Risk, Uncertainty and Monetary Policy

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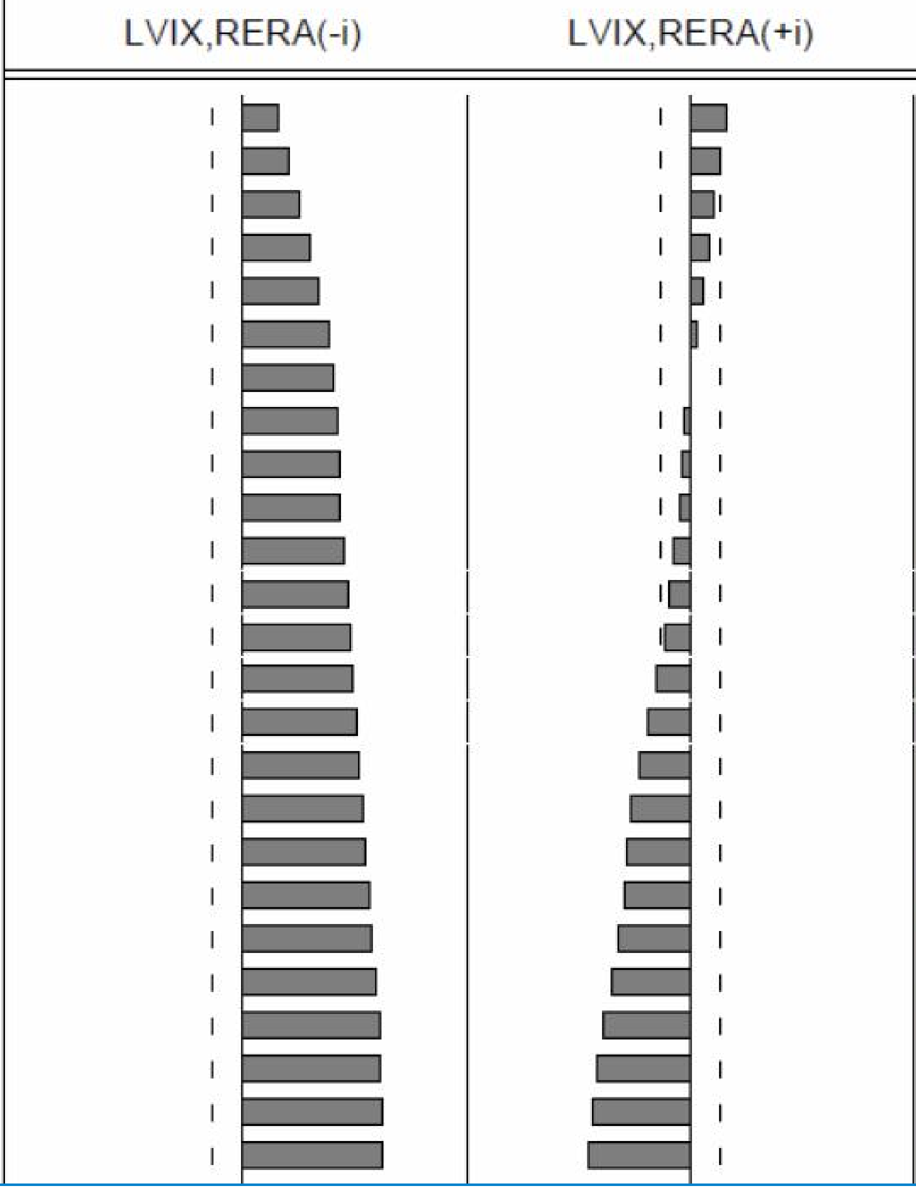
The “fear index” and MP



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1	0.2169	0.1391
2	0.2651	0.1119
3	0.3119	0.0846
4	0.3547	0.0586
5	0.3988	0.0300
6	0.4225	-0.0039
7	0.4401	-0.0283
8	0.4473	-0.0350
9	0.4560	-0.0513
10	0.4684	-0.0759
11	0.4912	-0.0935
12	0.5057	-0.1193
13	0.5150	-0.1628
14	0.5314	-0.2032
15	0.5485	-0.2321
16	0.5634	-0.2719
17	0.5731	-0.2947
18	0.5846	-0.3107
19	0.5979	-0.3344
20	0.6151	-0.3614
21	0.6329	-0.3979
22	0.6438	-0.4308
23	0.6491	-0.4544
24	0.6515	-0.4686

Research questions / Related research

- Does monetary policy (MP) affect stock market risk appetite?
  - Evidence for risk appetite of banks (loans); see Altunbas et al. (2010), Ioannidou et al. (2009), Jiménez et al. (2009), Maddaloni and Peydró (2010)
  - Role of broad liquidity and credit (Adrian and Shin, 2008; Borio and Zhu, 2004)
- What is the relation between MP and stock market volatility?
  - Heightened "uncertainty" decreases employment and output (Bloom, 2009)
- MP and the stock market – what is the channel?
  - Expansionary MP affects the stock market positively and vice versa; see Thorbecke (1997) , Rigobon and Sack (2003, 2004), Bernanke and Kuttner (2005)

Empirical challenges

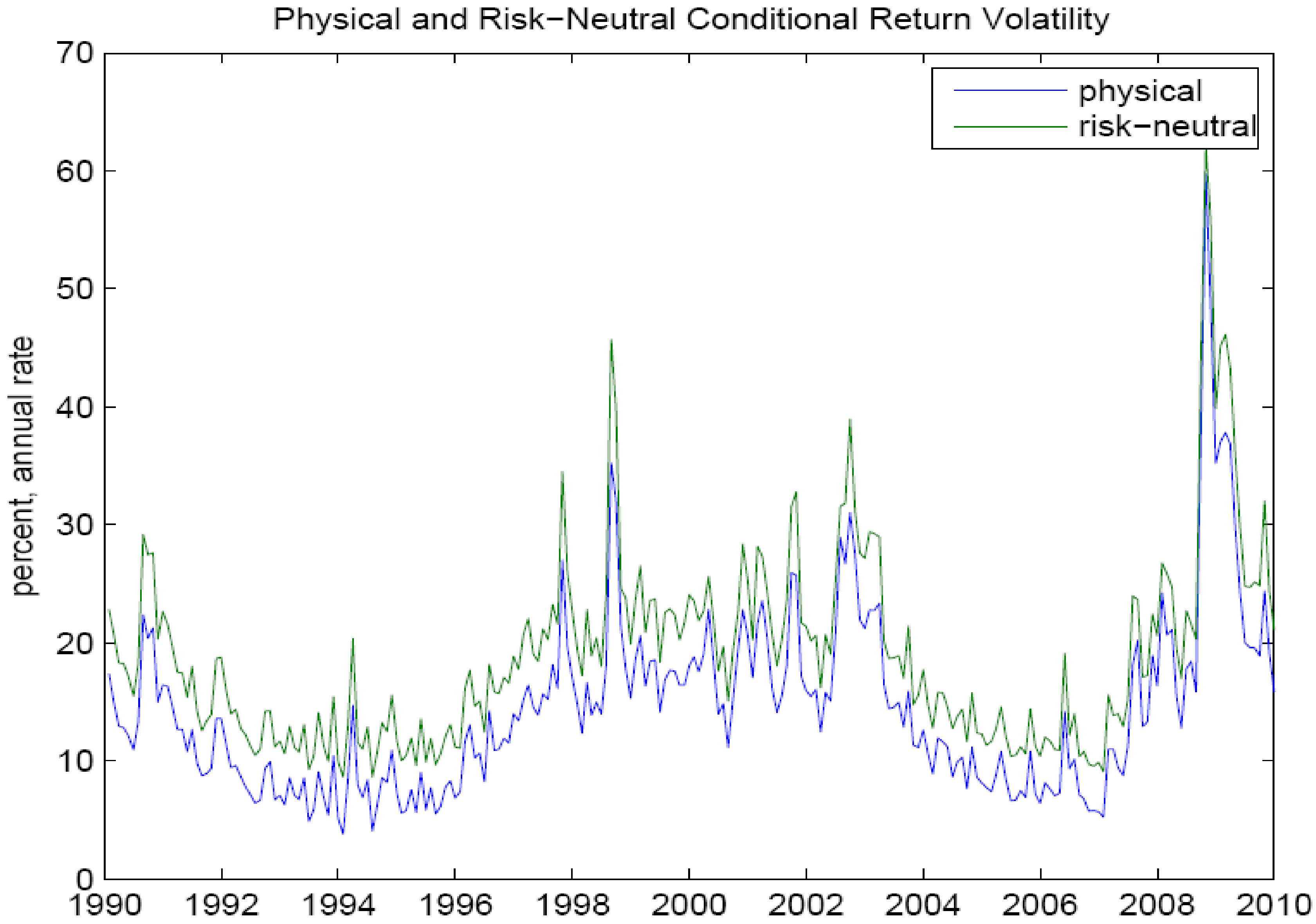
- Endogeneity
  - use structural VAR framework, different identifying restrictions
    → robust relations
- Measuring monetary policy stance/shocks
  - try various measures for robustness

    In particular: also identification using high frequency Fed funds futures changes
- Omitted variables
  - include a business cycle variable
- The VIX: indicator of risk aversion but also “uncertainty”
  - split into the two components

Data

- Monthly, January 1990 – August 2010; sub-sample; January 1990 – July 2007.
- Risk aversion RA and uncertainty UC
- Monetary policy stance: real rate RERA [Fed funds end of month target rate minus CPI annual inflation rate]
  - robustness: Fed Funds rate FED, Taylor rule deviations, M1 growth
- Business cycle: industrial production (IPI)
  - robustness: non-farm employment, ISM index
- Price level(s): CPI, PPI

The VIX!



Physical and Risk−Neutral Conditional Return Volatility
percent, annual rate
physical
risk−neutral
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

The VIX: risk aversion and uncertainty

- A simple discrete-state, one-period economy
- Return distribution with 3 states x_i, occur with prob. π_i:

State	Return x_i	Prob. π_i
Good	$x_g = \mu + a$	$\pi_g = \frac{1-p}{2}$
Bad	$x_b = \mu - a$	$\pi_b = \frac{1-p}{2}$
Crash	$x_c = c < 0$	$\pi_c = p$

- Investor has all wealth in the stock market:

$$U\left(\tilde{W}\right) = E\left[\frac{\left(W_0 \tilde{R}\right)^{1-\gamma}}{1-\gamma}\right]$$

where $\tilde{R}$ – gross return, W_0 – initial wealth, γ - CRRA

- "Pricing kernel": marginal utility *m*, proportional to $\tilde{R}^{-\gamma}$
  - Stock market down, *m* relatively high and vice versa

The VIX: risk aversion and uncertainty

- "Physical" stock market variance measured using actual probabilities:

$$V = \pi_g (x_g - \bar{x})^2 + \pi_b (x_b - \bar{x})^2 + \pi_c (x_c - \bar{x})^2$$

- The VIX measures the risk-neutral variance, using probabilities adjusted for risk π_j^{RN}:

$$VIX^2 = \pi_g^{RN} (x_g - \bar{x})^2 + \pi_b^{RN} (x_b - \bar{x})^2 + \pi_c^{RN} (x_c - \bar{x})^2$$

where

$$\pi_j^{RN} = \pi_j \frac{m_j}{E[m]} = \pi_j \frac{(1 + x_j)^{-\gamma}}{E[m]}$$

- The variance premium is given by:

$$VP \equiv VIX^2 - V = \sum_{j=g,b,c} (\pi_j^{RN} - \pi_j)(x_j - \bar{x})^2$$

The VIX: risk aversion and uncertainty

- Since $\pi_c^{RN} >> \pi_c$ and the crash state induces lots of variance, $VP > 0$
  - if $\gamma \uparrow \rightarrow$ weight on the crash state $\uparrow \rightarrow VP \uparrow$

- With a Campbell-Cochrane (1999)-like external habit:
  - the “pricing kernel” is given by $(\tilde{R} - W_{bm})^{-\gamma}$, where W_{bm} is benchmark wealth
  - the coefficient of relative risk aversion is $\frac{\gamma \tilde{R}}{\tilde{R} - W_{bm}}$

The VIX: risk aversion and uncertainty

- Suppose statistics to match are: $\bar{x} = 10\%, \quad \sigma = 15\%$, skewness $Sk = -1$ and $c = -25\%$

- The implied crash probability is p = 0.5%

- The VIX and VP as a function of γ or W_{bm}:

Parameters	VIX	VP	Parameters	VIX	VP
$\gamma = 2, W_{bm} = 0$	15.9871	0.0031	$\gamma = 4, W_{bm} = 0.05$	17.8677	0.0094
$\gamma = 4, W_{bm} = 0$	17.6115	0.0085	$\gamma = 4, W_{bm} = 0.25$	19.5977	0.0159
$\gamma = 6, W_{bm} = 0$	20.1388	0.0181	$\gamma = 4, W_{bm} = 0.50$	27.9344	0.0556

- VP$\uparrow$ as effective risk aversion$\uparrow$

The VIX: risk aversion and uncertainty

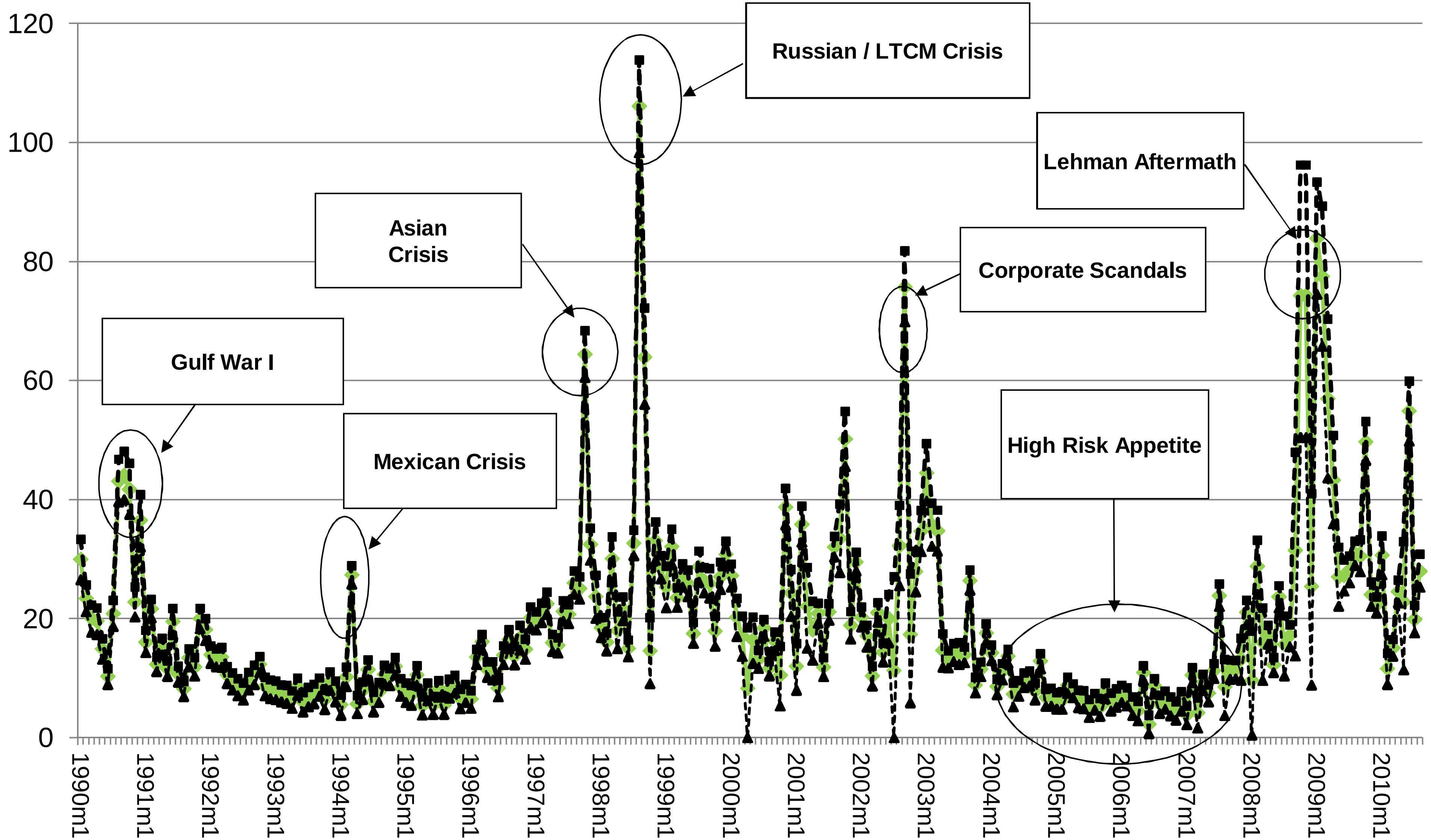
- Two components of the VIX (risk-neutral expected stock market volatility)!

- Actual expected stock market variance V, (log="uncertainty")
  - fitted values from regressing realized variance on lagged VIX and lagged realized variance

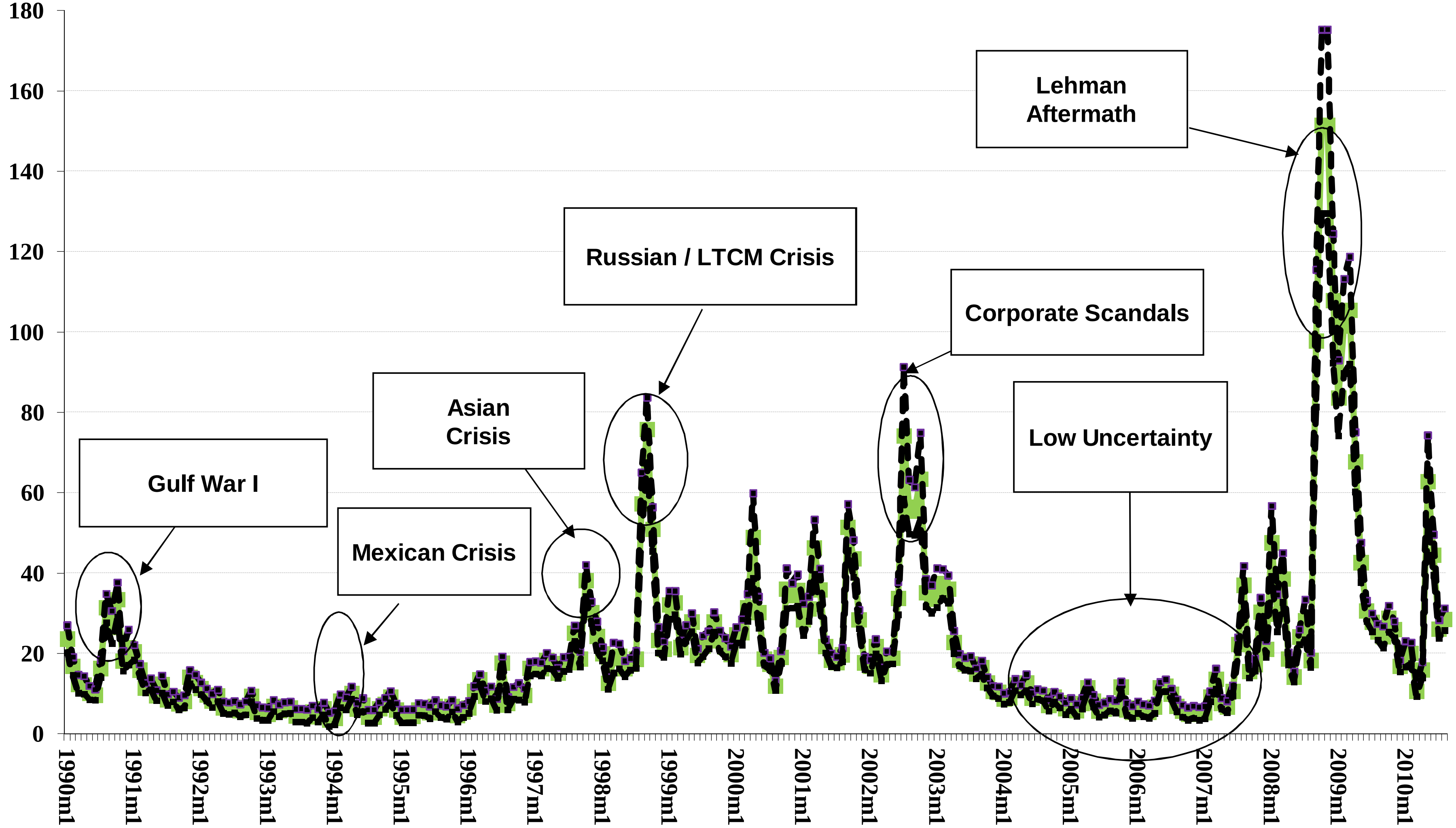
    → best model in horse race

- Variance premium, $VIX^2 - V$,(log = "risk aversion")
  - increases monotonically with effective risk aversion in the economy

VIX decomposed: RA (green)



VIX decomposed: UC (green)



Empirical strategy

- Structural VAR: $AZ_t = \Phi Z_{t-1} + \varepsilon_t$

- Reduced-form VAR: $Z_t = A^{-1}\Phi\, Z_{t-1} + A^{-1}\varepsilon_t$

- Structural identification: restrictions on contemporaneous responses (Cholesky)
  - A is lower triangular
  - order of variables: price and business cycle first (slow-moving); MP; RA and UC last (fast-moving)

Results: monetary policy shocks

- Model with RERA: DIPI RERA RA UC

- Model with FED: CPI IPI FED PPI RA UC

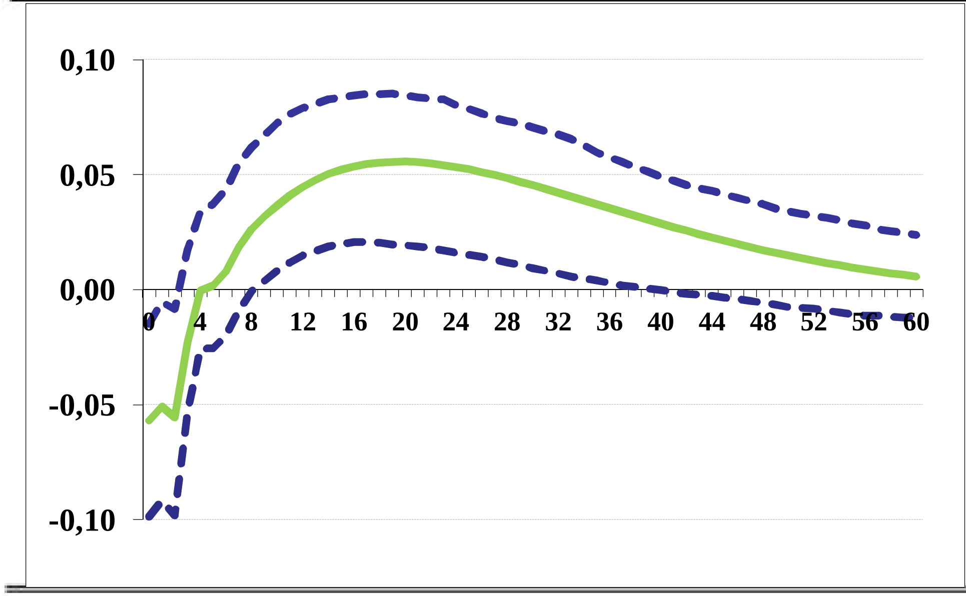
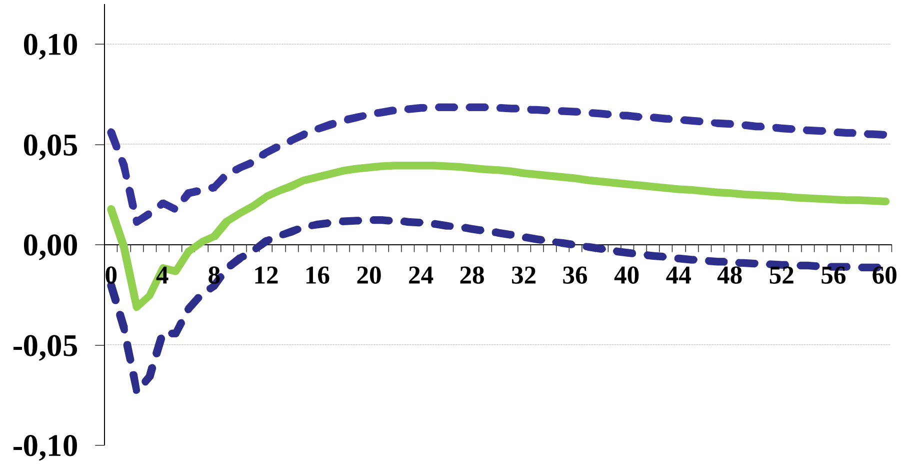
(See Christiano, Eichenbaum, Evans, 1999)

- A contractionary MP shock:
  - an increase in the real / Fed Funds rate of 35 / 15 b.p.
  - industrial production decreases in medium run (insignificant)
  - price level decreases (significant)

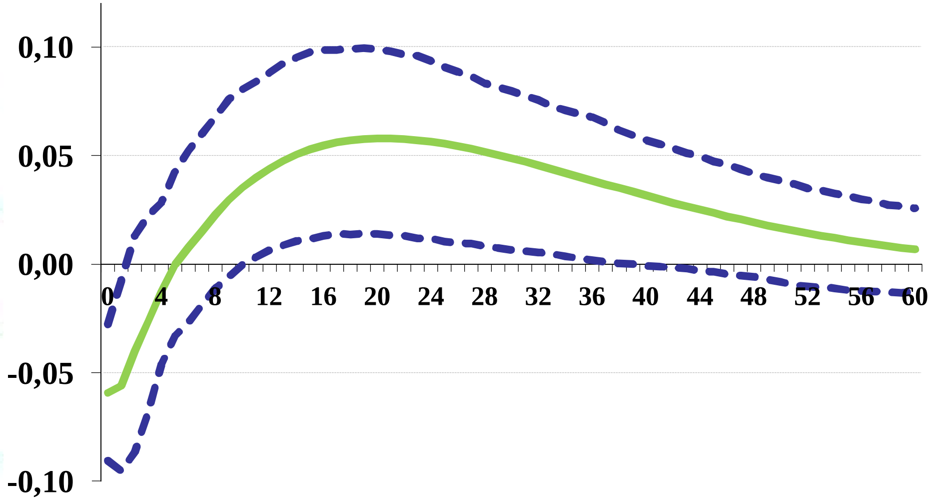
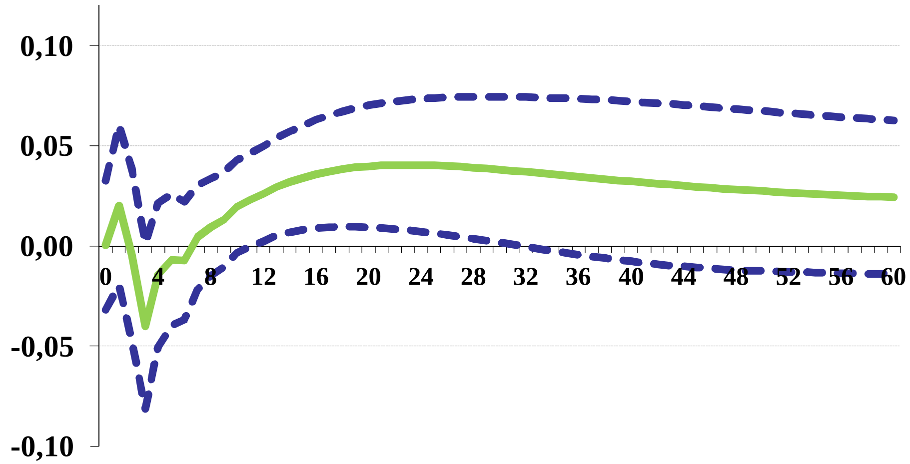
  Results with employment stronger.

Results: monetary policy shocks

Impulse MP, response RA

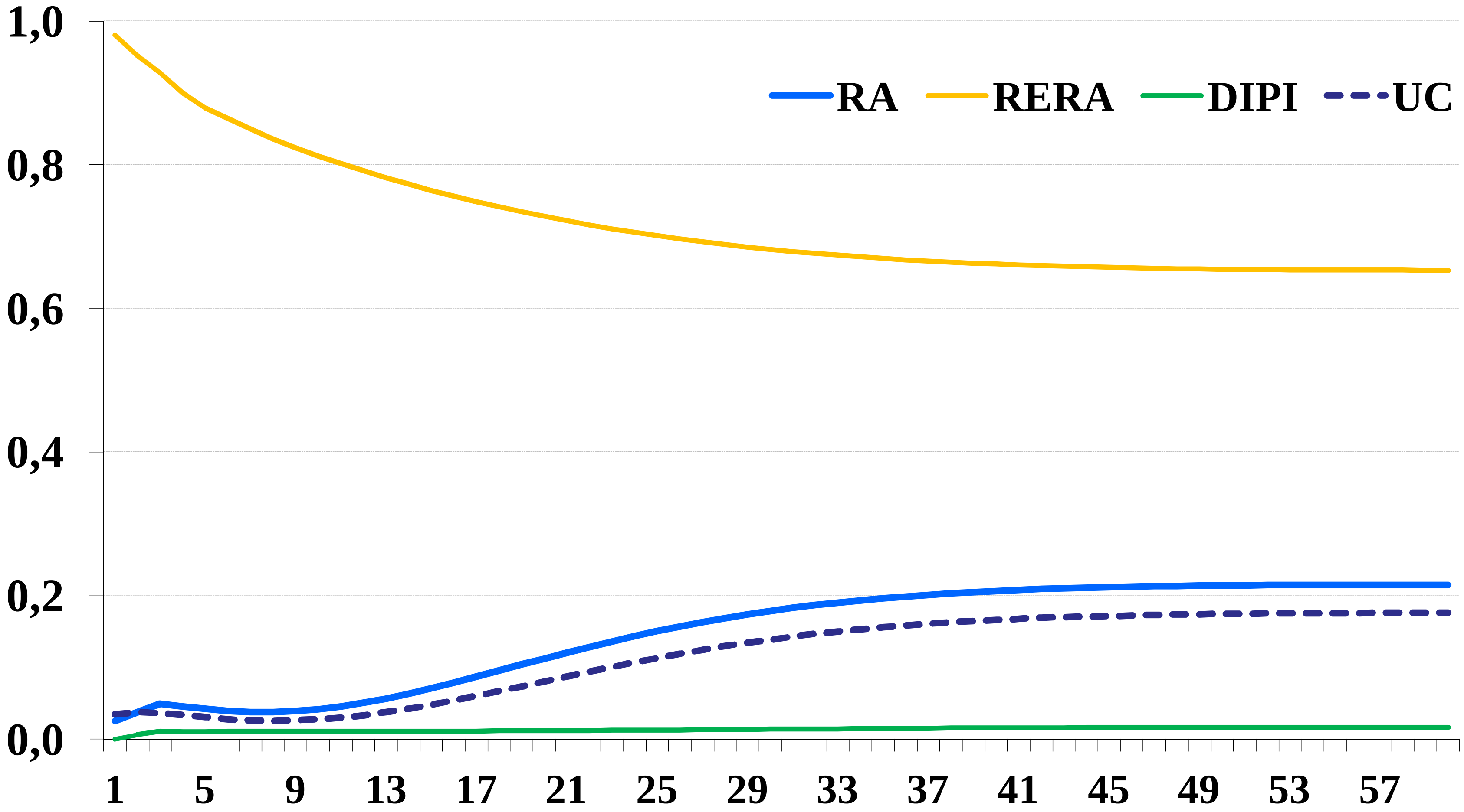
Model with RERA	Model with FED
	

Results: monetary policy shocks

Impulse MP, response UC	
Model with RERA	Model with FED
	

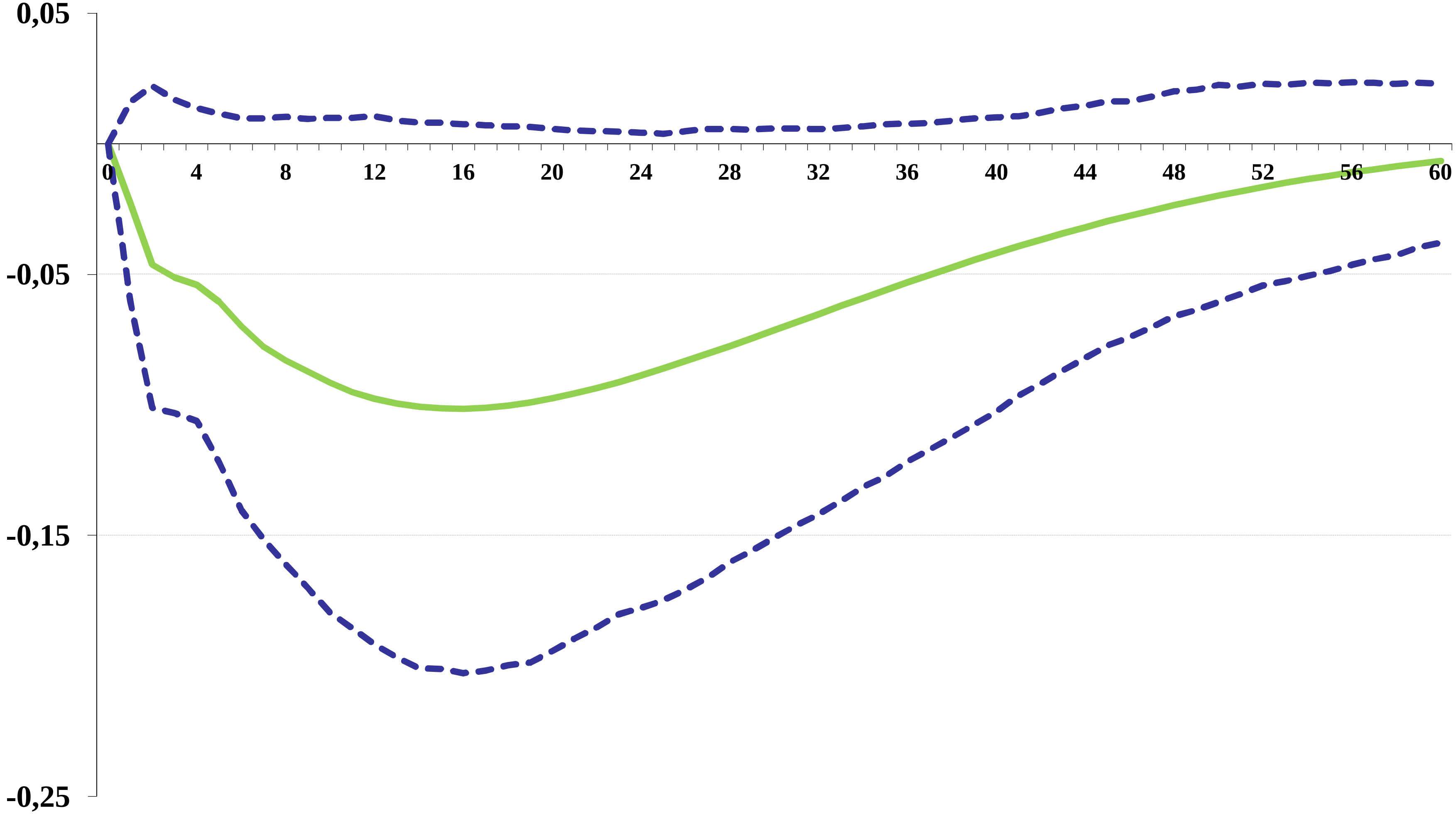
Results: Variance decomposition

- % of variance explained by MP shocks



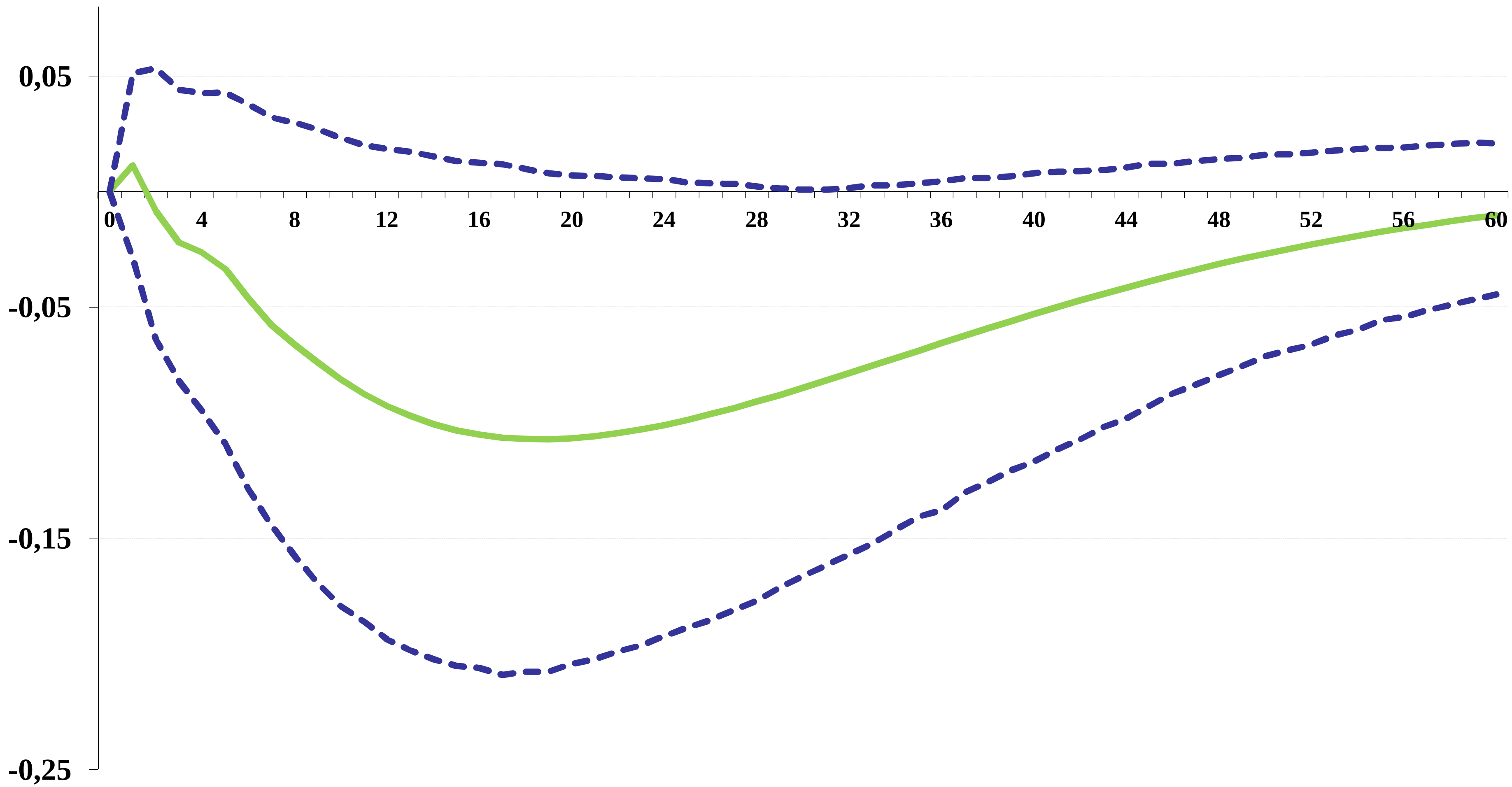
Results: RA/UC shocks

- Impulse: RA; Response: MP



Results: RA/UC shocks

♦ Impulse: UC; Response: MP



Robustness

- Measuring monetary policy:
  - Fed funds rate
  - Taylor rule residuals
  - Growth rate M1

- Business cycle measures:
  - Employment, ISM index

- Identification of monetary policy shocks:
  - long-run neutrality of money restrictions

Robustness: High frequency identification

- Can a monthly VAR really identify MP shocks?

- Two alternatives:

  - Bernanke-Kuttner (2005) exogenous monthly MP shocks using Federal funds futures contracts

  - New procedure using high-frequency data (inspired by D'Amico and Farka, 2011)

Robustness: High frequency identification

- Step 1: MP shocks = high frequency change in Fed futures rate around the FOMC announcement (Gürkaynak, Sack, and Swanson, 2005)

- Step 2: Run high frequency "response" regressions

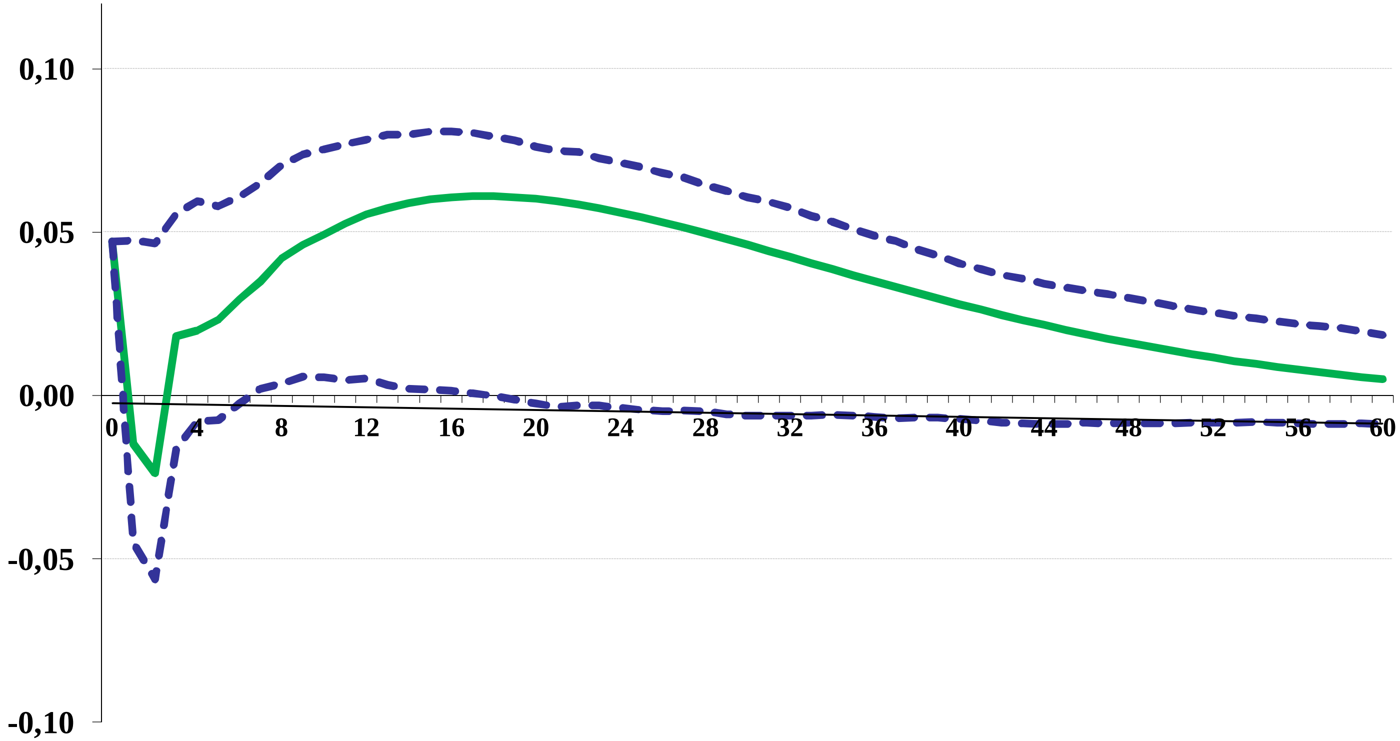
$$\underset{}{\Delta RA_t} = \underset{(0.007)}{-0.039} + \underset{(0.020)}{0.047}\,\Delta MP_t - \underset{(0.014)}{0.005}\,\Delta IP_t - \underset{(0.016)}{0.004}\,\Delta ISM_t - \underset{(0.017)}{0.004}\,\Delta EMP_t$$

$$\Delta UC_t = \underset{(0.003)}{-0.009} + \underset{(0.010)}{0.013}\,\Delta MP_t + \underset{(0.005)}{0.002}\,\Delta IP_t - \underset{(0.005)}{0.002}\,\Delta ISM_t - \underset{(0.011)}{0.008}\,\Delta EMP_t$$

- Step 3: Use these coefficients as the estimates of A^{-1} in the VAR! [delivers 4 restrictions]

Robustness: High frequency identification

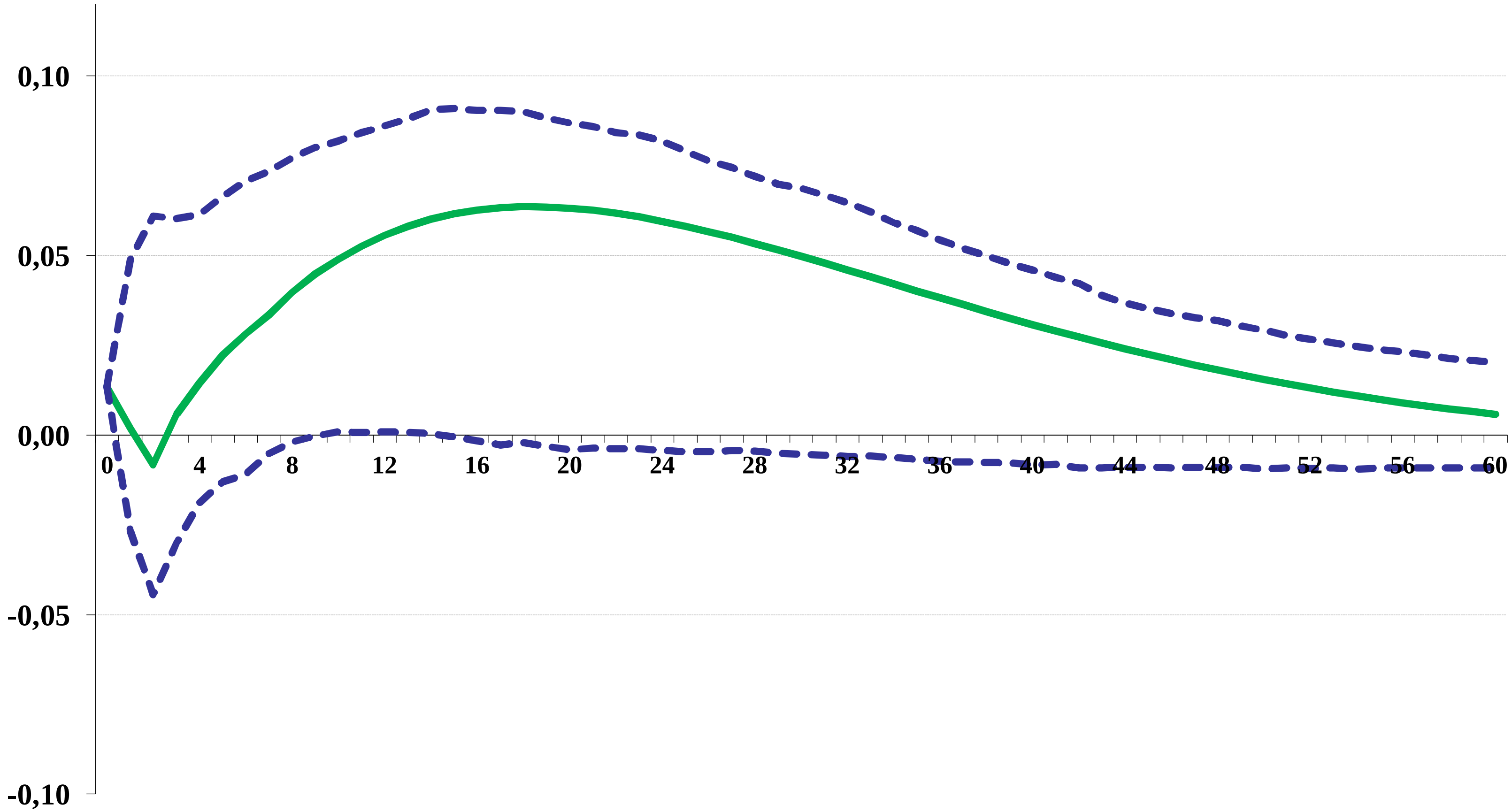
Impulse MP, Response RA



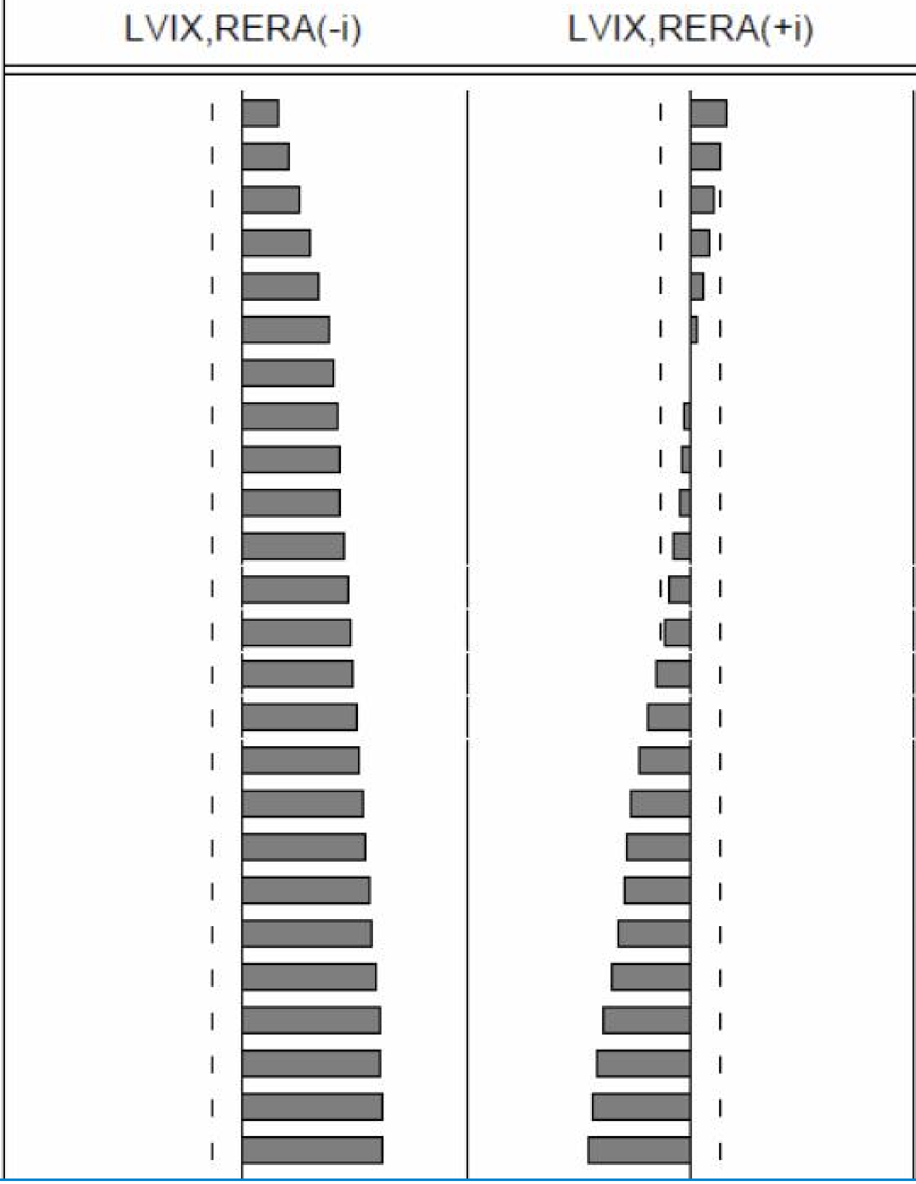
Note: BC and MP do not respond instantaneously to UC

Robustness: High frequency identification

Impulse MP, Response UC



Concluding remarks



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Concluding remarks

- VAR analysis to characterize links between RA, UC and MP

- Provide an interpretation of the VIX $\leftrightarrow$ MP relations:
  - co-movement between past MP and current VIX: channel is both RA and UC but RA effect stronger
  - co-movement between current VIX and future MP: MP accommodates but not statistically significant

- Monetary easing increases risk appetite
  - Effect significant after 8 months, lasts for 3 years

Concluding remarks

- What are the theoretical links between monetary policy and risk-taking behavior in asset markets?

- Structural sources of the VIX dynamics in consumption-based asset pricing models: Bekaert and Engstrom (2010), Bollerslev et al. (2008), Drechsler and Yaron (2011), but no MP equation

- Possible channels include (excessive) risk-taking in asset management (Rajan, 2006); balance sheets of financial intermediaries (Adrian and Shin, 2010); . . .

Asset Return Dynamics under Bad Environment - Good Environment Fundamentals

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