"Risk, Uncertainty and Monetary Policy": Online Appendix

1. The Expected Conditional Stock Return Variance: Horserace Results

To estimate the conditional variance of stock returns, we project future realized variances onto the VIX squared, current realized variances, dividend yields and real interest rates. It is important to come up with an accurate and stable forecasting model and we use overlapping daily data to run a horserace between eight monthly volatility forecast models, representing different combinations of predictors, with or without pre-fixed coefficients:

Model 1: OLS projection on the lagged realized monthly variance;

Model 2: OLS projection on the lagged squared VIX;

Model 3: OLS projection on the lagged squared VIX and the realized monthly variance;

Model 4: OLS projection on the lagged squared VIX, the past realized monthly variance and the lagged dividend yield;

Model 5: OLS projection on the lagged squared VIX, the past realized monthly variance, the lagged dividend yield and the lagged real three-month T-bill yield;

Model 6: 0.5 times the lagged squared VIX plus 0.5 times the lagged realized variance;

Model 7: the lagged realized variance (model used in Bollerslev, Tauchen and Zhou (2009));

Model 8: the lagged squared VIX.

First, we compare the out-of-sample forecasting performance of the 8 models. For estimated models (Models 1 through 5), we perform recursive estimations, starting in January 1994 (that is, after having at least 1013 overlapping daily data and 48 independent months) and adding one observation at a time. We compute the root-mean-squared error (RMSE) and mean absolute errors (MAE), both for the January 1994 – July 2007 sample (i.e., ending before the start of the financial turmoil in August 2007), and for the January 1994 – August 2010 sample (our full sample). Online Appendix Table OA1 (Panel A) contains the results. We only report the RMSE results. The MAE-results are completely analogous. The three multivariate prediction models (Models 3 through 5) consistently outperform the univariate and the non-estimated models. The multivariate models perform very similarly, and in fact, the correlation between the volatility forecasts based on two-, three- and four-variable models ranges between 0.988 and 0.998.

Based purely on RMSE and MAE, the richer models are slightly better than the bivariate model, although in the crisis period, it is the second best performing model. Moreover, the regression coefficient for the real three-month yield is not significant in the four-variable regressions, and the coefficient for the dividend yield is not significant in the three-variable regression.

Because the out-of-sample performance of all models worsens dramatically during the crisis period (August 2007 – August 2010), we perform two additional exercises. First, we winsorize the top 1% of the volatility observations in our sample, and perform regressions using the winsorized sample.[1] This yields root-mean-squared errors, reported in Panel B of Table OA1, which are half the size compared to the non-winsorized results.

Second, as we need reliable estimates for RA and UC for both pre-crisis period and the full sample, we also assess models based on their stability, i.e., the consistency of their performance before and during the crisis. We estimate the regressions using the sample until July 2007, and then compute RMSE and MAE for August 2007 – August 2010 period. Panel C in Table OA1 clearly shows that, in terms of stability, the bivariate model dominates all the other models.

Based on this analysis, we select the two-variable forecasting model estimated using daily winsorized data from January 1990 to August 2010, with the parameter estimates reported in the main text.

Table OA1: Volatility forecasting horserace

Panel A: RMSE out-of-sample, recursive estimation, non-winsorized sample

Model	Obs	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
01/94-07/07	3165	0.00129	0.00127	0.00121	**0.00115**	0.00116	0.00166	0.00138	0.00250
01/94-08/10	3942	0.00309	0.00313	0.00302	0.00302	**0.00296**	0.00334	0.00331	0.00389
08/07-08/10	771	0.00648	0.00659	0.00637	0.00641	**0.00627**	0.00677	0.00694	0.00717

Panel B: RMSE out-of-sample, recursive estimation, winsorized sample

Model	Obs	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
01/94-07/07	3165	as above	as above	as above	**as above**	as above	as above	as above	as above
01/94-08/10	3942	0.00192	0.00194	0.00185	0.00184	**0.00181**	0.00225	0.00203	0.00302
08/07-08/10	771	0.00347	0.00356	0.00340	0.00345	**0.00336**	0.00382	0.00363	0.00458

Panel C: Stability RMSE, non-recursive estimation for Aug 07-Aug 10

Model	Obs	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
non-winsor.	771	0.00647	0.00692	**0.00642**	0.00670	0.00669	0.00677	0.00694	0.00717
winsor.	771	0.00352	0.00381	**0.00349**	0.00375	0.00375	0.00382	0.00363	0.00458

Notes: Horserace results for eight monthly volatility forecast models (the best model in each row highlighted in bold). Panel A presents out-of-sample RMSE (estimated recursively using non-winsorized sample) for the period of 1) Jan 94-Jul 07, 2) Jan 94-Aug 10, 3) Aug 07-Aug 10. Panel B presents the same set of results for the winsorized sample. Panel C presents results of a stability horserace for both non-winsorized and winsorized samples whereby RMSE is computed for Aug 07-Aug 10, using regression models estimated until July 2007.

[1] When we introduce dummies for the financial crisis period for all coefficients, the dummies are insignificant in all regression models.

2. Stability of the VAR

To assess stability of our VAR through the 2007–2009 financial turmoil, we perform three stability tests. Results are presented in Table OA2. In Panel A, a standard Wald test rejects the null hypothesis of no breakpoint in August 2007 at the 1% significance level for industrial production, the real interest rate and risk aversion, and at the 5% level for uncertainty. In Panel B, the sup-Wald test of Andrews (1993) finds significant break dates between June 2007 and October 2008 for all variables except risk aversion where overall stability is rejected at the 10% level but no significant break date is detected. In Panel C, the Andrews (2003) test, formally designed for a break that occurs towards the end of the sample, rejects the null hypothesis of no breakpoint in August 2007 at the 1% significance level for industrial production, the real interest rate and uncertainty. These results indicate that our VAR is not stable beyond July 2007. We therefore focus on the January 1990 – July 2007 sample in our analysis.

Table OA2: Stability tests

Panel A: Wald test – H_0: no breakpoint in August 2007			
Equation	Test statistic	p-value	
DIPI	38.180	0.0002	
RERA	102.820	0.0000	
RA	27.930	0.009	
UC	24.950	0.023	
Panel B: sup-Wald test - H_0 : no breakpoint in the estimation sample			
Equation	Test Statistic	p-value	Most likely breakpoint
DIPI	1.605	0.029	October 2008
RERA	2.082	0.002	September 2007
RA	1.414	0.079	--
UC	1.964	0.004	June 2007
Panel C: end-of-sample Andrews test – H_0: no breakpoint in August 2007			
Equation	Test Statistic	5% critical value	1% critical value
DIPI	0.003	0.0017	0.0023
RERA	14.950	8.019	8.514
RA	5.120	10.421	12.689
UC	7.012	5.390	7.012

Notes: Stability tests for the 4-variable VAR with the log-difference of industrial production (DIPI), the real interest rate (RERA), log risk aversion (RA) and log uncertainty (UC). Panel A presents results of the Wald test. Panel B presents results of the sup-Wald test, based on the average likelihood ratio F-Statistic, with the most likely breakpoint in the last column based on the maximum likelihood ratio F-Statistic. Panel C presents results of the end-of-sample Andrews test (based on Andrews (2003)). The last two columns report the critical values for rejection at the 5% and 1% level, respectively. The sample period is January 1990 – August 2010.

3. Robustness

In what follows, we present supplemental results for our identified VARs. First, we report a long series of robustness checks for our benchmark four-variable VAR (with the log-difference of industrial production (DIPI), the real interest rate (RERA), log risk aversion (RA) and log uncertainty (UC)), for the sample until July 2007 (summarized in Sections 3.3.1 – 3.3.5 of the paper) and for the full sample (summarized in Section 3.3.6). In particular, in Table OA3 we report results of a robustness exercise in which we consider three alternative measures of the monetary policy stance: Taylor rule deviations, nominal Fed funds rate and the growth of the monetary aggregate M1 (see Section 3.3.1). In Figures OA1 and OA2, we present a full set of IRFs (the equivalent of Figure 3 in the main text) for VAR specifications in which DIPI is replaced by the log-difference of employment (DEMP) and the log of the ISM index (ISM), respectively (see Section 3.3.2). In Figures OA3 and OA4, we present a full set of IRFs for our benchmark VAR in which the ordering of RA and UC is reversed and for the specification with RERA ordered last, respectively (see Section 3.3.3). In Figure OA5, we present our benchmark VAR results that account for the sampling error in the RA and UC estimation (see Section 3.3.4). In Figure OA6, we present a full set of IRFs for our benchmark VAR with DIPI, RERA, RA, UC estimated for the full sample January 1990 – August 2010 (see Section 3.3.6).

In Figures OA7 – OA9, we present robustness results for Section 4. In Figure OA7 we present results of a robustness check where we only impose the high-frequency responses to monetary policy surprises in the monthly VAR with DIPI, RERA, RA, UC, for Jan 1990 – Jul 2007 sample (see Section 4.1). In Figure OA8, we present results of the same identification scheme for the full sample, Jan 1990 – Aug 2010 (see Section 4.1). In Figure OA9, we present results of our benchmark VAR with DIPI, RERA, RA, UC where monetary policy surprises are based on the unexpected change in the Fed Funds rate on a monthly basis, for the full sample Jan 1990 – Aug 2010 (see Section 4.2).

The list of Tables and Figures is as follows:

Figure OA5: Structural IRFs for the VAR with DIPI, RERA, RA, UC, accounting for the sampling error in RA and UC, Jan 1990 – Jul 2007.

Figure OA6: Structural IRFs for the benchmark VAR with DIPI, RERA, RA, UC, Jan 1990 – Aug 2010.

Figure OA7: Alternative identification of the benchmark VAR with DIPI, RERA, RA, UC using high-frequency futures, Jan 1990 – Jul 2007.

Figure OA8: Alternative identification of the benchmark VAR with DIPI, RERA, RA, UC using high-frequency futures, Jan 1990 – Aug 2010.

Figure OA9: Identification of the benchmark VAR with DIPI, RERA, RA, UC using monthly futures, Jan 1990 – Aug 2010.

Table OA3: Robustness to monetary policy measures

Panel A: Monetary policy instrument – risk aversion pair				
MP instrument	Impulse MP, response RA		Impulse RA, response MP	
	sign	significant from-to (month)	sign	significant from-to (month)
Real interest rate				
- COR	–/+	0 - 2 (–), 9 - 40 (+)	–	--
- CLR	–/+	2 (–), 9 – 40 (+)	–	12 - 24
Taylor rule				
- COR	–/+	0 (–), 8 - 44 (+)	–	--
- CLR	+	9 – 44	–	--
Fed funds rate				
- COR	+	21 - 38	–	0 - 10
- CLR	+	19 - 38	–	0 - 7
(-1) M1 growth				
- COR	–/+	--	–	--
- CLR	–/+	--	–	--
(-1) M1				
- COR	+	5 - 26	–	--

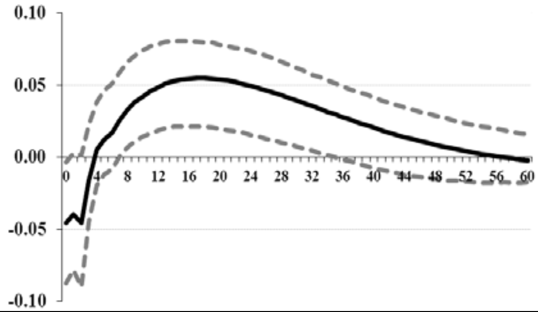
Panel B: Monetary policy instrument – uncertainty pair				
MP instrument	Impulse MP, response UC		Impulse UC, response MP	
	sign	significant from-to (month)	sign	significant from-to (month)
Real interest rate				
- COR	–/+	0 - 1 (–), 11 - 38 (+)	–	--
- CLR	+	0 - 3 (–), 11 - 40 (+)	–	--
Taylor rule				
- COR	–/+	0 - 1 (–), 15 - 42 (+)	–	--
- CLR	–/+	0 - 1 (–), 17 - 43 (+)	–	--
Fed funds rate				
- COR	–/+	--	–	14 - 31
- CLR	–/+	--	–	--
(-1) M1 growth				
- COR	+	3 - 12	–	--
- CLR	+	3 - 12	–	--
(-1) M1				
- COR	+	5 - 19	–	--

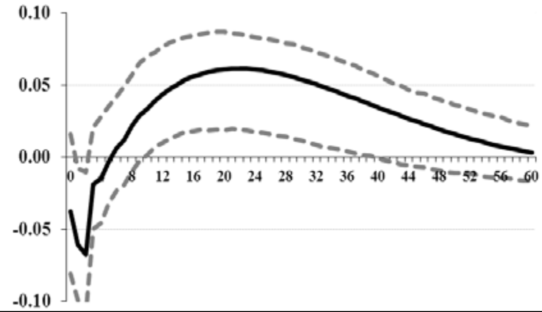
Notes: Summary results for the interactions between monetary policy, MP (as represented by four different measures) and risk aversion (RA) in Panel A and between monetary policy and uncertainty (UC) in panel B in the four-variable model with the log-difference of industrial production (DIPI), MP, RA and UC. The MP measures considered are: real rate, Taylor rule deviations, Fed funds rate, the negative of the M1 growth. Each Panel lists the range of months for which impulse-response functions (VARs with contemporaneous (COR) and contemporaneous/long-run (CLR) restrictions, respectively) were statistically significant within the 90% confidence interval in the direction indicated in the column "sign". The last row in each panel considers a specification with M1 and industrial production both entering in levels rather than growth rates (COR restrictions only)**.** The sample period is January 1990 – July 2007.

Figure OA1: Structural IRFs for the VAR with DEMP, RERA, RA, UC

Panel A: Impulse RERA, response RA

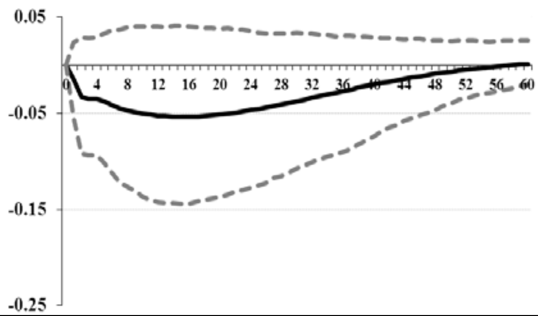
Contemporaneous restrictions	Contemporaneous/long-run restrictions

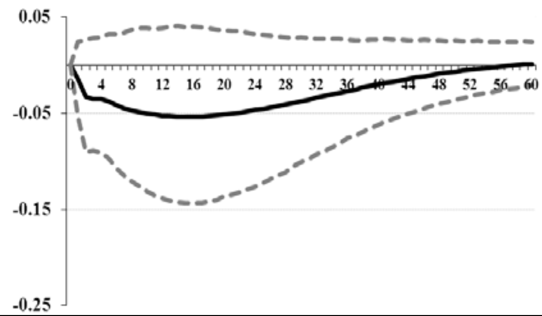




Panel B: Impulse RA, response RERA

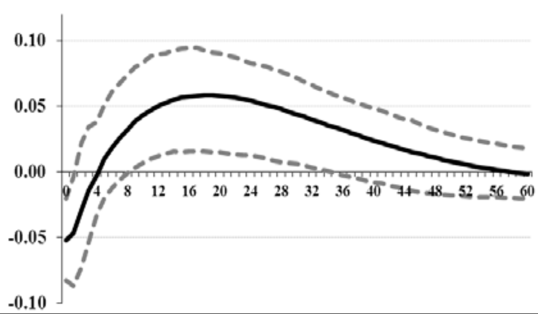
Contemporaneous restrictions	Contemporaneous/long-run restrictions

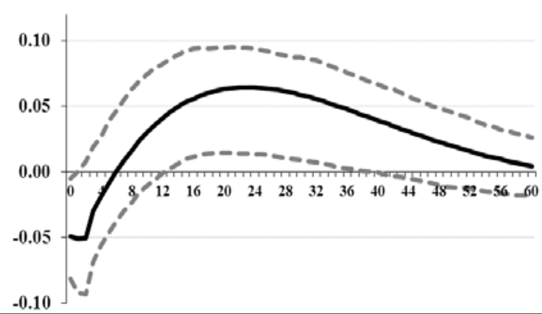




Panel C: Impulse RERA, response UC

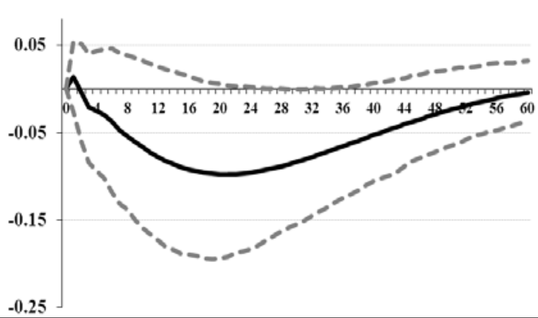
Contemporaneous restrictions	Contemporaneous/long-run restrictions

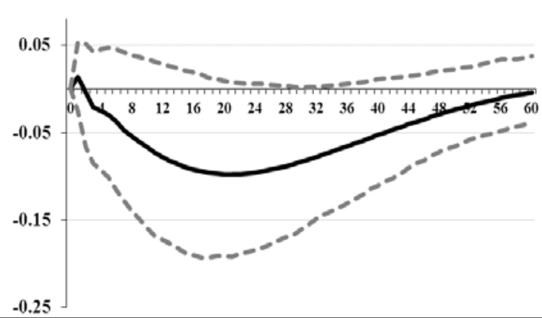




Panel D: Impulse UC, response RERA

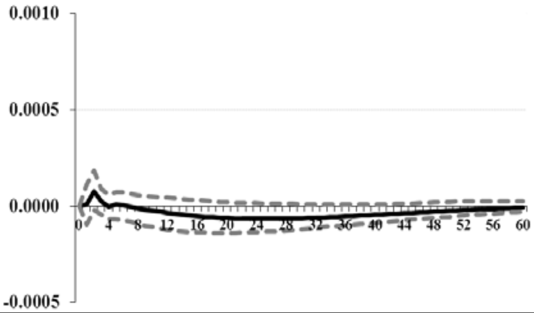
Contemporaneous restrictions	Contemporaneous/long-run restrictions



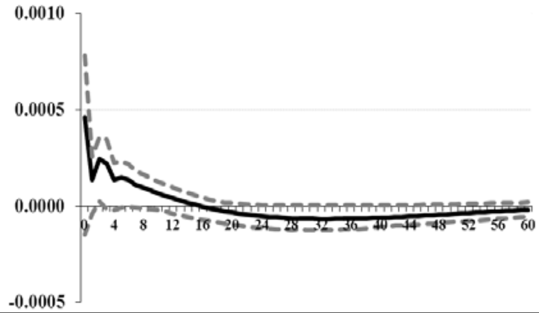


Panel E: Impulse RERA, response DEMP

Contemporaneous restrictions

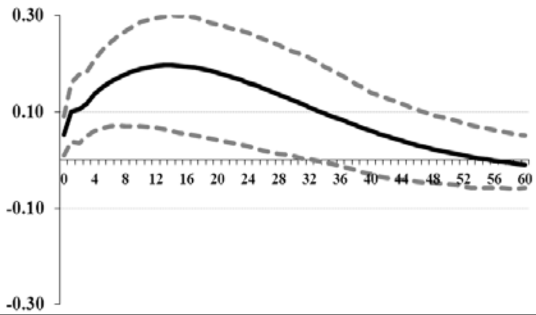


Contemporaneous/long-run restrictions

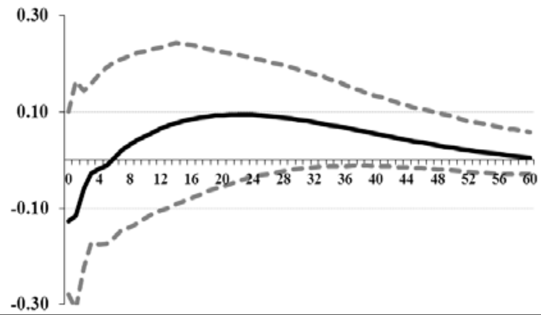


Panel F: Impulse DEMP, response RERA

Contemporaneous restrictions

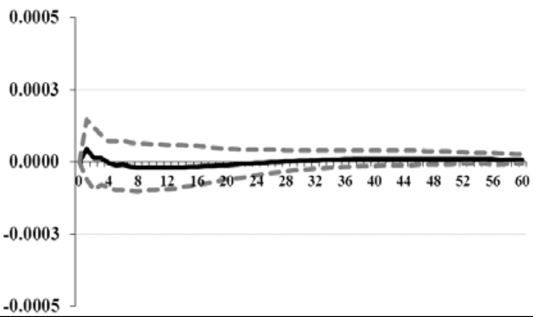


Contemporaneous/long-run restrictions

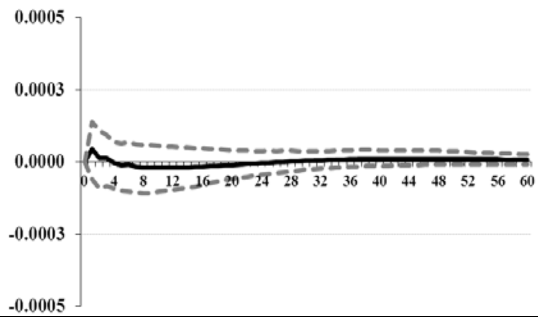


Panel G: Impulse RA, response DEMP

Contemporaneous restrictions

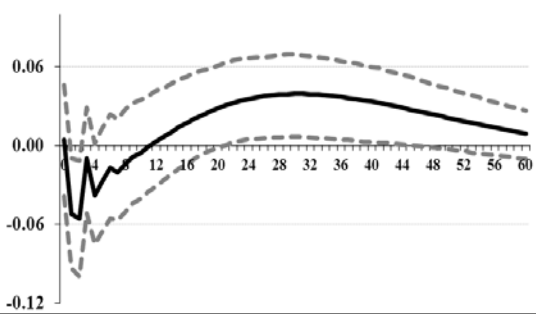


Contemporaneous/long-run restrictions

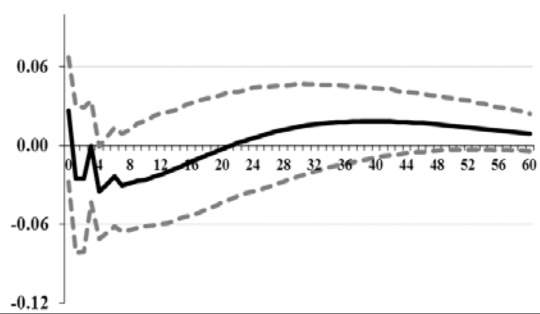


Panel H: Impulse DEMP, response RA

Contemporaneous restrictions

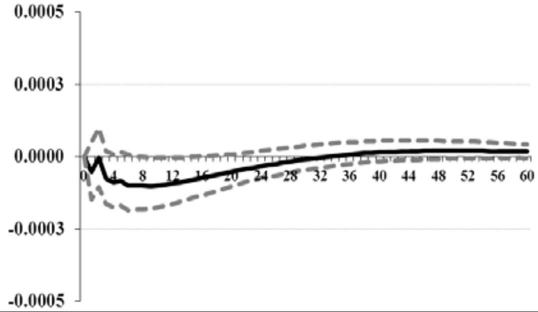


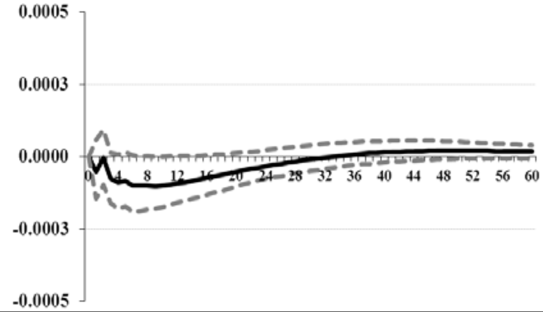
Contemporaneous/long-run restrictions



Panel I: Impulse UC, response DEMP

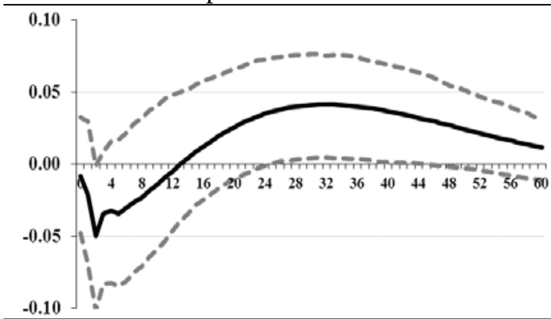
Contemporaneous restrictions	Contemporaneous/long-run restrictions

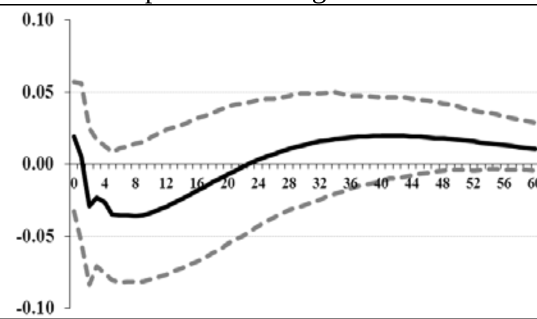




Panel J: Impulse DEMP, response UC

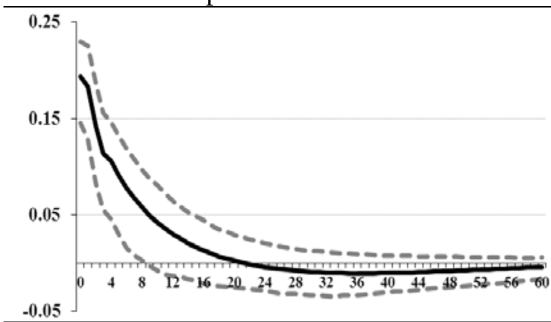
Contemporaneous restrictions	Contemporaneous/long-run restrictions

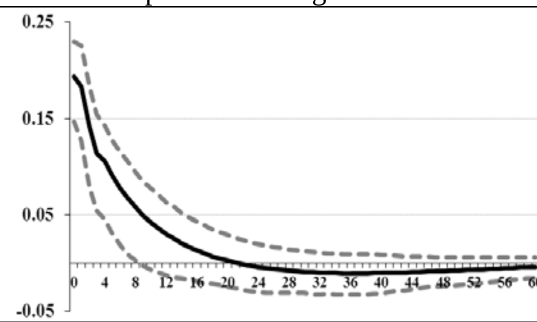




Panel K: Impulse RA, response UC

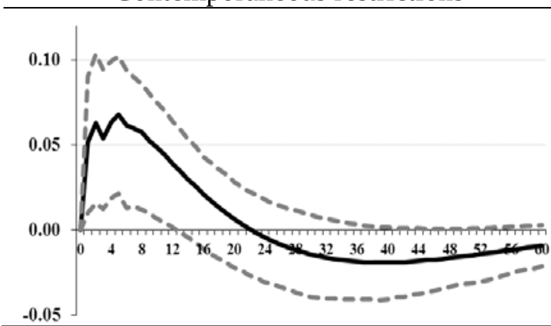
Contemporaneous restrictions	Contemporaneous/long-run restrictions

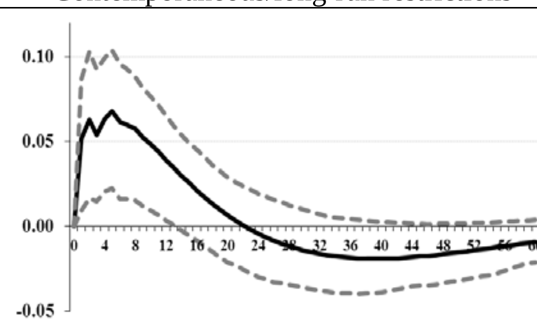




Panel L: Impulse UC, response RA

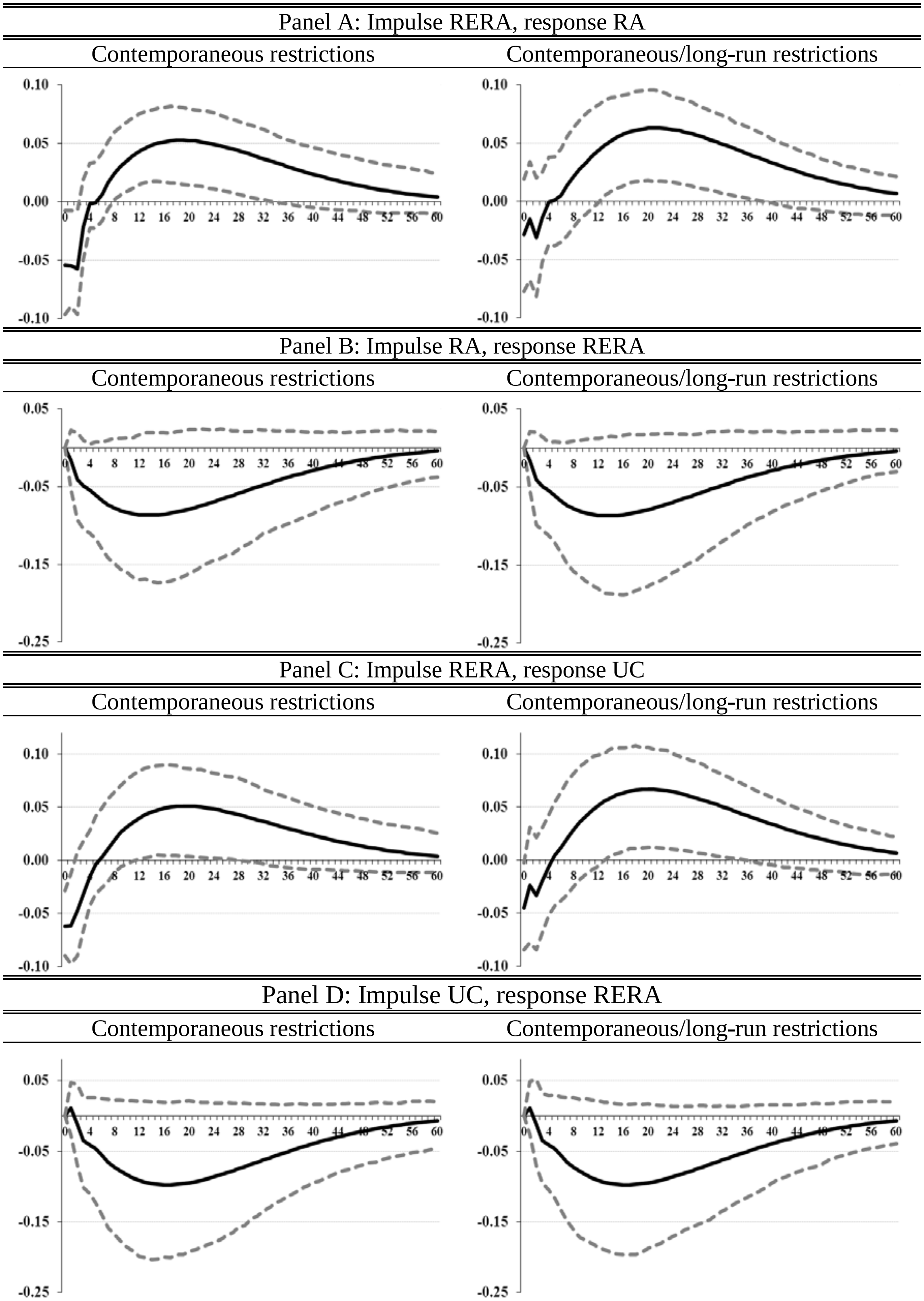
Contemporaneous restrictions	Contemporaneous/long-run restrictions



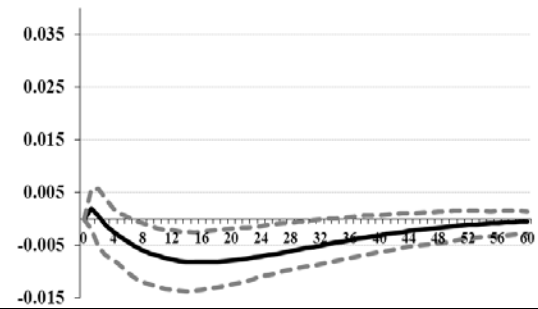
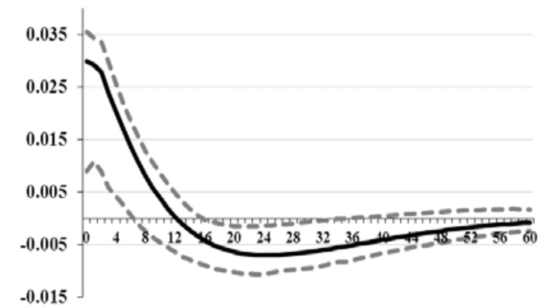


Notes: Estimated structural impulse-response functions (black lines) and 90% bootstrapped confidence intervals (grey dashed lines) for the 4-variable model (with the log-difference of employment (DEMP), real interest rate (RERA), log risk aversion (RA), and log uncertainty (UC)) with 3 lags (selected by the Akaike criterion), based on 1000 replications. Panels on the left present results of the model with contemporaneous (Cholesky) restrictions, panels on the right present results of the model with contemporaneous/long-run restrictions. The sample period is January 1990 – July 2007.

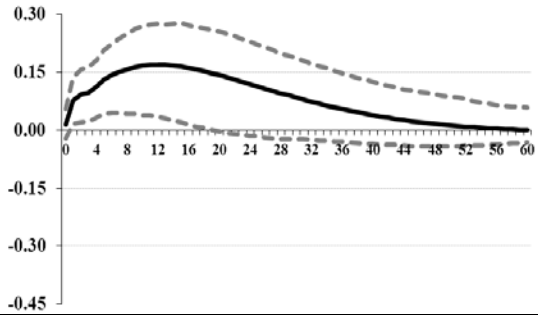
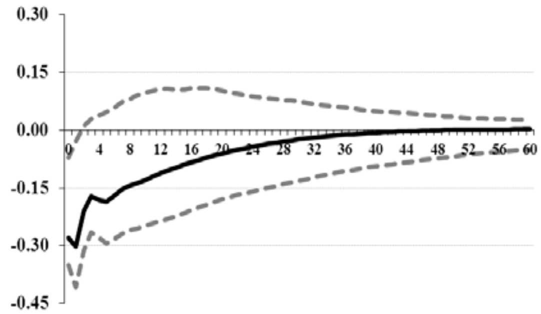
Figure OA2: Structural IRFs for the VAR with ISM, RERA, RA, UC



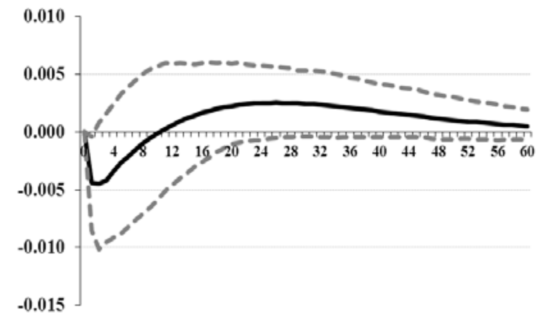
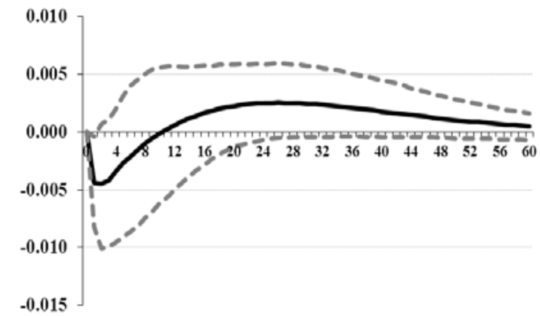
Panel E: Impulse RERA, response ISM

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

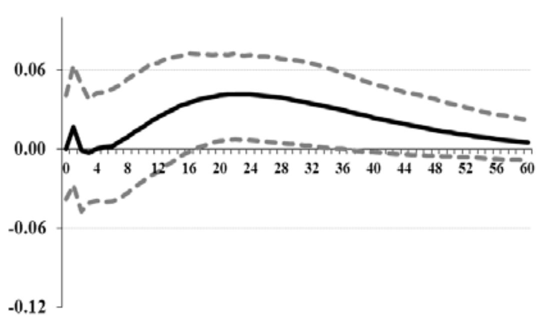
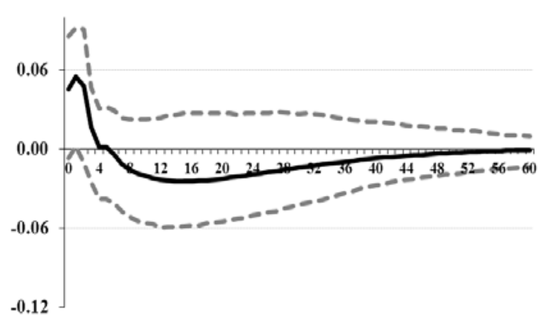
Panel F: Impulse ISM, response RERA

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

Panel G: Impulse RA, response ISM

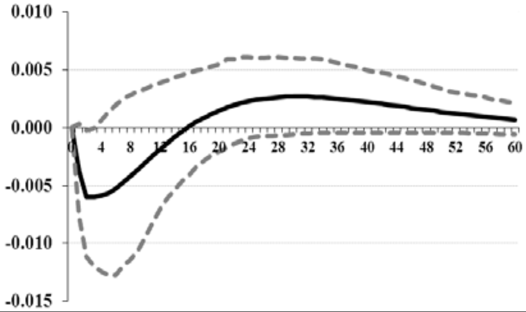
Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

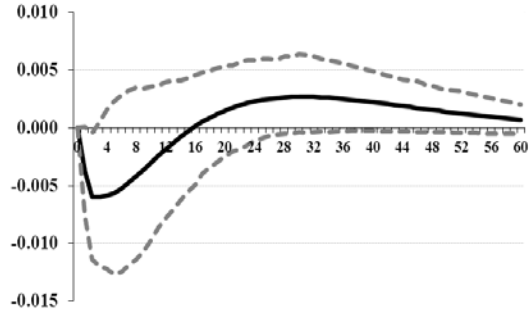
Panel H: Impulse ISM, response RA

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

Panel I: Impulse UC, response ISM

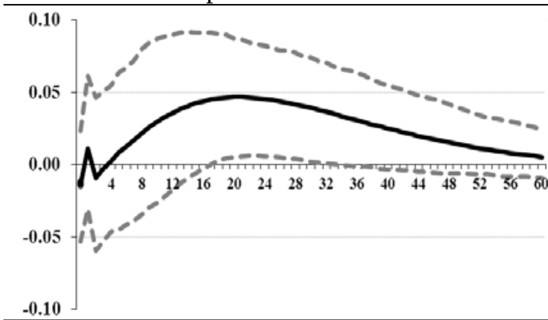
Contemporaneous restrictions	Contemporaneous/long-run restrictions

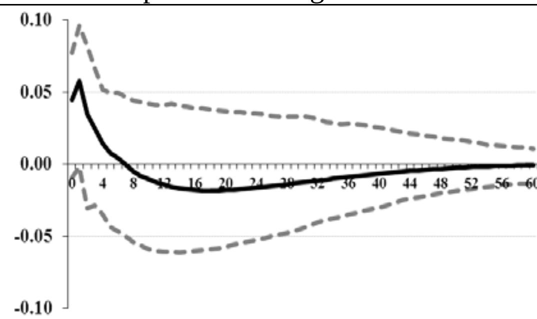




Panel J: Impulse ISM, response UC

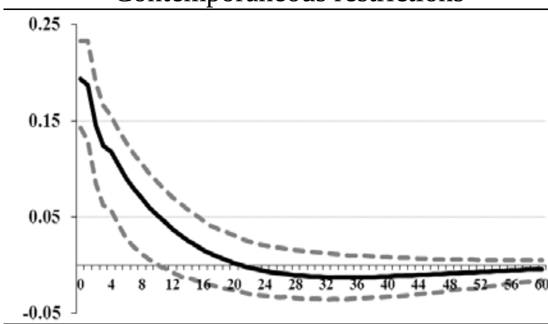
Contemporaneous restrictions	Contemporaneous/long-run restrictions

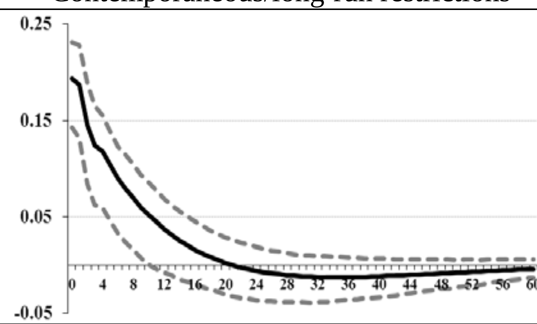




Panel K: Impulse RA, response UC

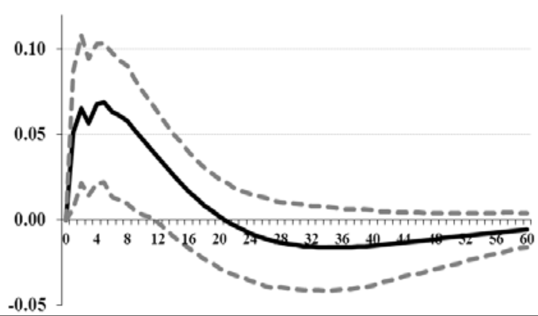
Contemporaneous restrictions	Contemporaneous/long-run restrictions

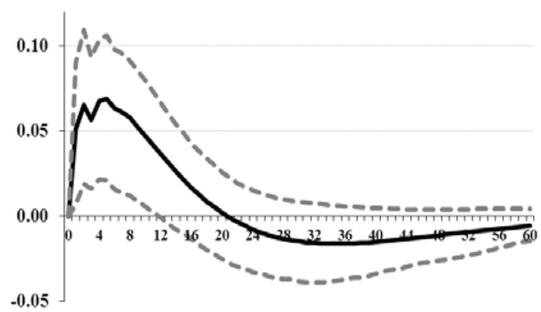




Panel L: Impulse UC, response RA

Contemporaneous restrictions	Contemporaneous/long-run restrictions



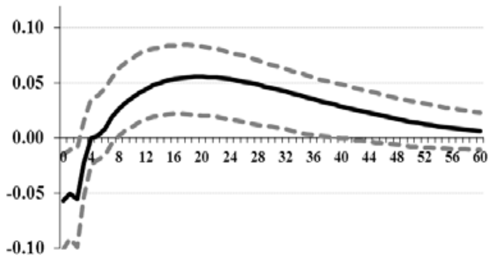


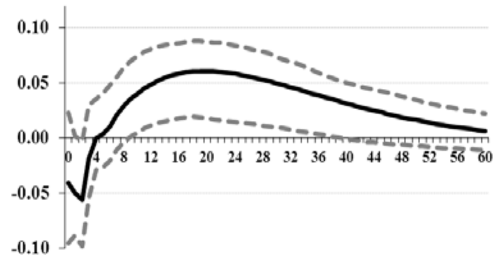
Notes: Estimated structural impulse-response functions (black lines) and 90% bootstrapped confidence intervals (grey dashed lines) for the 4-variable model (with the log ISM index (ISM), real interest rate (RERA), log risk aversion (RA), and log uncertainty (UC)) with 3 lags (selected by the Akaike criterion), based on 1000 replications. Panels on the left present results of the model with contemporaneous (Cholesky) restrictions, panels on the right present results of the model with contemporaneous/long-run restrictions. The sample period is January 1990 – July 2007.

Figure OA3: Structural IRFs for the VAR with DIPI, RERA, UC, RA

Panel A: Impulse RERA, response RA

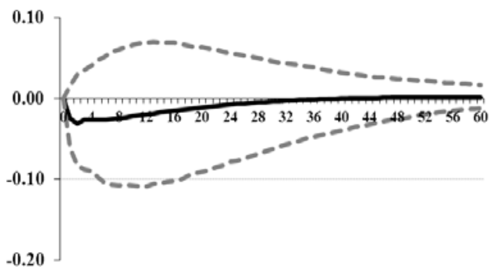
Contemporaneous restrictions	Contemporaneous/long-run restrictions

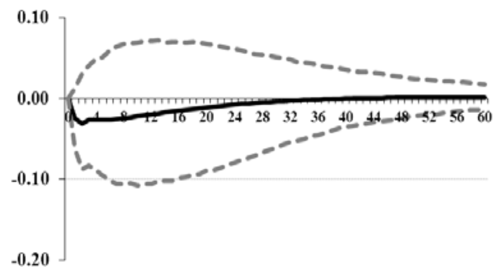




Panel B: Impulse RA, response RERA

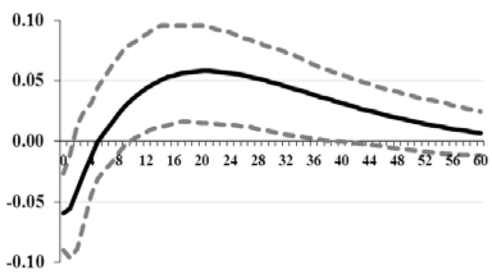
Contemporaneous restrictions	Contemporaneous/long-run restrictions

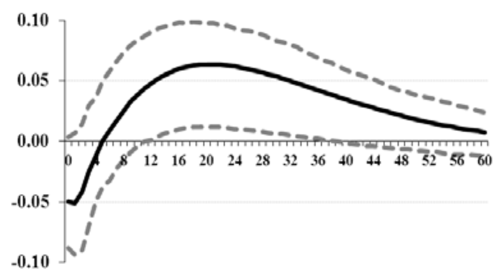




Panel C: Impulse RERA, response UC

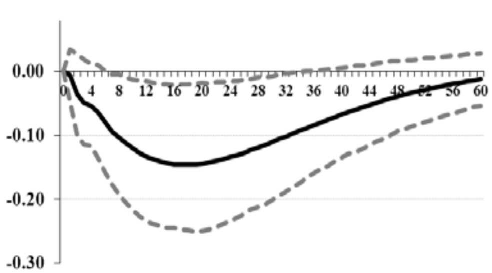
Contemporaneous restrictions	Contemporaneous/long-run restrictions

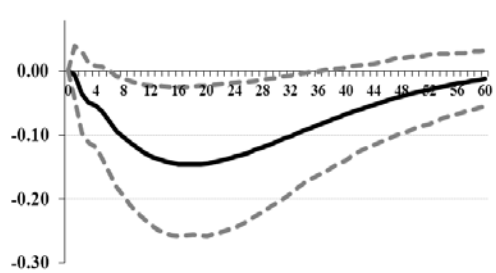




Panel D: Impulse UC, response RERA

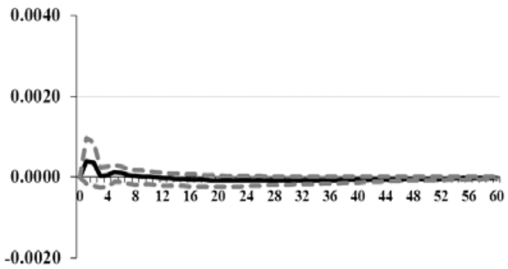
Contemporaneous restrictions	Contemporaneous/long-run restrictions

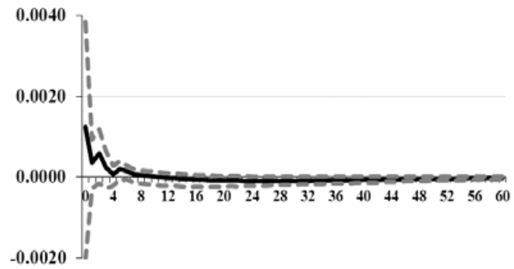




Panel E: Impulse RERA, response DIPI

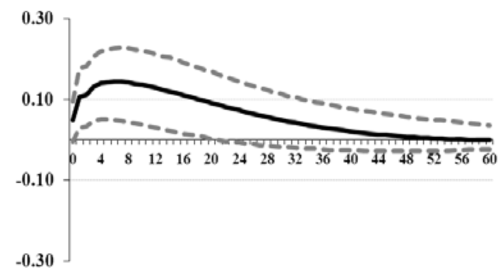
Contemporaneous restrictions	Contemporaneous/long-run restrictions

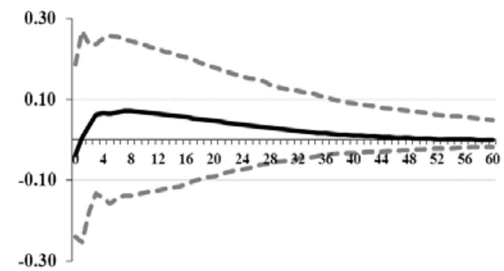




Panel F: Impulse DIPI, response RERA

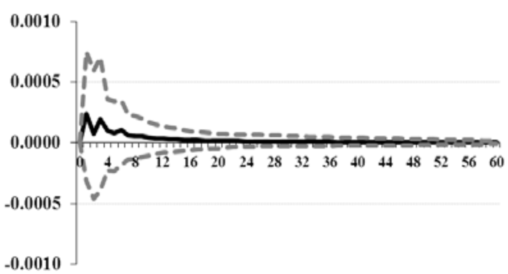
Contemporaneous restrictions	Contemporaneous/long-run restrictions

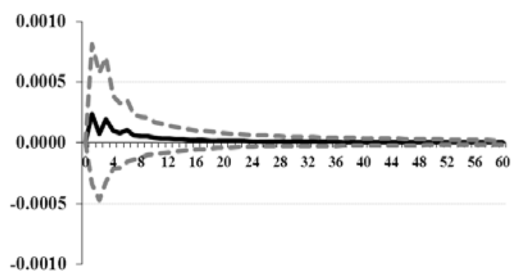




Panel G: Impulse RA, response DIPI

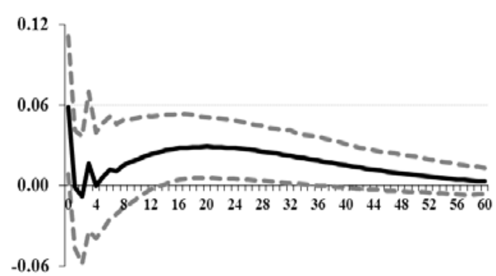
Contemporaneous restrictions	Contemporaneous/long-run restrictions

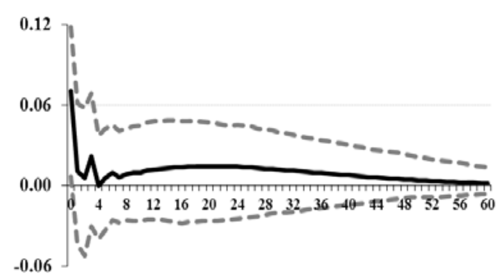




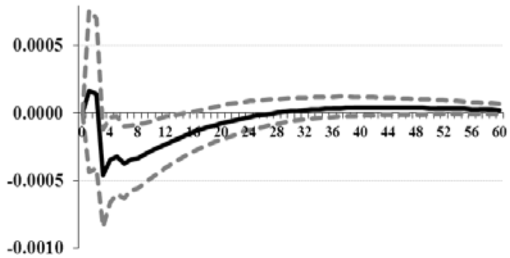
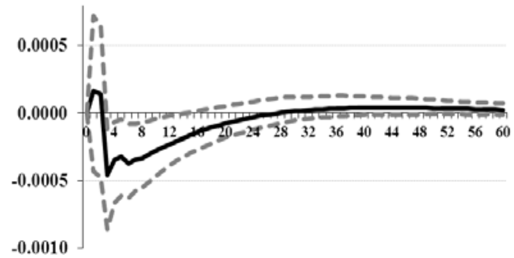
Panel H: Impulse DIPI, response RA

Contemporaneous restrictions	Contemporaneous/long-run restrictions

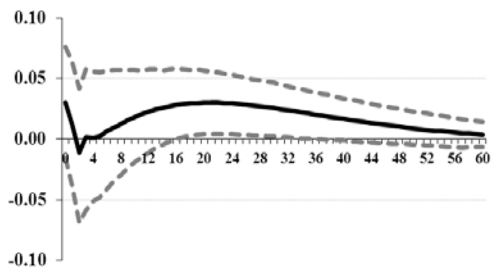
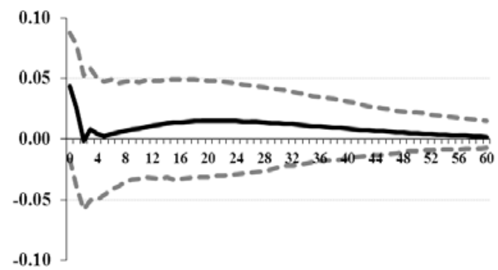




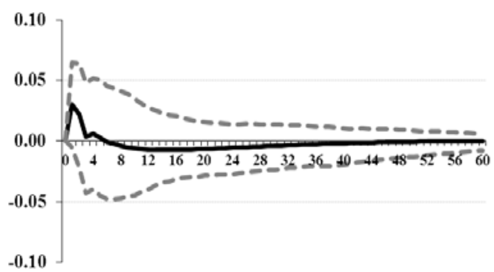
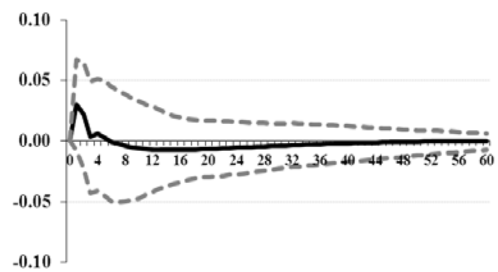
Panel I: Impulse UC, response DIPI

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

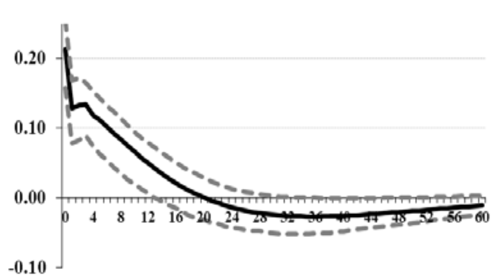
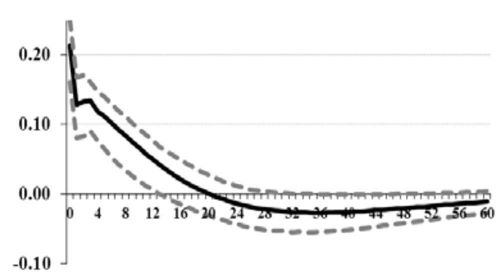
Panel J: Impulse DIPI, response UC

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

Panel K: Impulse RA, response UC

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

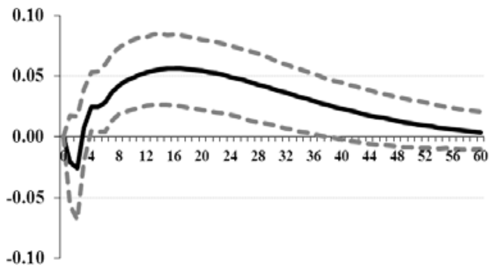
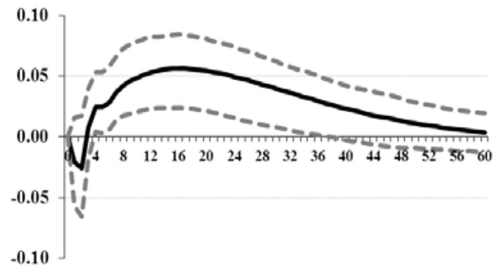
Panel L: Impulse UC, response RA

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

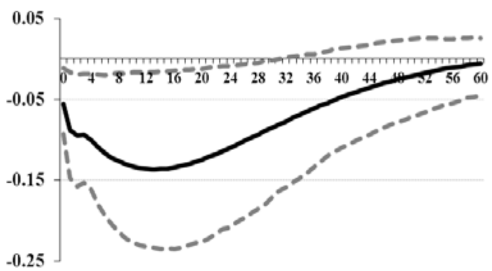
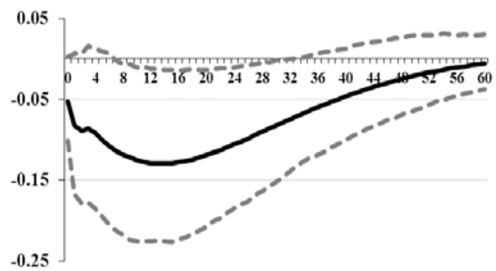
Notes: Estimated structural impulse-response functions (black lines) and 90% bootstrapped confidence intervals (grey dashed lines) for the 4-variable model (with the log-difference of industrial production (DIPI), real interest rate (RERA), log uncertainty (UC) and log risk aversion (RA)) with 3 lags (selected by the Akaike criterion), based on 1000 replications. Panels on the left present results of the model with contemporaneous (Cholesky) restrictions, panels on the right present results of the model with contemporaneous/long-run restrictions. The sample period is January 1990 – July 2007.

Figure OA4: Structural IRFs for the VAR with DIPI, RA, UC, RERA

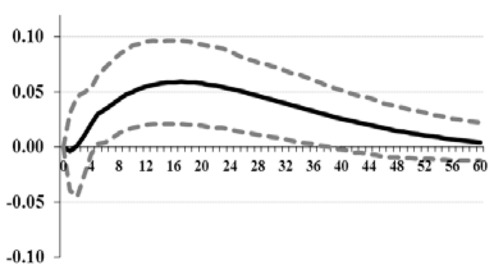
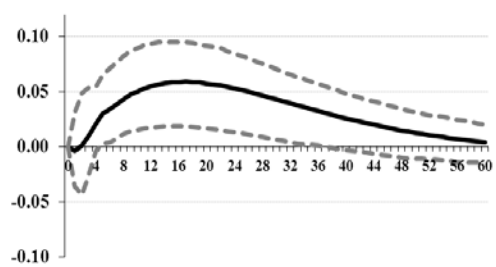
Panel A: Impulse RERA, response RA

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

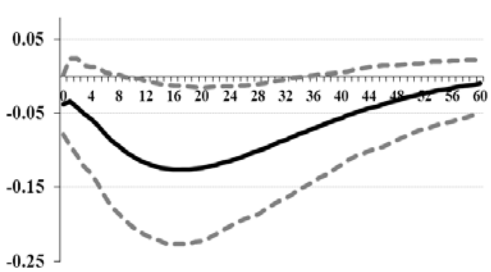
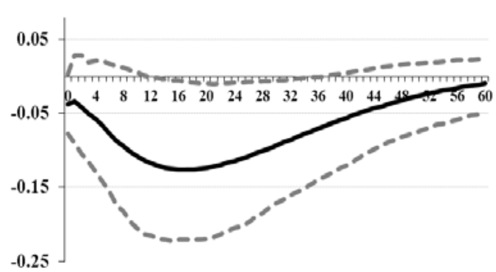
Panel B: Impulse RA, response RERA

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

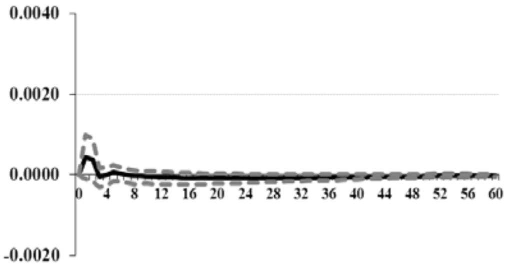
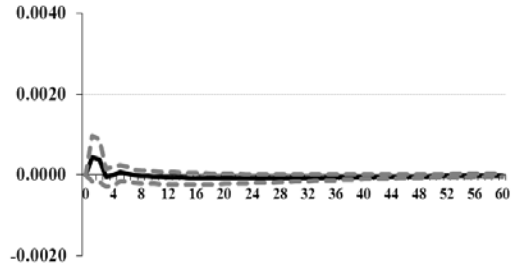
Panel C: Impulse RERA, response UC

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

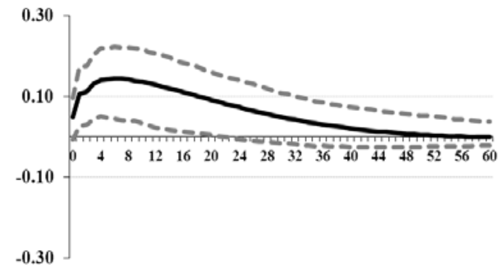
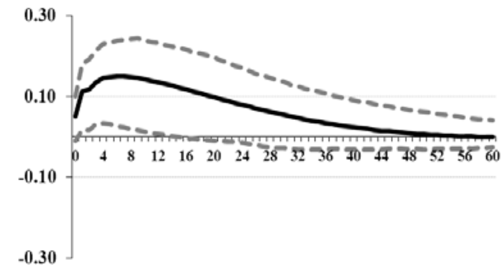
Panel D: Impulse UC, response RERA

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

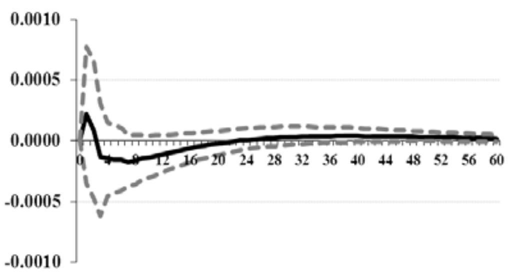
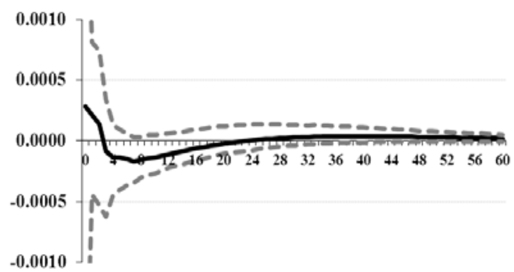
Panel E: Impulse RERA, response DIPI

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

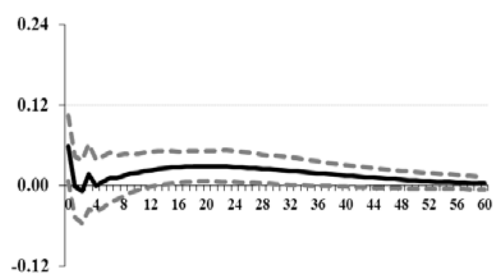
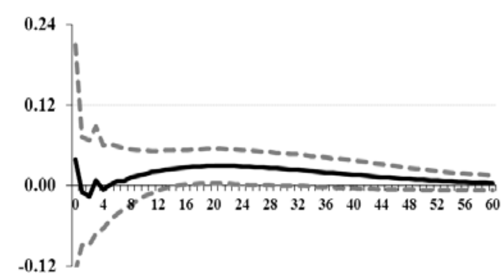
Panel F: Impulse DIPI, response RERA

Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

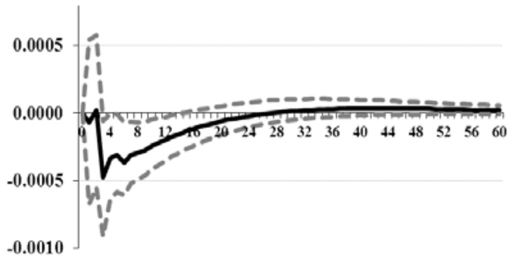
Panel G: Impulse RA, response DIPI

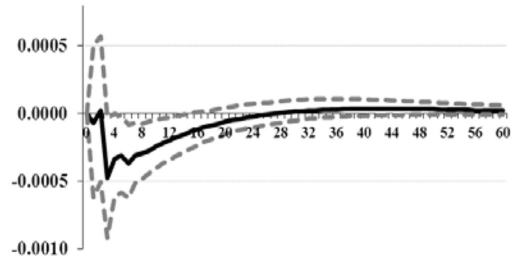
Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

Panel H: Impulse DIPI, response RA

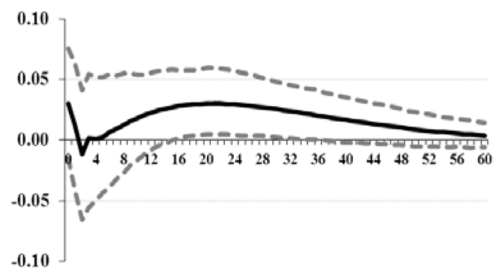
Contemporaneous restrictions	Contemporaneous/long-run restrictions
	

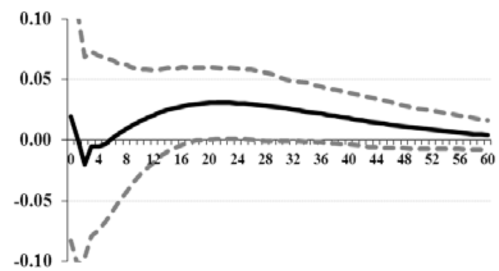
Panel I: Impulse UC, response DIPI	
Contemporaneous restrictions	Contemporaneous/long-run restrictions



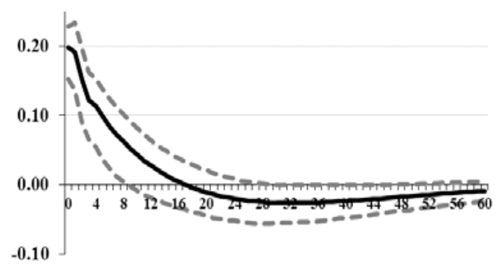


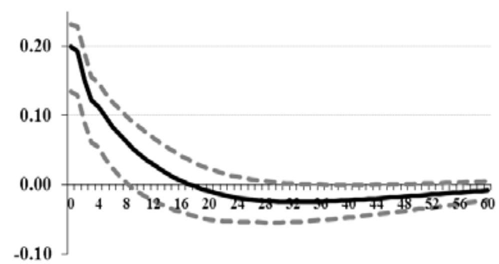
Panel J: Impulse DIPI, response UC	
Contemporaneous restrictions	Contemporaneous/long-run restrictions



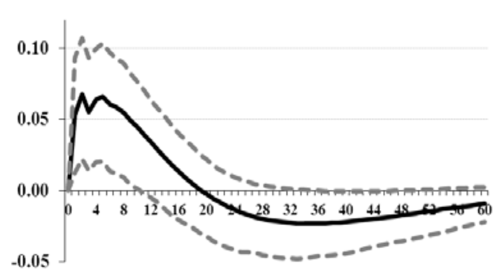


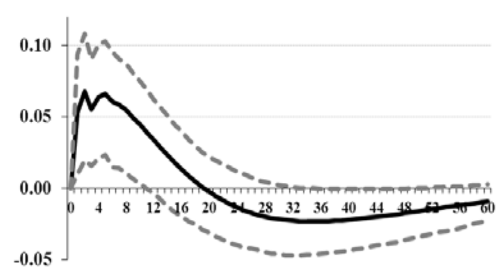
Panel K: Impulse RA, response UC	
Contemporaneous restrictions	Contemporaneous/long-run restrictions





Panel L: Impulse UC, response RA	
Contemporaneous restrictions	Contemporaneous/long-run restrictions



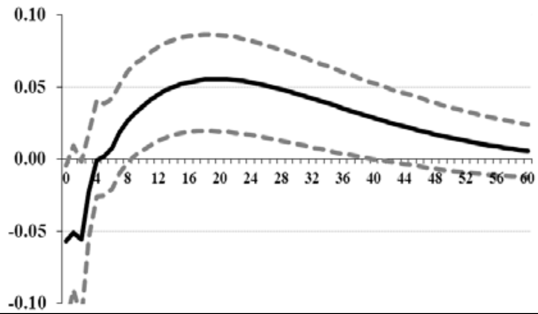


Notes: Estimated structural impulse-response functions (black lines) and 90% bootstrapped confidence intervals (grey dashed lines) for the 4-variable model (with the log-difference of industrial production (DIPI), log uncertainty (UC), log risk aversion (RA) and real interest rate (RERA)) with 3 lags (selected by the Akaike criterion), based on 1000 replications. Panels on the left present results of the model with contemporaneous (Cholesky) restrictions, panels on the right present results of the model with contemporaneous/long-run restrictions. The sample period is January 1990 – July 2007.

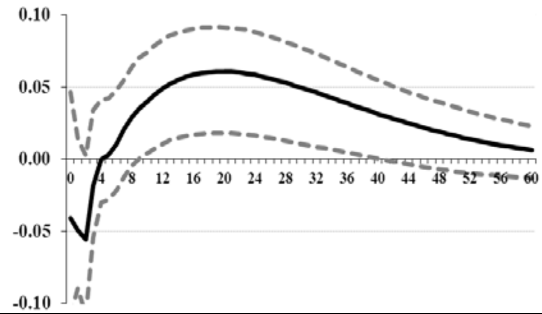
Figure OA5: Structural IRFs for the VAR with DIPI, RERA, RA, UC (sampling error)

Panel A: Impulse RERA, response RA

Contemporaneous restrictions

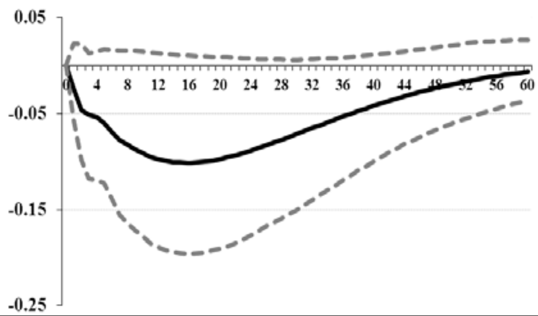


Contemporaneous/long-run restrictions

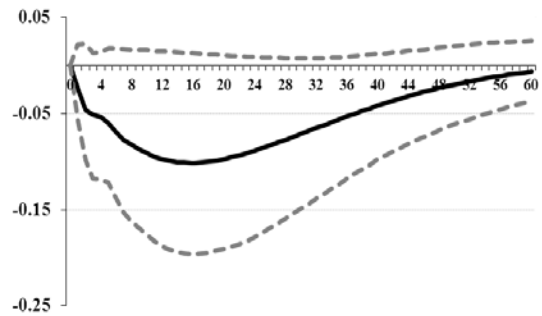


Panel B: Impulse RA, response RERA

Contemporaneous restrictions

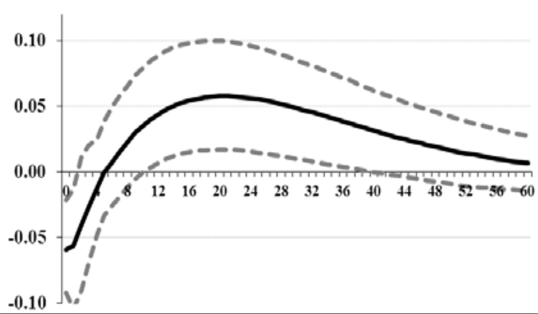


Contemporaneous/long-run restrictions

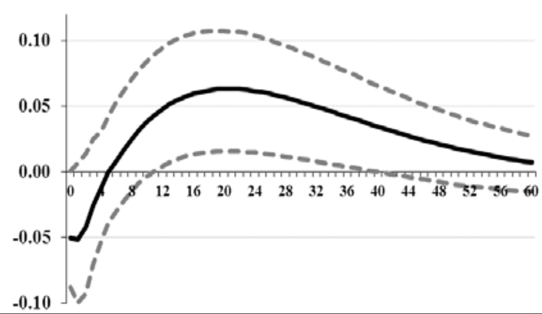


Panel C: Impulse RERA, response UC

Contemporaneous restrictions

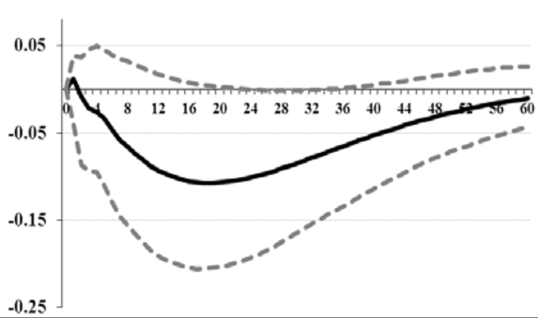


Contemporaneous/long-run restrictions

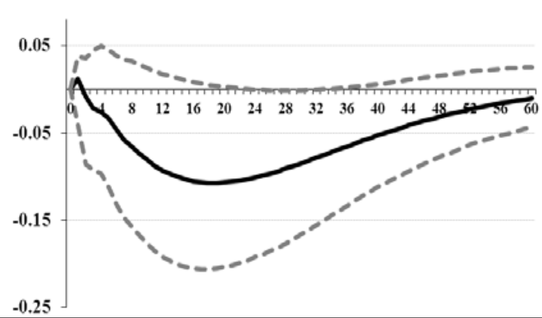


Panel D: Impulse UC, response RERA

Contemporaneous restrictions

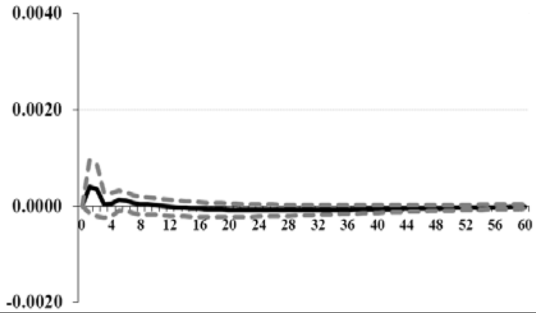


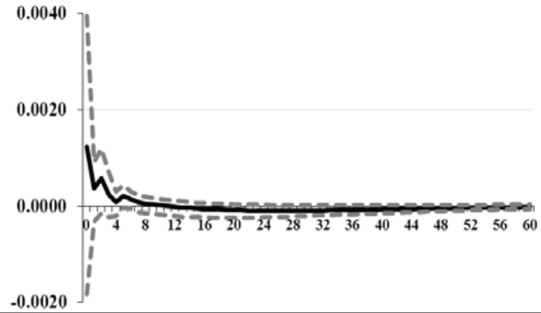
Contemporaneous/long-run restrictions



Panel E: Impulse RERA, response DIPI

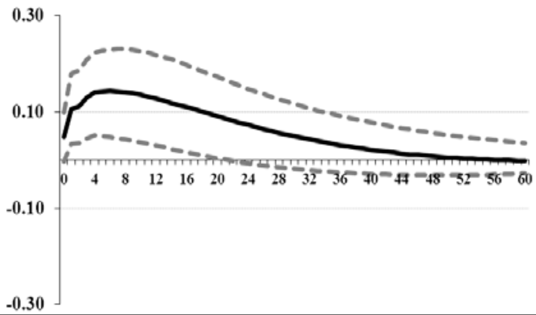
Contemporaneous restrictions	Contemporaneous/long-run restrictions

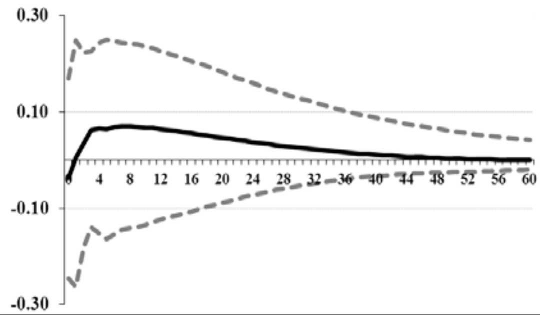




Panel F: Impulse DIPI, response RERA

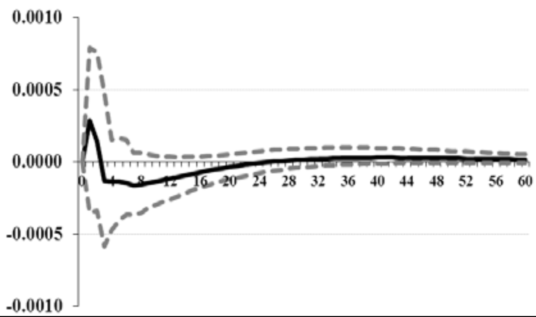
Contemporaneous restrictions	Contemporaneous/long-run restrictions

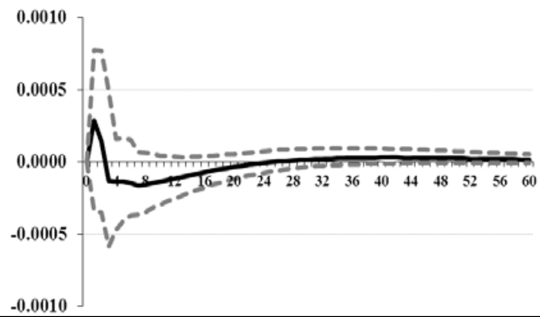




Panel G: Impulse RA, response DIPI

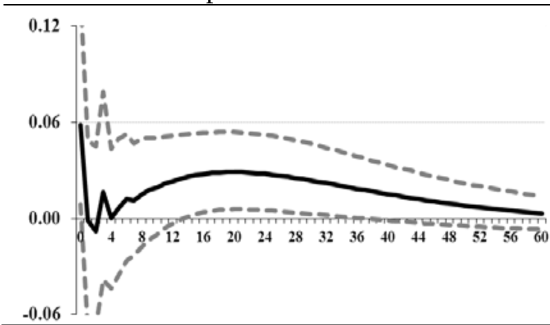
Contemporaneous restrictions	Contemporaneous/long-run restrictions

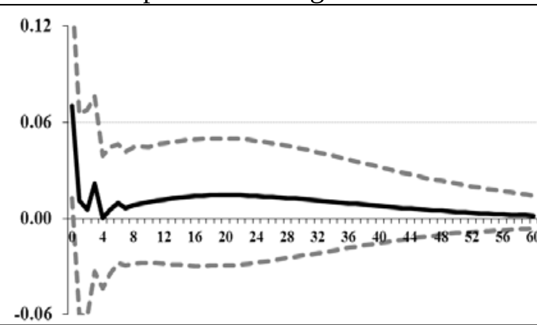




Panel H: Impulse DIPI, response RA

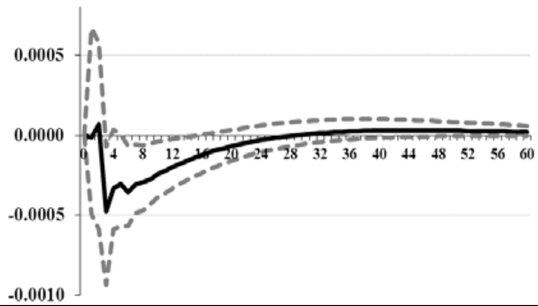
Contemporaneous restrictions	Contemporaneous/long-run restrictions

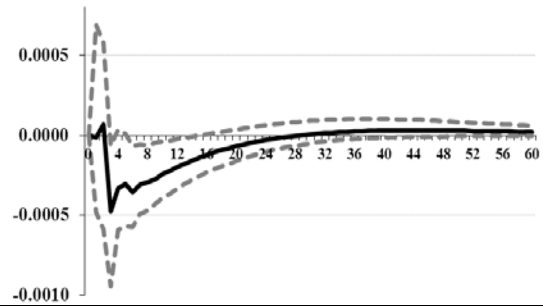




Panel I: Impulse UC, response DIPI

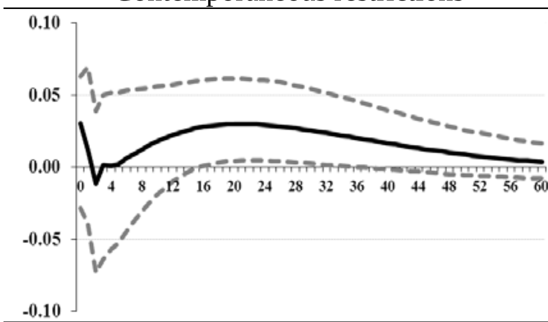
Contemporaneous restrictions	Contemporaneous/long-run restrictions

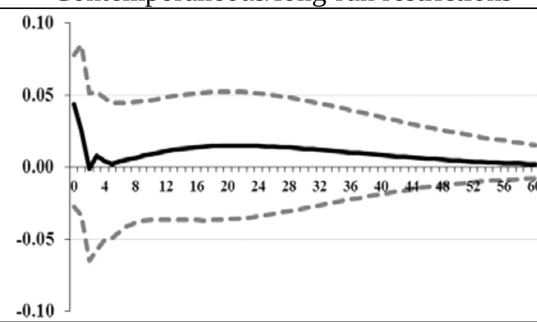




Panel J: Impulse DIPI, response UC

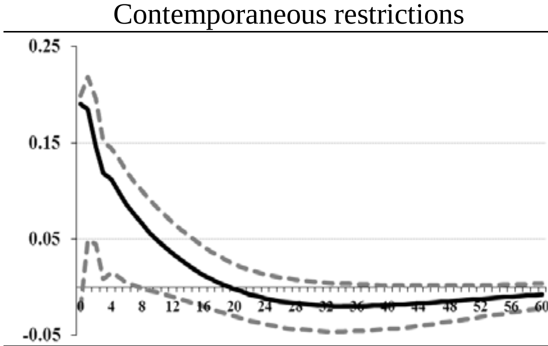
Contemporaneous restrictions	Contemporaneous/long-run restrictions

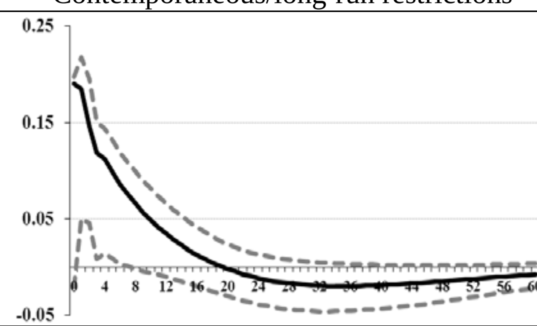




Panel K: Impulse RA, response UC

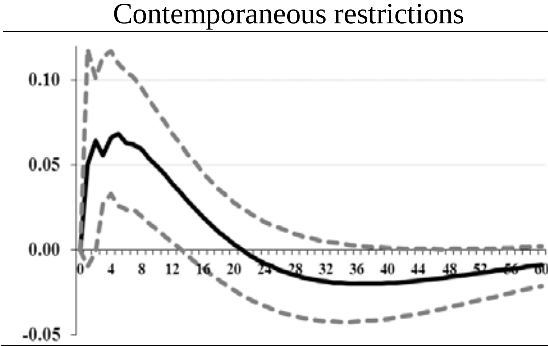
Contemporaneous restrictions	Contemporaneous/long-run restrictions





Panel L: Impulse UC, response RA

Contemporaneous restrictions	Contemporaneous/long-run restrictions

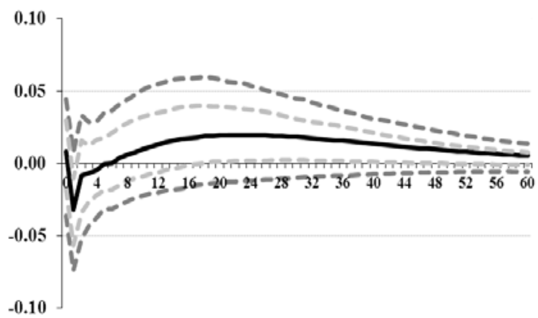


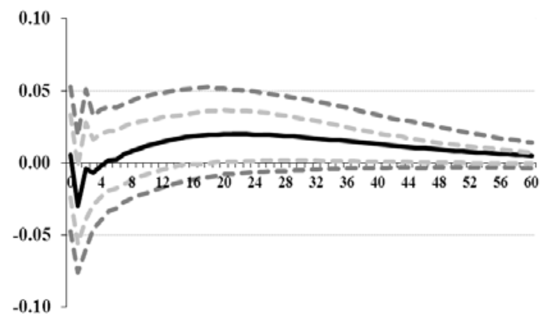
Notes: Estimated structural impulse-response functions (black lines) and 90% bootstrapped confidence intervals (grey dashed lines) for the 4-variable model (with the log-difference of industrial production (DIPI), real interest rate (RERA), log risk aversion (RA), and log uncertainty (UC)) with 3 lags (selected by the Akaike criterion), based on 1000 replications. Panels on the left present results of the model with contemporaneous (Cholesky) restrictions, panels on the right present results of the model with contemporaneous/long-run restrictions. The sample period is January 1990 – July 2007.

Figure OA6: Structural IRFs for the benchmark VAR, Jan 1990 - Aug 2010

Panel A: Impulse RERA, response RA

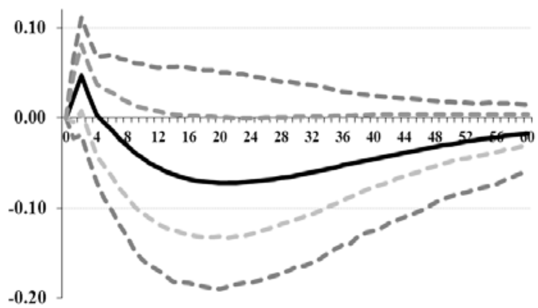
Contemporaneous restrictions	Contemporaneous/long-run restrictions

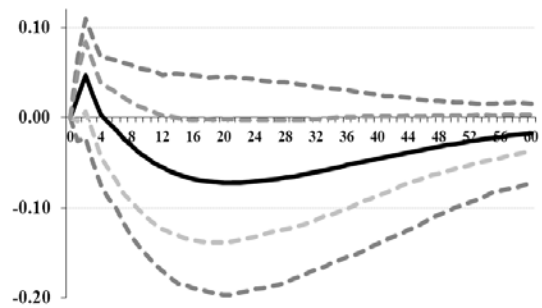




Panel B: Impulse RA, response RERA

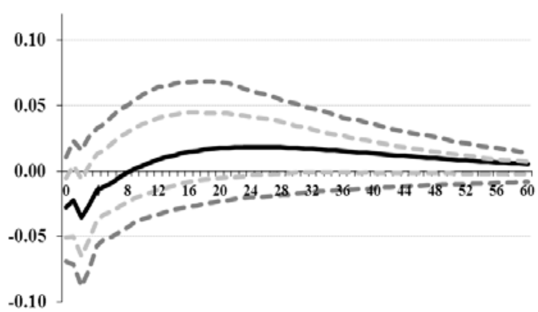
Contemporaneous restrictions	Contemporaneous/long-run restrictions

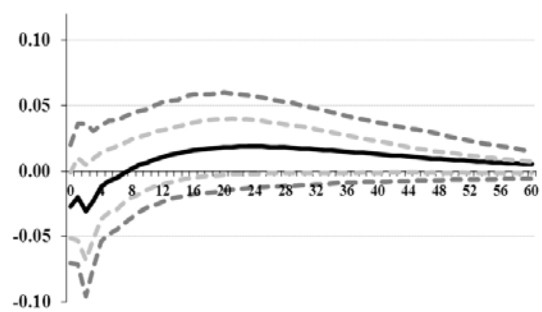




Panel C: Impulse RERA, response UC

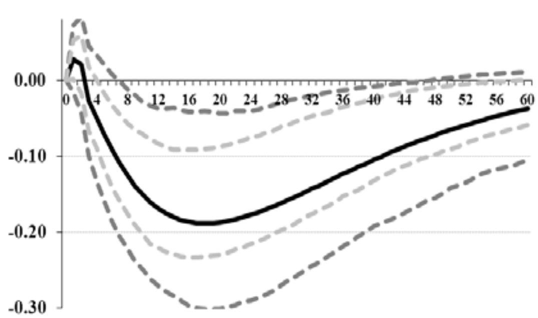
Contemporaneous restrictions	Contemporaneous/long-run restrictions

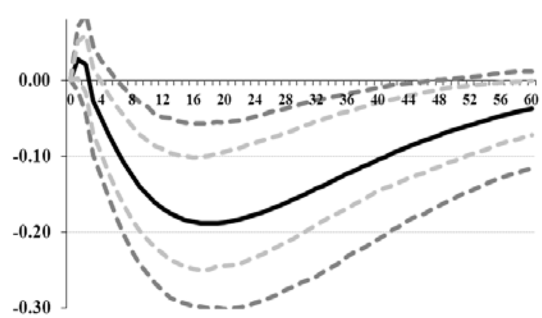




Panel D: Impulse UC, response RERA

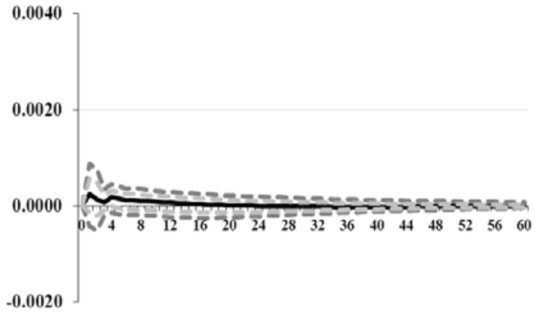
Contemporaneous restrictions	Contemporaneous/long-run restrictions



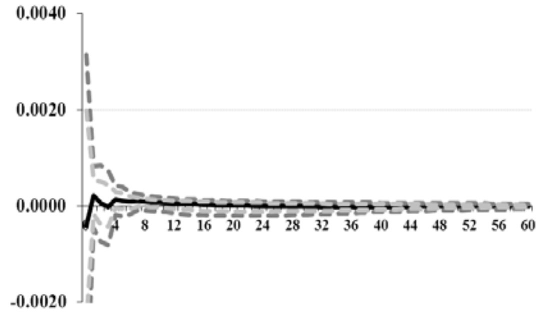


Panel E: Impulse RERA, response DIPI

Contemporaneous restrictions

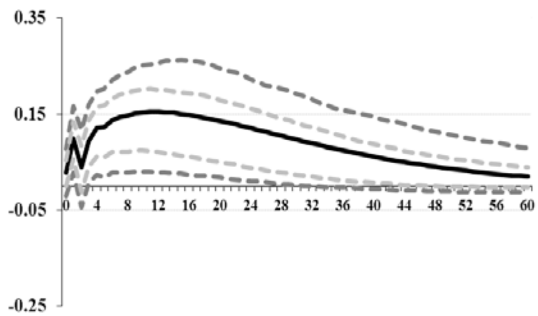


Contemporaneous/long-run restrictions

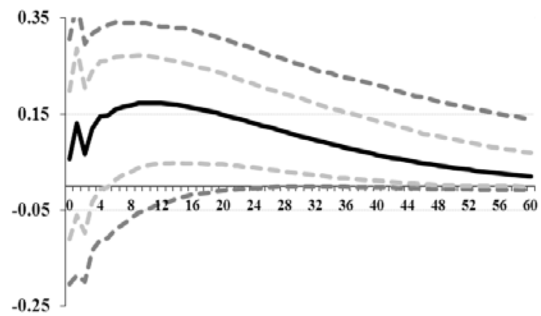


Panel F: Impulse DIPI, response RERA

Contemporaneous restrictions

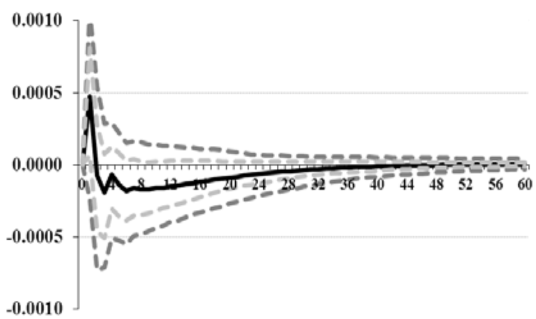


Contemporaneous/long-run restrictions

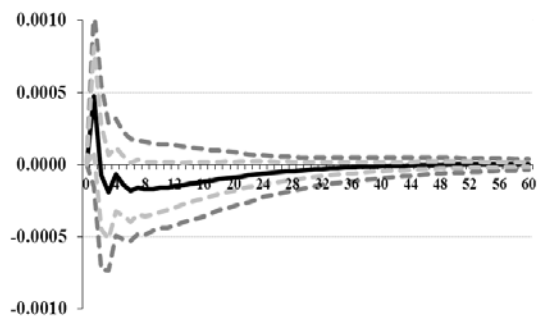


Panel G: Impulse RA, response DIPI

Contemporaneous restrictions

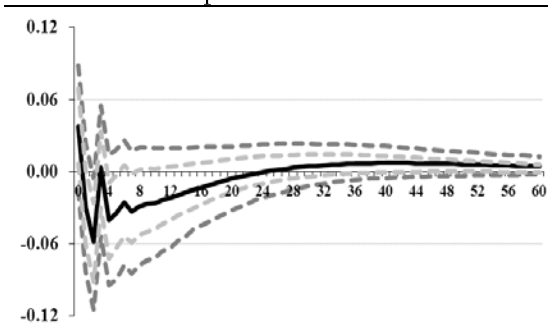


Contemporaneous/long-run restrictions

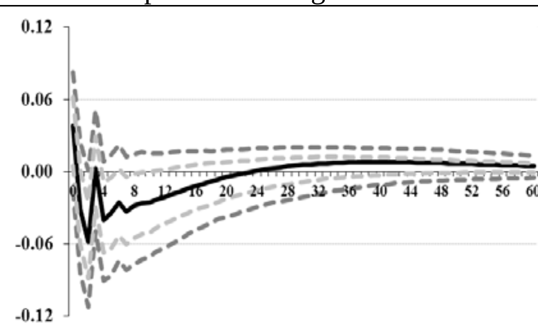


Panel H: Impulse DIPI, response RA

Contemporaneous restrictions

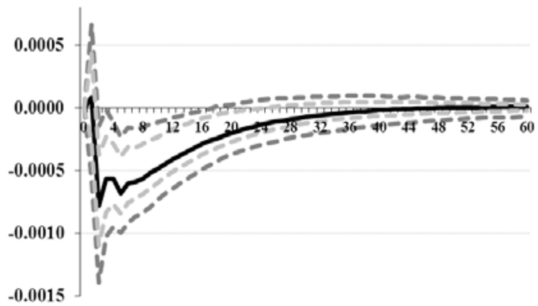


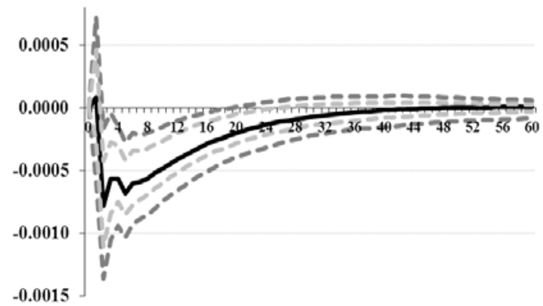
Contemporaneous/long-run restrictions



Panel I: Impulse UC, response DIPI

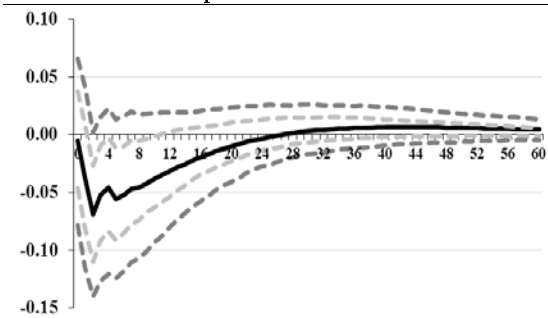
Contemporaneous restrictions | Contemporaneous/long-run restrictions

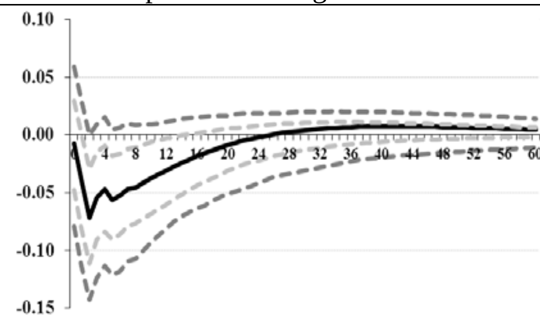




Panel J: Impulse DIPI, response UC

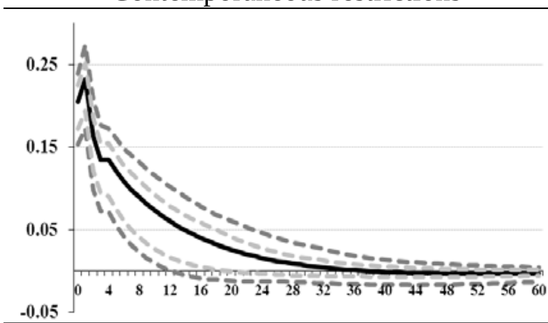
Contemporaneous restrictions | Contemporaneous/long-run restrictions

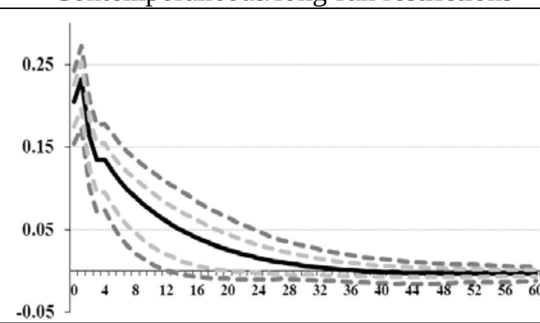




Panel K: Impulse RA, response UC

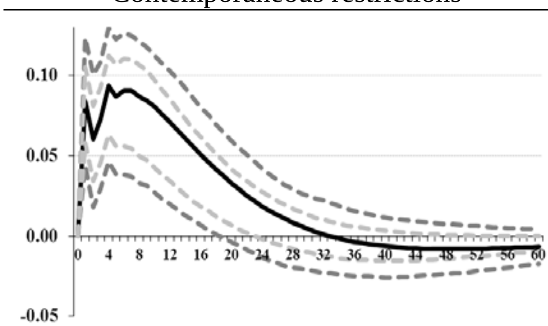
Contemporaneous restrictions | Contemporaneous/long-run restrictions

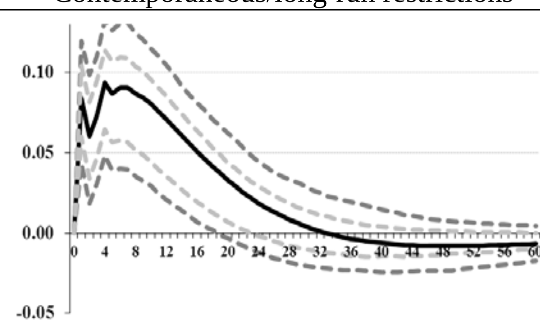




Panel L: Impulse UC, response RA

Contemporaneous restrictions | Contemporaneous/long-run restrictions



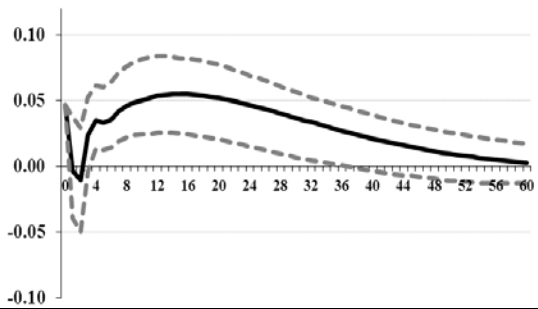


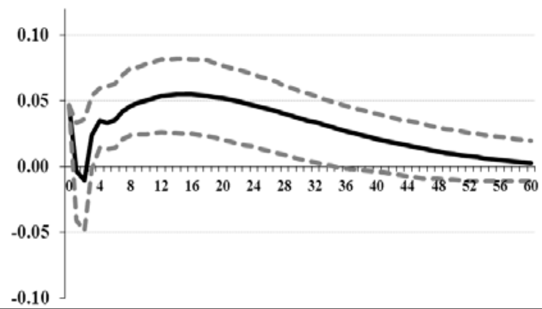
Notes: Estimated structural impulse-response functions (black lines) and 90% / 68% bootstrapped confidence intervals (dark / light grey dashed lines, respectively) for the 4-variable model (with the log-difference of industrial production (DIPI), real interest rate (RERA), log risk aversion (RA), and log uncertainty (UC)) with 3 lags (selected by Akaike), based on 1000 replications. Panels on the left present results of the model with contemporaneous restrictions, panels on the right present results of the model with contemporaneous/long-run restrictions. The sample period is January 1990 – August 2010.

Figure OA7: Identification using high-frequency futures

Panel A: Impulse RERA, response RA

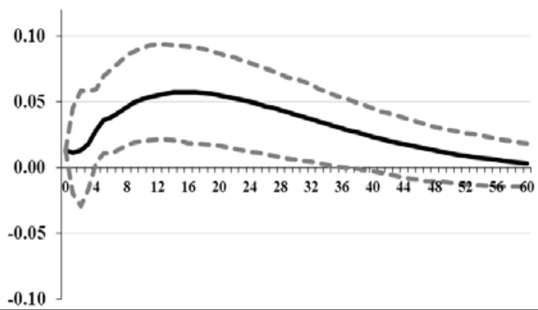
Model 3	Model 4

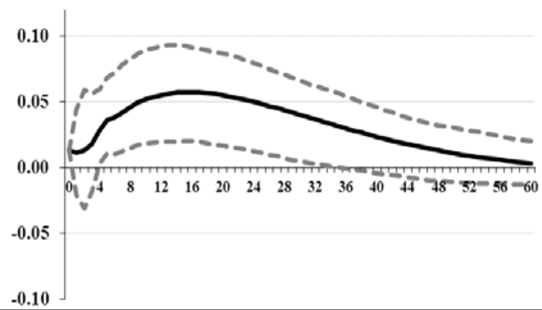




Panel B: Impulse RERA, response UC

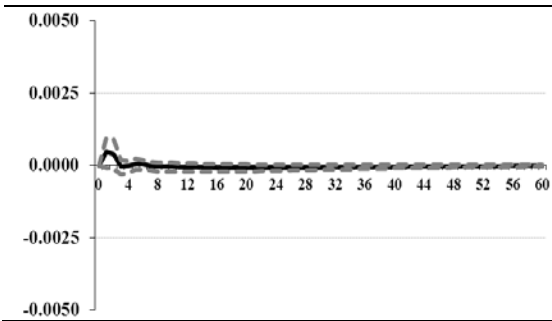
Model 3	Model 4

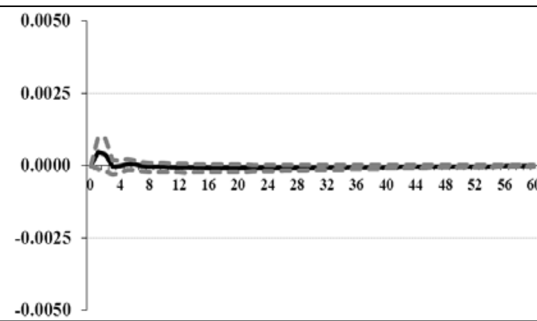




Panel C: Impulse RERA, response DIPI

Model 3	Model 4

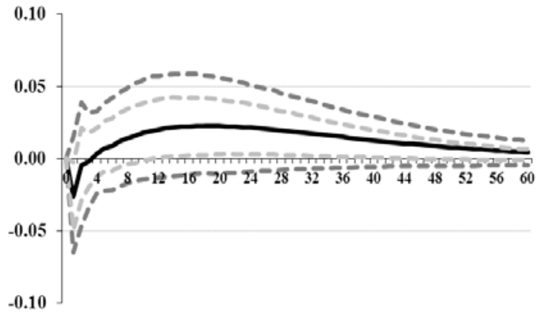
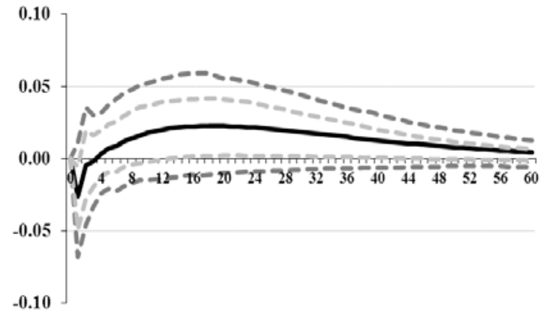




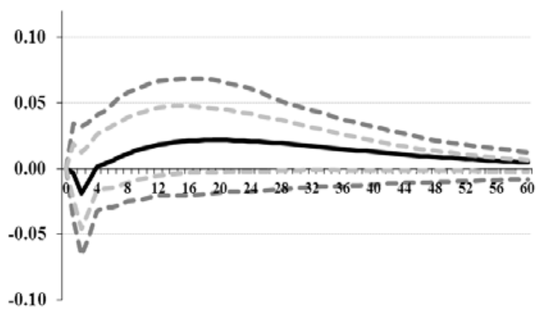
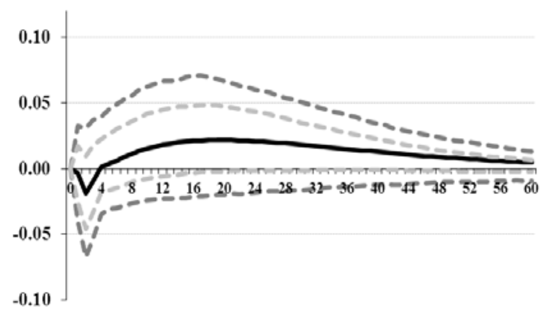
Notes: Estimated structural impulse-response functions (black lines) and 90% bootstrapped confidence intervals (grey dashed lines) for the 4-variable model (with the log-difference of industrial production (DIPI), real interest rate (RERA), log risk aversion (RA), and log uncertainty (UC)) with 3 lags (selected by the Akaike criterion), based on 1000 replications. Panels on the left present results of Model 3, panels on the right present results of Model 4. Both models assume zero contemporaneous responses of DIPI to the other variables. Model 3 (Model 4) assumes that monetary policy does not instantaneously react to RA (UC). The sample period is January 1990 – July 2007.

Figure OA8: Identification using high-frequency futures, Jan 1990 – Aug 2010

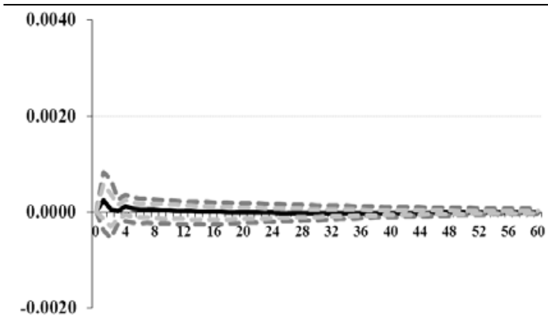
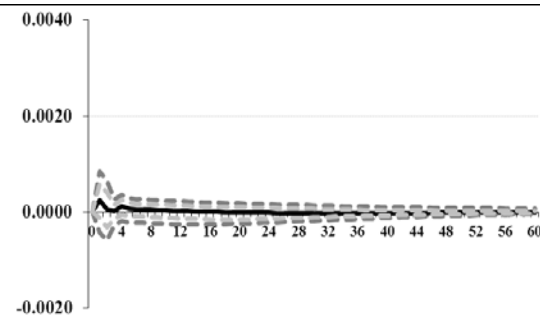
Panel A: Impulse RERA, response RA

Model 3	Model 4
	

Panel B: Impulse RERA, response UC

Model 3	Model 4
	

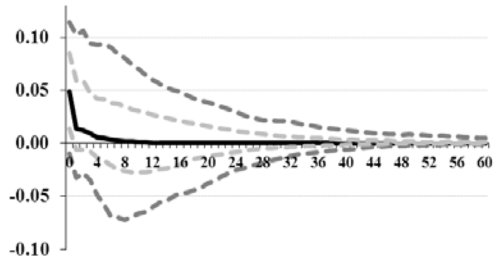
Panel C: Impulse RERA, response DIPI

Model 3	Model 4
	

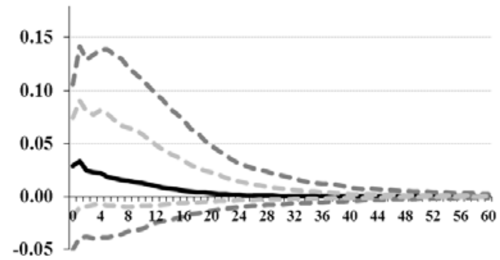
Notes: Estimated structural impulse-response functions (black lines) and 90% / 68% bootstrapped confidence intervals (dark / light grey dashed lines, respectively) for the 4-variable model (with the log-difference of industrial production (DIPI), real interest rate (RERA), log risk aversion (RA), and log uncertainty (UC)) with 3 lags, based on 1000 replications. Panels on the left present results of Model 3, panels on the right present results of Model 4. Both models assume zero contemporaneous responses of DIPI to the other variables. Model 3 (Model 4) assumes that monetary policy does not instantaneously react to RA (UC). The sample period is January 1990 – August 2010.

Figure OA9: Identification using monthly futures, Jan 1990 - Aug 2010

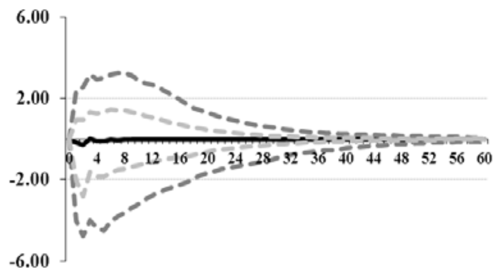
Panel A: Impulse MP, response RA



Panel B: Impulse MP, response UC



Panel C: Impulse MP, response DIPI



Notes: Estimated impulse-response functions (black lines) of the log risk aversion (RA), log uncertainty (UC) and log-difference of industrial production (DIPI) to "cleansed" monetary policy (MP) surprises computed using monthly futures following Bernanke and Kuttner (2005). Dark / light grey dashed lines are the 90% / 68% bootstrapped confidence intervals, respectively. The sample period is January 1990 – August 2010.