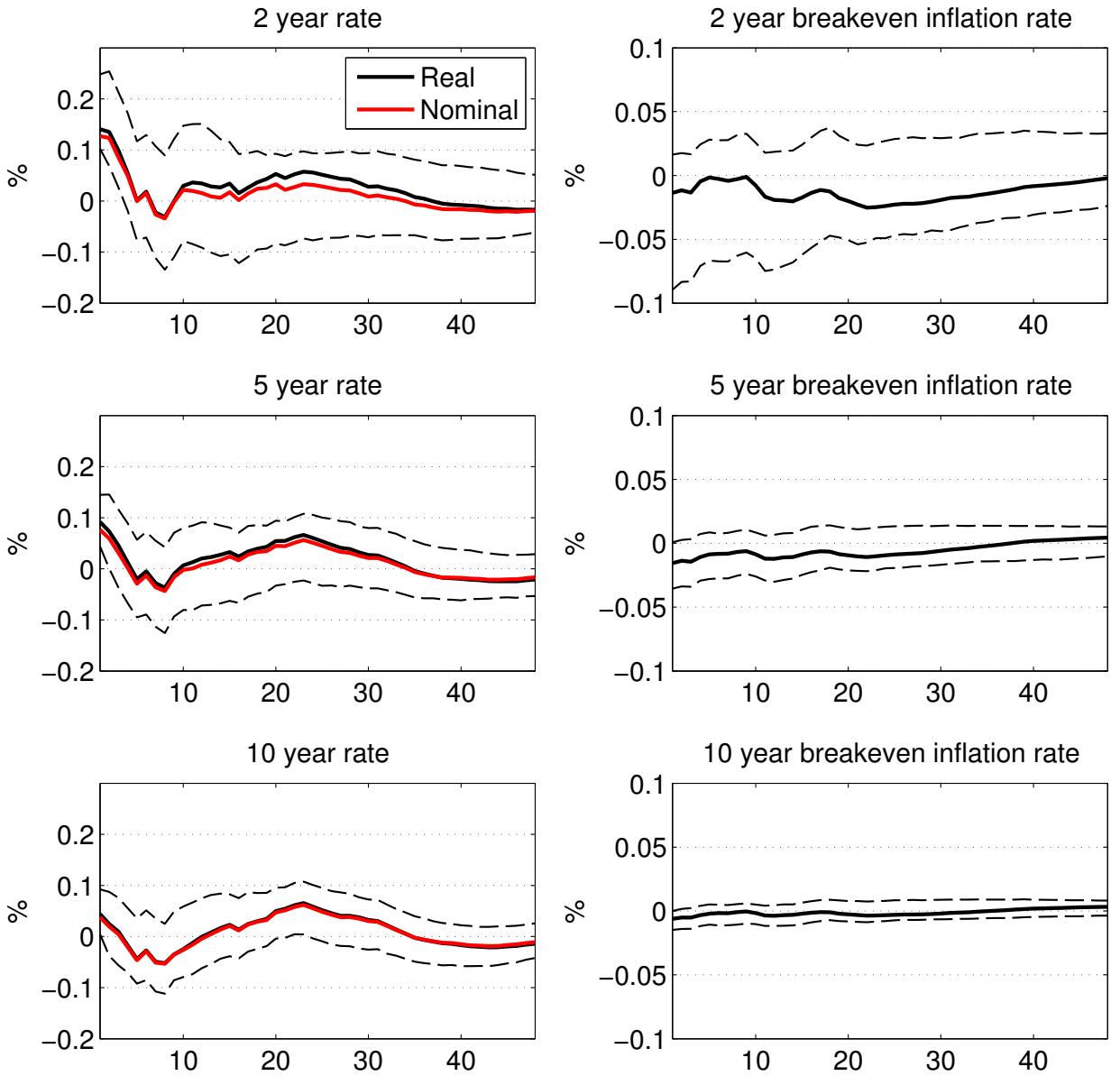
First stage regression: F: 21.61 robust F: 17.26 R2: 7.78% Adjusted R2: 7.42%

Figure 3: 1 year rate shock: Response of other interest rates



First stage regression: F: 21.61 robust F: 17.26 R2: 7.78% Adjusted R2: 7.42%

Figure 4: 1 year rate shock: Response of real rates and breakeven inflation rates



First stage regression: F: 21.61 robust F: 17.26 R2: 7.78% Adjusted R2: 7.42%

Calculating Term Premia and Excess Return Responses

- Term premium on m period gov't bond, ϕ_t^m:

$$\phi_t^m = i_t^m - \frac{1}{m} E_t\{\sum_{j=0}^{m-1} i_{t+j}\}$$

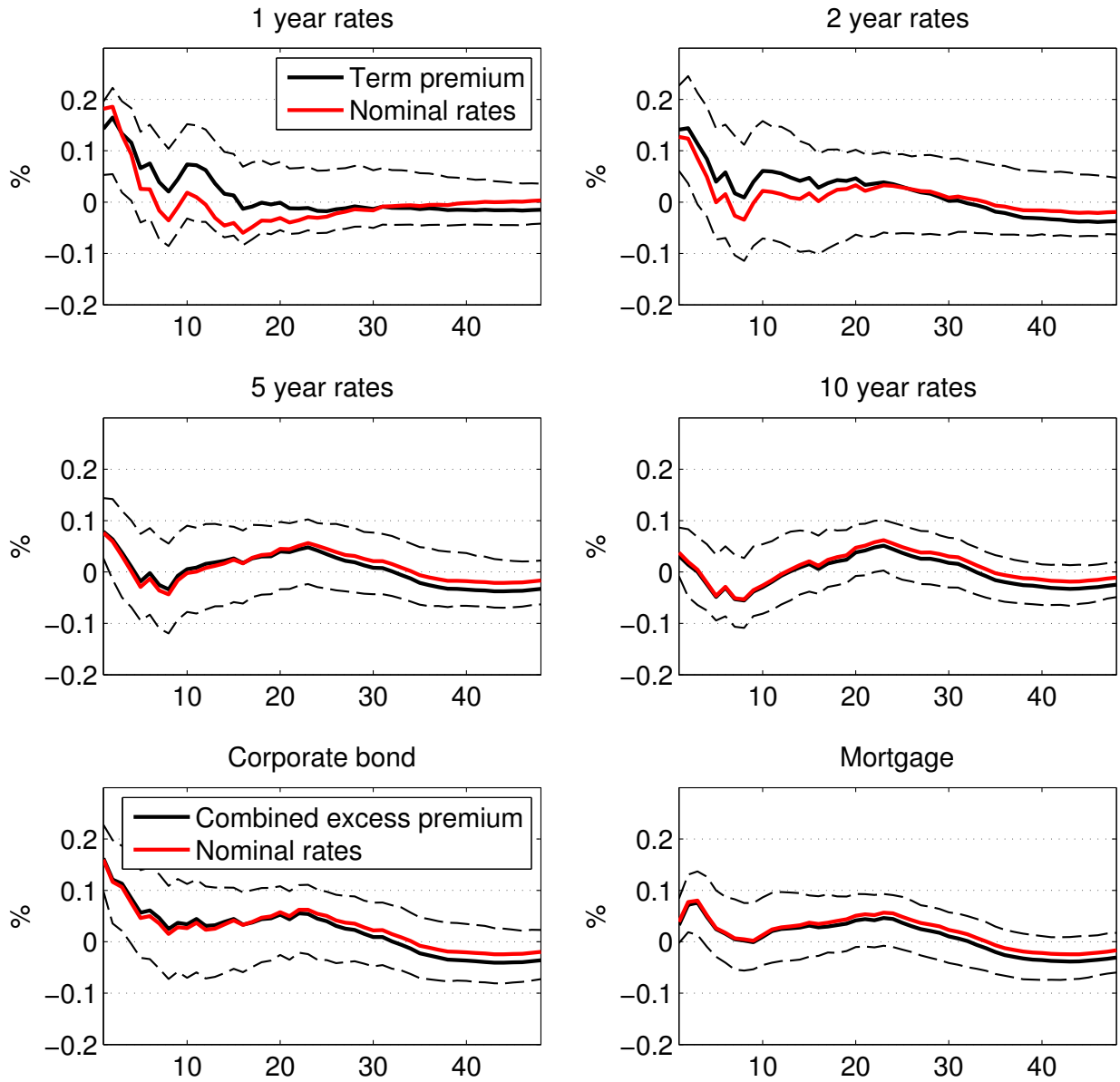
  - Obtain response of i_t^m and i_t from VAR
  - Use path of i_t to compute $E_t\{\sum_{j=0}^{m-1} i_{t+j}\}$ for each t.

- Excess return on private m period bond, χ_t

$$\begin{aligned} \chi_t &= i_t^{mp} - \frac{1}{m} E_t\{\sum_{j=0}^{m-1} i_{t+j}\} \\ &= (i_t^{mp} - i_t^m) + \phi_t^m \end{aligned}$$

$i_t^{mp} \equiv$ rate on m period private bond

Figure 5: 1 year rate shock: Response of term premia and excess premia

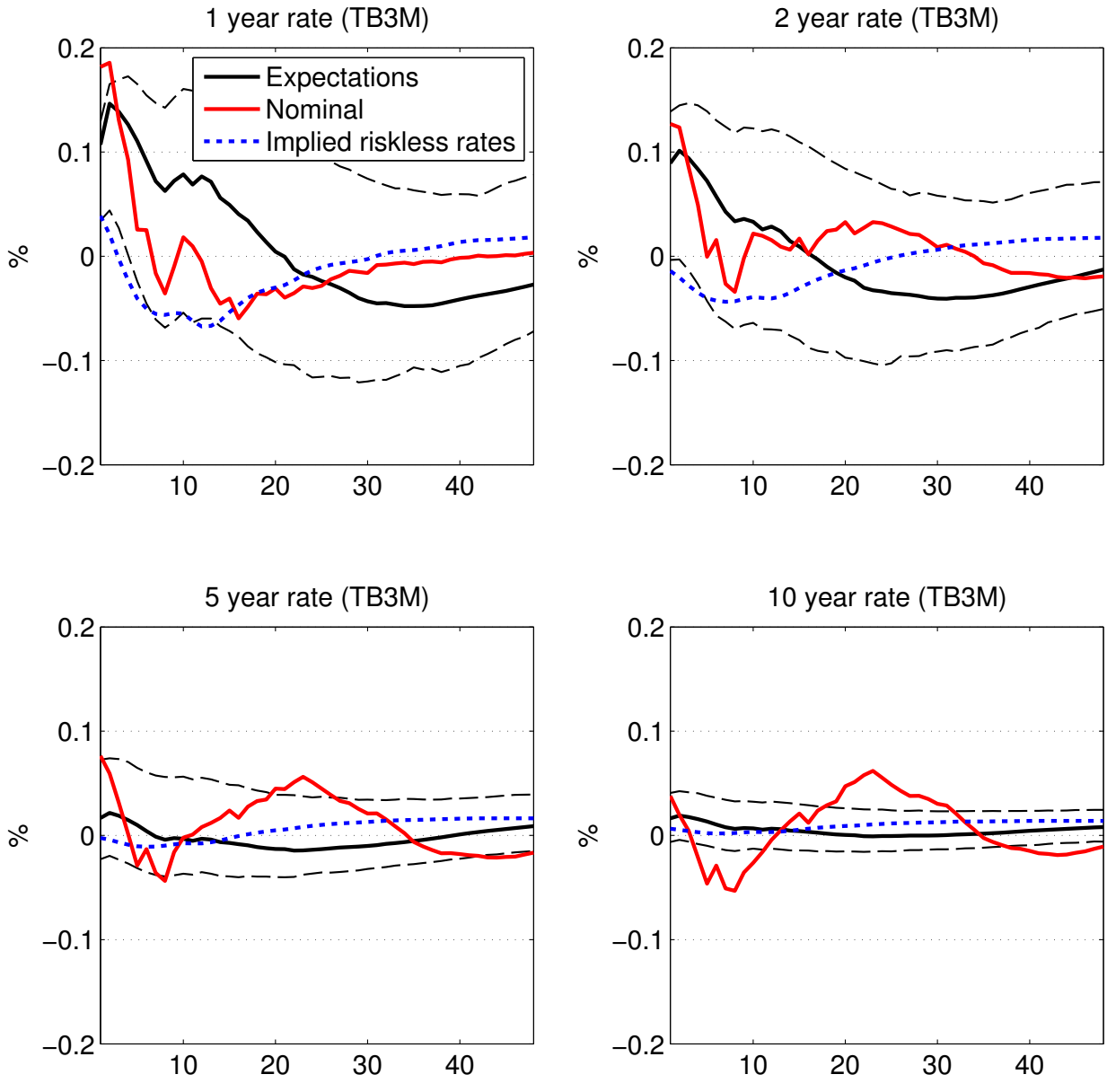


First stage regression: F: 21.61 robust F: 17.26 R2: 7.78% Adjusted R2: 7.42%

Term Premia Responses Using Expectations Data

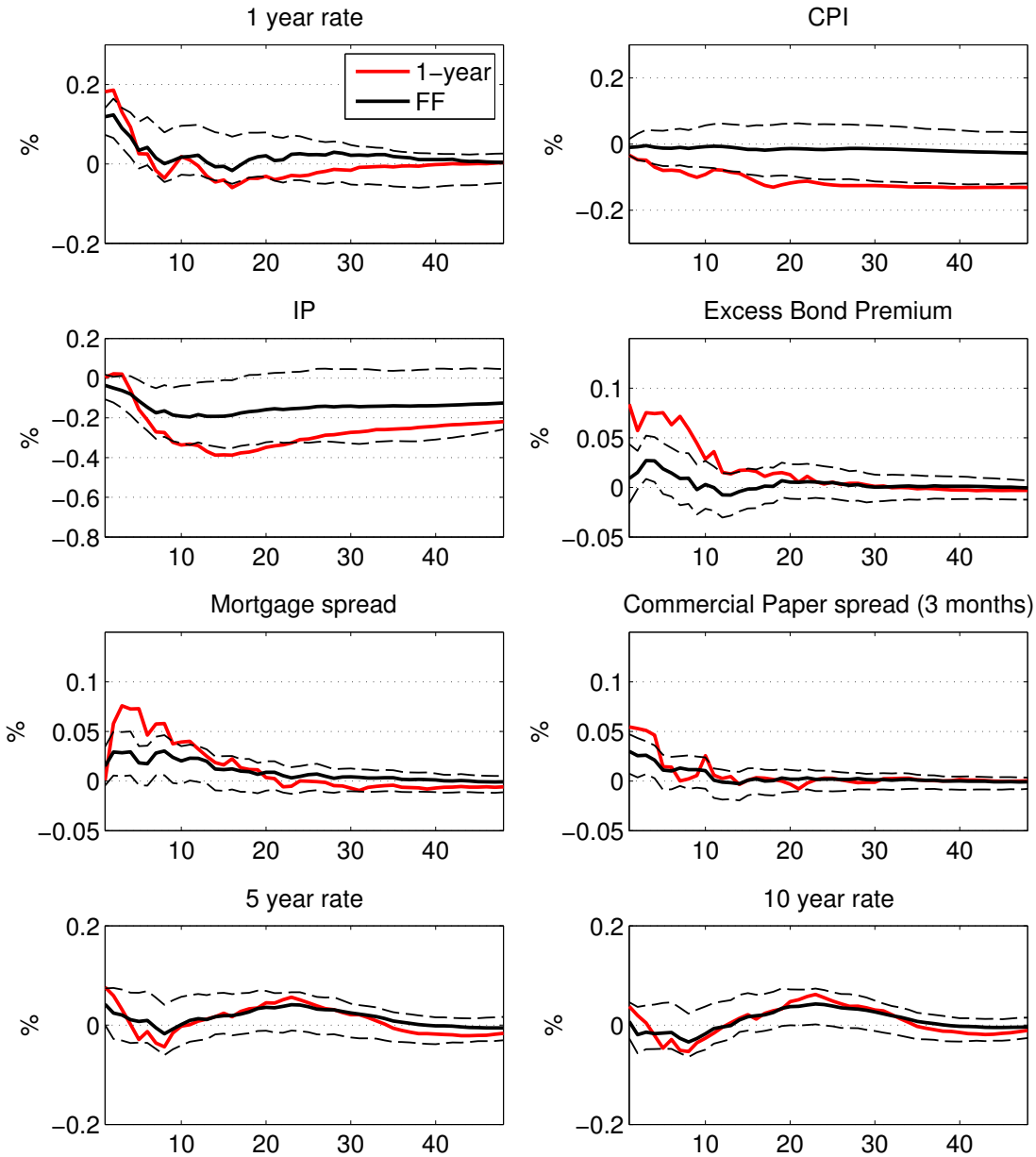
- Term premia responses may reflect "non-rational" forecasts of future short rates
- Can evaluate using survey data on expectations:
  - Blue Chip Economic Indicators survey: 3 month T-bill rate forecasts up to 6 quarters ahead; available 1983:03 - 2012:06.
- Results:
  - At longer horizons (5-10 years):
    - Cannot reject that market expectations of the future path of the Funds rate are "rational"; i.e. consistent with the impulse responses of the Funds rate.
    - Term premium effects not due to "irrational expectations."
  - As shorter horizons (1-2) years
    - "Over-reaction" of expectations could explain term premium effects
    - Data is too noisy to say for sure.

Figure 6: 1 year rate shock: Response of private sector expectations, 1979-2012



First stage regression: F: 21.61 robust F: 17.26 R2: 7.78% Adjusted R2: 7.42%

Figure 7: Federal Funds rate shock



First stage regression: F: 25.16 robust F: 14.04 R2: 8.95% Adjusted R2: 8.59%

A Model Consistent with Facts: Gertler-Karadi 2012

- Baseline: conventional monetary DSGE (CEE 2005)

- Banks intermediate funding of private securities and govt bonds
  - Financial frictions introduce balance sheet constraints on banks $\Rightarrow$
  - Limits to arbitrage that depend inversely on balance sheet strength
  - Frictions greater for private securities than for gov't bonds

- Contractionary monetary policy shock increases both term premia and credit spreads
  - Tightening weakens bank balance sheets $\Rightarrow$
  - Tightens limits to arbitrage, raising term premia and credit spreads
  - Amplifies impact on economy.

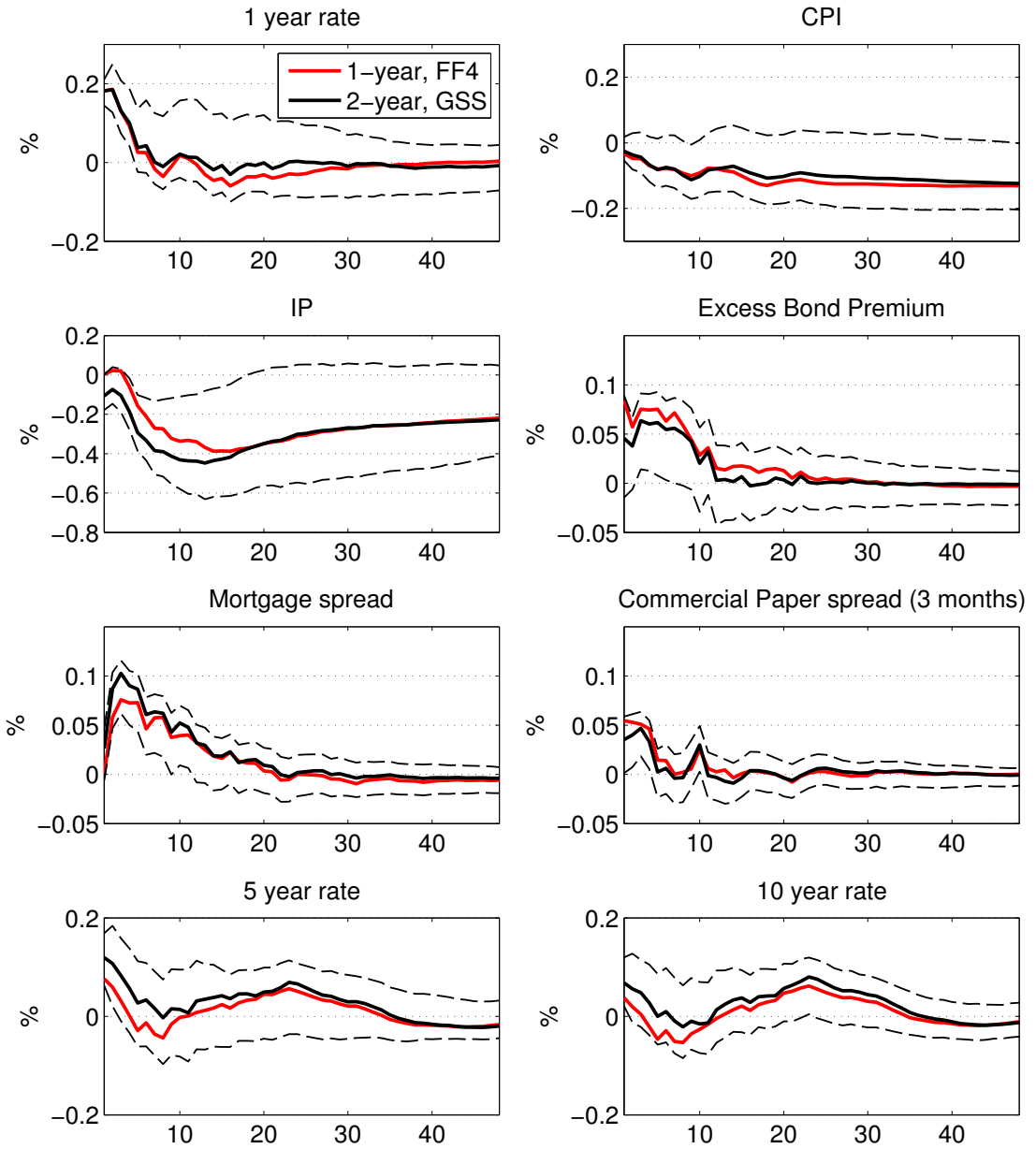
Concluding Remarks

- VAR with FF/ED futures as external instruments used to study monetary policy transmission

- Key findings:
  - Responses of output and inflation consistent with earlier VAR analysis
  - "Modest" movements in short rates $\Rightarrow$ "large" movements in credit costs
    - Due to responses of term premia and credit spreads
  - Forward guidance enhances impact of policy

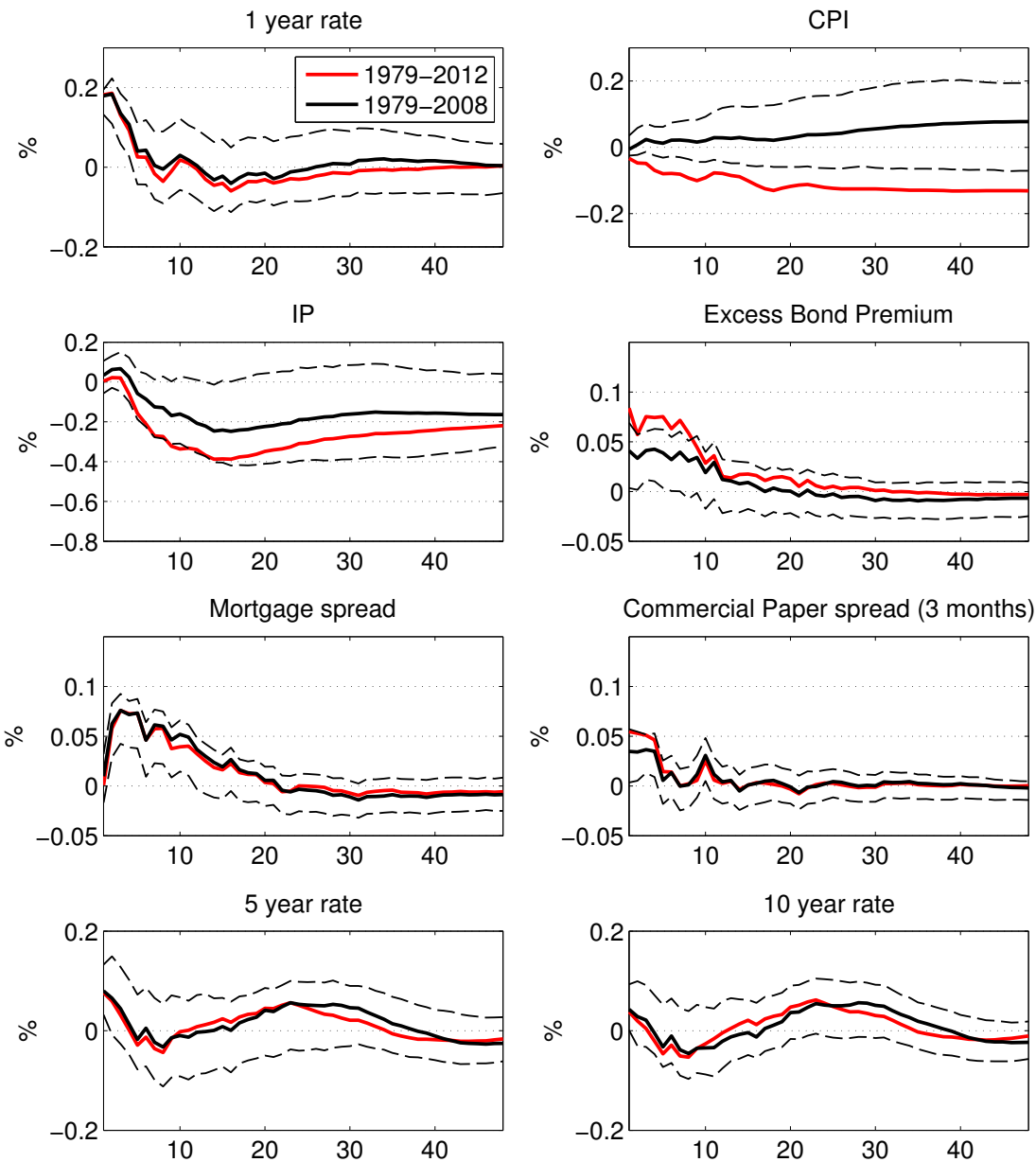
- Main implication: need to modify conventional model to allow for term premia and credit spread effects.

Figure 8: 2 year rate shock with a full set of GSS instruments



First stage regression: F: 2.65 robust F: 3.99 R2: 4.99% Adjusted R2: 3.10%

Figure 9: 1 year rate shock, 1979-2008



First stage regression: F: 17.62 robust F: 14.76 R2: 7.81% Adjusted R2: 7.37%

Table 1: Yield effects of monetary policy shocks (event study, daily, 1991-2012)

Indicator & Instruments	(1) 2 yr	(2) 5yr	(3) 10yr	(4) 30yr	(5) 5x5 forw	(6) baa^{+}	(7) Mortg.$^{+}$
FF,FF1	0.367***	0.233**	0.0980	0.00637	-0.0369	0.139	0.170
	(3.467)	(2.241)	(1.053)	(0.103)	(-0.388)	(1.475)	(1.445)
1YR,FF1	0.739***	0.469***	0.197	0.0128	-0.0744	0.280	0.343
	(8.493)	(3.094)	(1.173)	(0.103)	(-0.379)	(1.544)	(1.416)
1YR,FF4	0.880***	0.683***	0.375***	0.145*	0.0668	0.333**	0.427**
	(15.81)	(8.201)	(4.410)	(1.694)	(0.614)	(2.176)	(2.239)
2YR, FF4		0.778***	0.432***	0.169*	0.0848	0.355**	0.483**
		(11.80)	(5.306)	(1.839)	(0.702)	(1.986)	(2.141)
2YR, GSS		0.878***	0.575***	0.234***	0.271***	0.231*	0.350**
		(18.70)	(11.84)	(4.139)	(3.601)	(1.844)	(2.049)

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1
QE dates and crisis period are excluded, 188 observations
$^{+}$: 2-week cumulative changes

Table 2: TIPS and breakeven inflation effects of monetary policy shocks (daily event study, 1999-2012)

Indicator & Instruments	(1) TIPS 2yr	(2) TIPS 5yr	(3) TIPS 10yr	(4) Bkeven 2yr	(5) Bkeven 5yr	(6) Bkeven 10yr
FF, FF1	0.245	0.263**	0.149**	0.0427	-0.116	-0.109**
	(1.348)	(2.217)	(2.287)	(0.596)	(-1.553)	(-2.081)
1YR	0.800***	0.639***	0.384***	0.282*	-0.0932	-0.125
	(4.141)	(7.606)	(6.121)	(1.913)	(-0.620)	(-1.165)
1YR, FF4	0.804***	0.565***	0.315***	0.0990	0.00376	-0.0738
	(5.171)	(5.763)	(4.136)	(0.474)	(0.0269)	(-0.815)
2YR, FF4	0.759***	0.618***	0.344***	0.0935	0.00412	-0.0808
	(5.090)	(4.302)	(3.592)	(0.525)	(0.0269)	(-0.743)
2YR, GSS	0.754***	0.630***	0.462***	0.196**	0.189**	0.101*
	(7.749)	(8.394)	(9.350)	(1.981)	(2.165)	(1.818)

Robust z-statistics in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$
QE dates and crisis period are excluded, 58 (2yr), 100 observations
$^{+}$: 2-week cumulative changes

Table 3: Effects of high-frequency instruments on the first stage residuals of the 4 variable VAR (monthly, 1991-2012)

VARIABLES	(1) 1YR	(2) 1YR	(3) 1YR	(4) 1YR	(5) 1YR	(6) 2YR	(7) 2YR	(8) 2YR	(9) 2YR	(10) 2YR
FF1	0.890***				0.394	0.533**				0.174
	(4.044)				(1.129)	(2.116)				(0.462)
FF4		1.151***		1.266***	1.243***		0.779**		1.013***	1.379***
		(4.184)		(4.224)	(3.608)		(2.272)		(2.643)	(3.361)
ED2					1.440					1.134
					(1.244)					(0.859)
ED3					-4.443***					-4.733**
					(-2.635)					(-2.448)
ED4			0.624**	-0.167	2.674**			0.293	-0.339	2.946**
			(2.039)	(-0.476)	(2.493)			(0.923)	(-0.863)	(2.465)
Observations	258	258	258	258	258	258	258	258	258	258
R-squared	0.066	0.078	0.025	0.079	0.110	0.020	0.029	0.005	0.033	0.064
F-statistic	16.36	17.50	4.159	11.00	8.347	4.477	5.160	0.851	3.760	5.162

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1