Online Appendix:
“State-Dependent Impulse Responses under Uncertainty”

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Abstract

This online appendix has two parts. Appendix A documents the data generating process parameters, describes the estimation methods used to recover the target impulse responses, and presents additional simulation results across shock sizes and transition rules. Appendix B provides supplementary empirical results.
Keywords: state-dependence; impulse response; misspecification; potential outcomes; local projections; vector autoregressions; uncertainty; inflation sensitivity.
JEL Classification: C22; C24; E31.

Appendix A Monte Carlo Simulation Results

Appendix A.1 Parameters used in the data generating process

The data generating process in Section 3, equation (8), uses parameter values estimated from the quarterly data used in Ramey and Zubairy (2018).

TVAR Expansion ($s = 1$) and recession ($s = 0$) regimes are defined by equation (9) in Section 3. Here, $A_i = C^{-1}B_{i,t-1}$ for $i = 1, \dots, p$.

$$C_E = \begin{bmatrix} 1 & 0 & 0 \\ 0.5276 & 1 & 0 \\ 0.2847 & 0.3167 & 1 \end{bmatrix}, C_R = \begin{bmatrix} 1 & 0 & 0 \\ 0.2264 & 1 & 0 \\ 0.0698 & 0.1616 & 1 \end{bmatrix}, k_E = \begin{bmatrix} 0.1274 \\ 0.1329 \\ 0.2294 \end{bmatrix}, k_R = \begin{bmatrix} 0.0401 \\ 0.0166 \\ 0.0443 \end{bmatrix},$$

$$A_{E,1} = \begin{bmatrix} 0.1518 & -0.2209 & -0.2900 \\ 0.0744 & 1.1803 & -0.0495 \\ 0.0718 & 0.0581 & 0.9717 \end{bmatrix}, A_{E,2} = \begin{bmatrix} 0.0850 & 0.4754 & 0.1571 \\ 0.1632 & -0.2914 & 0.0638 \\ 0.0417 & 0.0347 & -0.3235 \end{bmatrix},$$

$$A_{E,3} = \begin{bmatrix} -0.0406 & -0.3795 & 0.2344 \\ 0.0406 & -0.0572 & 0.1201 \\ -0.0284 & -0.0224 & 0.3219 \end{bmatrix}, A_{E,4} = \begin{bmatrix} -0.0323 & 0.1133 & -0.2194 \\ 0.0041 & 0.1254 & -0.1899 \\ 0.0121 & -0.0428 & -0.1408 \end{bmatrix},$$

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$$A_{R,1} = \begin{bmatrix} -0.0892 & 0.6558 & 0.3970 \\ 0.0549 & 0.8942 & 0.0025 \\ -0.0309 & 0.1851 & 1.1223 \end{bmatrix}, A_{R,2} = \begin{bmatrix} 0.2422 & -0.7420 & -0.0494 \\ 0.0791 & -0.1824 & 0.0463 \\ 0.0373 & -0.0804 & -0.1712 \end{bmatrix},$$

$$A_{R,3} = \begin{bmatrix} -0.0165 & 0.0396 & -0.2121 \\ -0.0912 & 0.1944 & -0.1357 \\ -0.0378 & -0.0564 & -0.0399 \end{bmatrix}, A_{R,4} = \begin{bmatrix} 0.2159 & 0.0072 & -0.1646 \\ 0.0276 & 0.0462 & 0.0865 \\ 0.0475 & -0.0379 & 0.0442 \end{bmatrix}.$$

MSVAR Expansion ($s = 1$) and recession ($s = 0$) regimes are selected by the equation (10) in Section 3. Here, $A_i = C^{-1} B_{i,t-1}$ and $i = 1, \dots, p$.

$$C_E = \begin{bmatrix} 1 & 0 & 0 \\ 0.5555 & 1 & 0 \\ 0.1534 & 0.0055 & 1 \end{bmatrix}, C_R = \begin{bmatrix} 1 & 0 & 0 \\ 0.1084 & 1 & 0 \\ 0.1112 & 0.1653 & 1 \end{bmatrix}, k_E = \begin{bmatrix} 0.0911 \\ 0.0730 \\ 0.0820 \end{bmatrix}, k_R = \begin{bmatrix} 0.0448 \\ 0.0330 \\ 0.0913 \end{bmatrix},$$

$$A_{E,1} = \begin{bmatrix} 0.2096 & 0.6415 & 0.0133 \\ 0.1113 & 0.6104 & -0.0292 \\ -0.0252 & 0.3811 & 1.1533 \end{bmatrix}, A_{E,2} = \begin{bmatrix} -0.2094 & 0.4334 & 0.0936 \\ -0.0801 & 0.2074 & 0.0377 \\ -0.0517 & -0.0990 & -0.2793 \end{bmatrix},$$

$$A_{E,3} = \begin{bmatrix} 0.0660 & -0.7831 & 0.0350 \\ -0.0438 & 0.1442 & -0.0002 \\ 0.0436 & -0.2491 & -0.0638 \end{bmatrix}, A_{E,4} = \begin{bmatrix} 0.2863 & -0.3480 & -0.2239 \\ -0.0076 & 0.0155 & -0.0271 \\ 0.0571 & 0.0116 & 0.1095 \end{bmatrix},$$

$$A_{R,1} = \begin{bmatrix} 0.3494 & 1.0109 & 0.0889 \\ 0.0149 & 1.5814 & 0.1652 \\ 0.0379 & 0.1779 & 1.2218 \end{bmatrix}, A_{R,2} = \begin{bmatrix} -0.1436 & -2.0090 & -0.1124 \\ 0.0543 & -0.6451 & -0.2571 \\ -0.0127 & -0.1440 & -0.3527 \end{bmatrix},$$

$$A_{R,3} = \begin{bmatrix} -0.0375 & 1.5200 & -0.0098 \\ -0.0435 & -0.0394 & 0.1517 \\ -0.0421 & 0.0165 & 0.1105 \end{bmatrix}, A_{R,4} = \begin{bmatrix} 0.0237 & -0.5220 & -0.0073 \\ 0.0117 & 0.0803 & -0.0837 \\ 0.0270 & -0.0270 & -0.0650 \end{bmatrix}.$$

Appendix A.2 Estimation methods for target impulse responses

This subsection provides more detail on the model specifications used in Section 3 to estimate the target impulse responses.

VAR-based approaches

1. **Plain VAR.** The standard VAR model, introduced by Sims (1980), estimates the reduced-form coefficients equation by equation using ordinary least squares (OLS). Structural impulse responses are then obtained by orthogonalizing the residuals and recursively applying the estimated system.

2. **Bias-corrected VAR** (abbreviated "BC VAR"). Following Pope (1990), bias correction adjusts the OLS VAR coefficients using an analytical approximation to the small-sample bias. The goal is to mitigate finite-sample distortions that are pronounced with persistent series or short samples. Identification is unchanged relative to the plain

VAR; impulse responses are computed from the bias-corrected reduced form using the same orthogonalization scheme.

3. **Bayesian VAR** (abbreviated "BVAR"). I estimate a Bayesian VAR with a Minnesota-type Normal-inverse-Wishart prior. The prior tightness hyperparameters follow the guidelines in Canova (2011), which recommend setting prior variances relative to the persistence and scale of each variable to control overparameterization in finite samples. The prior centers the coefficients on their own first lags and shrinks cross-variable and higher-order lag coefficients toward zero. Impulse responses are computed for each posterior draw using the same identification scheme as in the plain VAR, and I report posterior means based on 100 posterior draws.

LP-based approaches

1. **Plain LP** (abbreviated "LS LP"). Following Jordà (2005), local projections estimate horizon-specific regressions of the future outcome on the shock at time t and suitable controls (e.g., lags of variables). Each horizon is estimated separately by OLS, and the impulse response at horizon h is the coefficient on the shock in the h step regression.

2. **Bias-corrected LP** (abbreviated "BC LP"). Following Herbst and Johannsen (2024), I adjust the horizon-specific OLS LP coefficients using an analytical small sample bias correction. The correction addresses an order 1/T bias that can be sizable with persistent series or short samples, while leaving the shock definition and controls unchanged. Impulse responses are obtained from the bias-corrected coefficients, and inference is conducted using the same variance estimation approach as in the plain LP.

3. **Bayesian LP** (abbreviated "BLP"). Following Miranda-Agrippino and Ricco (2021), I estimate horizon-specific LP regressions in a Bayesian linear-regression framework. A conjugate Normal-inverse-Wishart prior is placed jointly on the regression coefficients and the disturbance covariance, yielding closed-form posterior updates at each horizon. The prior induces shrinkage that manages the trade off between bias and variance in small samples.

4. **Penalized LP** (abbreviated "Pen LP"). Following Barnichon and Brownlees (2019), I estimate LPs with a B-spline basis and a roughness penalty that smooths the impulse response across horizons. The penalty is applied to discrete second differences of the horizon profile, which reduces variance by shrinking toward a low-degree polynomial shape rather than toward zero. The smoothing parameter is selected by cross validation.

Appendix A.3 Additional results: alternative shock sizes (TVAR)

Tables A.1 to A.5 report the continuously ranked probability score (CRPS) for impulse responses obtained from the single estimators and the model averaging estimators in Appendix A.2 under a range of misspecifications when the true transition process is threshold and the shock size is $\delta \in \{5, 10, -1, -5, -10\}$ with $\sigma_1 = 1$. Values are averaged across regimes, dependent variables, and horizons and normalized by the CRPS of the plain VAR(4) under no misspecification for a shock size of $\delta = 1$.

Appendix A.4 Additional results: Markov-Switching VAR (MSVAR)

Tables A.6 to A.11 report CRPS values for impulse responses obtained from the single estimators and the model averaging estimators in Appendix A.2 under a range of misspecifications when the true transition process is Markov switching. The shock size is $\delta \in \{1, 5, 10, -1, -5, -10\}$ with $\sigma_1 = 1$. Values are averaged across regimes, dependent variables, and horizons, and normalized by the CRPS of the plain VAR(4) under no misspecification for a shock size of $\delta = 1$ with a threshold transition process. This common benchmark facilitates comparison across designs.

Table A.1: CRPS across simulation specifications, $\delta/\sigma_1 = 5$

Misspecification	True transition process: Threshold														
	VARs			**LPs**				$\mathbf{MAVG_{VAR}}$		$\mathbf{MAVG_{LP}}$		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	8.24	8.18	7.94	7.78	7.75	7.76	7.88	8.13	8.19	7.80	7.71	8.11	8.13	8.13	8.13
Transition process	9.31	9.31	9.12	8.86	8.87	8.80	8.95	9.25	9.31	8.88	8.78	9.23	9.25	9.24	9.24
State variable z	8.71	8.69	8.57	8.25	8.24	8.29	8.34	8.66	8.69	8.29	8.25	8.63	8.64	8.65	8.65
Lag order $p = 1$	7.63	7.56	7.57	7.80	7.76	7.88	7.88	7.59	7.57	7.84	7.85	7.67	7.65	7.74	7.72
Lag order $p = 6$	8.17	8.10	7.95	7.77	7.74	7.72	7.87	8.09	8.11	7.78	7.68	8.06	8.06	8.07	8.05
Transition process and z	9.58	9.59	9.62	9.19	9.21	9.22	9.27	9.60	9.60	9.23	9.18	9.56	9.54	9.59	9.56
Transition process and $p = 1$	9.01	9.00	8.93	8.80	8.80	8.93	8.88	8.98	9.00	8.87	8.89	9.02	9.04	9.08	9.11
Transition process and $p = 6$	9.23	9.22	9.11	8.85	8.86	8.75	8.94	9.19	9.22	8.86	8.74	9.17	9.16	9.17	9.14
State variable z and $p = 1$	8.28	8.25	8.24	8.33	8.32	8.48	8.41	8.26	8.25	8.40	8.45	8.31	8.31	8.41	8.42
State variable z and $p = 6$	8.59	8.57	8.52	8.24	8.23	8.26	8.33	8.57	8.58	8.27	8.21	8.55	8.53	8.56	8.53
Linear	9.77	9.81	9.15	9.51	9.54	9.35	9.56	9.62	9.80	9.47	9.36	9.61	9.74	9.62	9.72

This table shows the mean CRPS for each estimation method when the true model's transition process is threshold-based. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is TVAR(4). An incorrect transition occurs with the Markov-switching process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.2: CRPS across simulation specifications, $\delta/\sigma_1 = 10$

Misspecification	True transition process: Threshold														
	VARs			**LPs**				**MAVG$_{\mathbf{VAR}}$**		**MAVG$_{\mathbf{LP}}$**		$\boldsymbol{\alpha}_{\mathrm{LP,MSPE}}$		$\boldsymbol{\alpha}_{\mathrm{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	17.55	17.48	17.25	16.98	16.94	17.02	17.11	17.44	17.49	17.03	16.93	17.40	17.42	17.44	17.44
Transition process	18.60	18.59	18.40	18.05	18.06	18.03	18.16	18.54	18.59	18.09	17.99	18.51	18.53	18.53	18.52
State variable z	18.01	17.98	17.87	17.44	17.43	17.53	17.56	17.96	17.99	17.50	17.45	17.92	17.93	17.95	17.95
Lag order $p = 1$	16.89	16.81	16.82	17.00	16.96	17.11	17.11	16.84	16.82	17.06	17.06	16.93	16.91	17.02	17.01
Lag order $p = 6$	17.46	17.39	17.26	16.97	16.93	17.00	17.10	17.39	17.41	17.01	16.89	17.35	17.34	17.37	17.34
Transition process and z	18.85	18.86	18.89	18.34	18.36	18.43	18.45	18.87	18.86	18.41	18.34	18.83	18.80	18.86	18.82
Transition process and $p = 1$	18.25	18.24	18.16	17.99	17.99	18.14	18.09	18.21	18.23	18.07	18.09	18.26	18.28	18.33	18.35
Transition process and $p = 6$	18.50	18.49	18.38	18.04	18.04	18.00	18.15	18.47	18.49	18.07	17.94	18.44	18.43	18.45	18.41
State variable z and $p = 1$	17.52	17.48	17.47	17.52	17.51	17.68	17.63	17.49	17.48	17.60	17.64	17.57	17.57	17.67	17.68
State variable z and $p = 6$	17.88	17.86	17.83	17.43	17.42	17.51	17.55	17.87	17.86	17.49	17.41	17.84	17.81	17.85	17.82
Linear	18.62	18.63	18.22	18.21	18.23	17.99	18.23	18.52	18.62	18.16	18.04	18.47	18.54	18.49	18.54

This table shows the mean CRPS for each estimation method when the true model's transition process is threshold-based. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is TVAR(4). An incorrect transition occurs with the Markov-switching process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.3: CRPS across simulation specifications, $\delta/\sigma_1 = -1$

Misspecification	True transition process: Threshold														
	VARs			**LPs**				$\mathbf{MAVG_{VAR}}$		$\mathbf{MAVG_{LP}}$		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	2.02	2.03	2.47	2.06	2.08	2.23	2.00	2.16	2.04	2.08	2.22	2.13	2.07	2.11	2.08
Transition process	2.11	2.15	2.39	2.24	2.29	2.13	2.20	2.21	2.15	2.21	2.19	2.19	2.15	2.19	2.14
State variable z	1.94	1.95	2.25	2.02	2.04	2.04	1.97	2.04	1.96	2.01	2.08	2.02	1.97	2.01	1.98
Lag order $p = 1$	2.92	2.98	3.00	2.09	2.11	2.04	2.04	2.97	2.97	2.07	2.06	2.76	2.76	2.71	2.71
Lag order $p = 6$	1.98	2.00	2.45	2.06	2.08	2.31	2.00	2.12	2.01	2.09	2.26	2.10	2.04	2.09	2.07
Transition process and z	2.45	2.48	2.62	2.54	2.57	2.40	2.50	2.51	2.47	2.49	2.48	2.49	2.46	2.49	2.45
Transition process and $p = 1$	2.51	2.57	2.64	2.20	2.24	2.11	2.15	2.57	2.57	2.17	2.14	2.44	2.43	2.49	2.47
Transition process and $p = 6$	2.15	2.20	2.38	2.24	2.28	2.15	2.20	2.23	2.19	2.21	2.22	2.21	2.19	2.20	2.18
State variable z and $p = 1$	2.76	2.80	2.84	2.05	2.07	1.93	2.00	2.80	2.79	2.01	1.96	2.60	2.58	2.57	2.55
State variable z and $p = 6$	1.93	1.94	2.24	2.02	2.04	2.09	1.97	2.02	1.94	2.02	2.11	2.01	1.96	2.00	1.98
Linear	3.15	3.21	2.55	3.14	3.18	3.15	3.10	3.00	3.20	3.11	3.07	3.04	3.21	3.02	3.16

This table shows the mean CRPS for each estimation method when the true model's transition process is threshold-based. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is TVAR(4). An incorrect transition occurs with the Markov-switching process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.4: CRPS across simulation specifications, $\delta/\sigma_1 = -5$

Misspecification	True transition process: Threshold														
	VARs			**LPs**				$\mathbf{MAVG_{VAR}}$		$\mathbf{MAVG_{LP}}$		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	9.09	9.10	9.67	8.61	8.62	9.14	8.67	9.29	9.12	8.79	8.97	9.22	9.11	9.22	9.15
Transition process	8.07	8.06	8.52	7.82	7.82	8.19	7.84	8.22	8.07	7.93	8.10	8.18	8.09	8.18	8.13
State variable z	8.65	8.63	9.07	8.28	8.28	8.60	8.34	8.79	8.65	8.39	8.51	8.73	8.64	8.75	8.68
Lag order $p = 1$	10.22	10.27	10.30	8.65	8.67	8.66	8.70	10.27	10.27	8.68	8.65	10.00	10.00	9.97	9.97
Lag order $p = 6$	8.92	8.93	9.62	8.60	8.62	9.29	8.67	9.16	8.95	8.81	9.02	9.11	8.98	9.12	9.03
Transition process and z	8.00	7.96	8.21	7.63	7.60	7.91	7.67	8.06	7.96	7.72	7.79	8.01	7.95	8.04	7.99
Transition process and $p = 1$	8.93	8.94	9.05	7.89	7.89	7.75	7.92	8.97	8.94	7.86	7.79	8.78	8.75	8.77	8.73
Transition process and $p = 6$	8.00	7.98	8.50	7.82	7.82	8.32	7.84	8.16	7.99	7.96	8.16	8.13	8.04	8.14	8.09
State variable z and $p = 1$	9.64	9.65	9.70	8.23	8.22	8.10	8.28	9.66	9.65	8.21	8.13	9.40	9.38	9.39	9.36
State variable z and $p = 6$	8.56	8.54	9.07	8.28	8.28	8.73	8.34	8.72	8.55	8.43	8.57	8.68	8.57	8.70	8.62
Linear	8.53	8.50	9.34	8.27	8.27	9.28	8.29	8.73	8.52	8.51	9.06	8.74	8.65	8.72	8.65

This table shows the mean CRPS for each estimation method when the true model's transition process is threshold-based. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is TVAR(4). An incorrect transition occurs with the Markov-switching process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.5: CRPS across simulation specifications, $\delta/\sigma_1 = -10$

Misspecification	**True transition process: Threshold**														
	VARs			**LPs**				**MAVG$_{\text{VAR}}$**		**MAVG$_{\text{LP}}$**		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	18.41	18.41	19.00	17.76	17.77	18.37	17.86	18.61	18.43	17.97	18.14	18.53	18.40	18.54	18.46
Transition process	17.20	17.15	17.69	16.77	16.75	17.26	16.83	17.35	17.17	16.93	17.13	17.30	17.19	17.31	17.24
State variable z	17.94	17.91	18.36	17.40	17.38	17.79	17.48	18.07	17.93	17.53	17.64	18.01	17.91	18.03	17.96
Lag order $p = 1$	19.54	19.59	19.62	17.78	17.80	17.81	17.87	19.59	19.59	17.83	17.79	19.31	19.31	19.29	19.29
Lag order $p = 6$	18.21	18.22	18.94	17.75	17.76	18.54	17.85	18.46	18.23	18.00	18.20	18.40	18.25	18.42	18.31
Transition process and z	17.09	17.04	17.32	16.59	16.54	16.95	16.64	17.16	17.05	16.70	16.77	17.10	17.04	17.13	17.09
Transition process and $p = 1$	18.13	18.12	18.24	16.85	16.83	16.68	16.90	18.16	18.12	16.82	16.73	17.97	17.92	17.94	17.89
Transition process and $p = 6$	17.06	17.01	17.66	16.77	16.75	17.41	16.83	17.25	17.03	16.97	17.20	17.22	17.08	17.23	17.15
State variable z and $p = 1$	18.92	18.93	18.98	17.32	17.31	17.20	17.39	18.95	18.93	17.31	17.22	18.69	18.66	18.67	18.64
State variable z and $p = 6$	17.82	17.79	18.36	17.39	17.38	17.93	17.47	17.99	17.80	17.57	17.71	17.95	17.82	17.97	17.87
Linear	17.74	17.71	18.60	17.31	17.30	18.50	17.35	17.96	17.73	17.62	18.22	17.95	17.86	17.94	17.87

This table shows the mean CRPS for each estimation method when the true model's transition process is threshold-based. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is TVAR(4). An incorrect transition occurs with the Markov-switching process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.6: CRPS across simulation specifications, $\frac{\delta}{\sigma_1} = 1$

Misspecification	True transition process: Markov-switching														
	VARs			**LPs**				$\mathbf{MAVG_{VAR}}$		$\mathbf{MAVG_{LP}}$		$\boldsymbol{\alpha}_{\mathrm{LP,MSPE}}$		$\boldsymbol{\alpha}_{\mathrm{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	7.32	7.42	7.85	6.85	6.94	7.12	6.93	7.54	7.42	6.89	7.10	7.50	7.42	7.46	7.42
Transition process	5.52	5.52	5.75	5.35	5.38	5.42	5.42	5.60	5.54	5.41	5.42	5.60	5.55	5.60	5.55
State variable z	7.53	7.64	7.97	7.02	7.11	7.26	7.10	7.72	7.63	7.15	7.24	7.67	7.61	7.64	7.61
Lag order $p = 1$	8.24	8.39	8.35	6.92	7.01	7.01	6.99	8.32	8.38	7.00	7.03	8.19	8.25	8.02	8.25
Lag order $p = 6$	7.21	7.30	7.82	6.82	6.91	7.17	6.90	7.45	7.29	6.97	7.10	7.42	7.30	7.37	7.32
Transition process and state variable z	7.02	7.09	7.40	6.55	6.62	6.76	6.65	7.18	7.09	6.66	6.71	7.15	7.08	7.13	7.07
Transition process and lag order $p = 1$	6.91	7.00	6.91	5.82	5.86	5.58	5.87	6.94	6.97	5.78	5.66	6.81	6.82	6.74	6.72
Transition process and lag order $p = 6$	5.54	5.54	5.80	5.34	5.36	5.64	5.40	5.63	5.56	5.40	5.42	5.62	5.56	5.61	5.56
State variable z and lag order $p = 1$	8.06	8.18	8.21	7.16	7.25	7.24	7.23	8.15	8.17	7.24	7.28	8.05	8.08	7.97	8.00
State variable z and lag order $p = 6$	7.42	7.52	7.95	7.01	7.10	7.32	7.10	7.64	7.51	7.16	7.27	7.60	7.51	7.57	7.53
Linear	5.38	5.41	4.78	5.02	5.04	4.76	5.08	5.23	5.40	4.96	4.79	5.23	5.34	5.21	5.26

This table shows the mean CRPS for each estimation method when the true model's transition process is Markov-switching. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is MSVAR(4). An incorrect transition occurs with the threshold process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.7: CRPS across simulation specifications, $\frac{\delta}{\sigma_1} = 5$

Misspecification	True transition process: Markov-switching														
	VARs			**LPs**				**MAVG$_{\text{VAR}}$**		**MAVG$_{\text{LP}}$**		$\alpha_{\text{LP,MSPE}}$		$\alpha_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	27.93	28.03	28.46	27.43	27.52	27.71	27.52	28.15	28.03	27.57	27.69	28.12	28.03	28.07	28.03
Transition process	26.13	26.13	26.37	25.84	25.87	25.94	25.93	26.21	26.15	25.91	25.92	26.21	26.15	26.21	26.16
State variable z	28.15	28.25	28.58	27.61	27.70	27.85	27.70	28.33	28.24	27.74	27.83	28.29	28.22	28.25	28.22
Lag order $p = 1$	28.85	29.00	28.96	27.51	27.60	27.60	27.58	28.94	28.99	27.59	27.61	28.81	28.86	28.64	28.86
Lag order $p = 6$	27.82	27.91	28.43	27.40	27.49	27.76	27.49	28.06	27.91	27.56	27.68	28.03	27.91	27.99	27.93
Transition process and state variable z	27.64	27.70	28.02	27.09	27.16	27.33	27.20	27.79	27.70	27.22	27.26	27.76	27.69	27.74	27.69
Transition process and lag order $p = 1$	27.52	27.61	27.53	26.33	26.37	26.09	26.40	27.55	27.58	26.31	26.17	27.43	27.43	27.35	27.33
Transition process and lag order $p = 6$	26.14	26.14	26.41	25.81	25.84	25.98	25.91	26.24	26.16	25.91	25.92	26.22	26.16	26.22	26.16
State variable z and lag order $p = 1$	28.67	28.79	28.83	27.75	27.84	27.83	27.83	28.76	28.79	27.83	27.87	28.66	28.69	28.58	28.61
State variable z and lag order $p = 6$	28.03	28.14	28.56	27.60	27.69	27.92	27.69	28.25	28.12	27.75	27.86	28.21	28.12	28.19	28.14
Linear	24.70	24.68	24.55	24.11	24.09	23.86	24.15	24.67	24.68	24.06	23.91	24.62	24.62	24.59	24.54

This table shows the mean CRPS for each estimation method when the true model's transition process is Markov-switching. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is MSVAR(4). An incorrect transition occurs with the threshold process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.8: CRPS across simulation specifications, $\frac{\delta}{\sigma_1} = 10$

Misspecification	True transition process: Markov-switching														
	VARs			**LPs**				$\textbf{MAVG}_{\textbf{VAR}}$		$\textbf{MAVG}_{\textbf{LP}}$		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	53.62	53.72	54.15	53.10	53.19	53.39	53.18	53.83	53.72	53.24	53.36	53.80	53.72	53.75	53.72
Transition process	51.81	51.81	52.05	51.47	51.50	51.58	51.57	51.90	51.83	51.55	51.55	51.89	51.84	51.90	51.85
State variable z	53.83	53.93	54.27	53.28	53.37	53.53	53.37	54.01	53.92	53.41	53.50	53.97	53.91	53.94	53.91
Lag order $p = 1$	54.53	54.68	54.64	53.17	53.27	53.27	53.25	54.62	54.67	53.26	53.28	54.49	54.54	54.32	54.54
Lag order $p = 6$	53.50	53.59	54.11	53.06	53.15	53.44	53.15	53.74	53.59	53.23	53.35	53.71	53.60	53.67	53.61
Transition process and state variable z	53.32	53.39	53.70	52.73	52.80	52.98	52.85	53.47	53.39	52.86	52.90	53.44	53.37	53.42	53.37
Transition process and lag order $p = 1$	53.21	53.29	53.21	51.97	52.02	51.73	52.05	53.24	53.27	51.95	51.81	53.11	53.12	53.03	53.02
Transition process and lag order $p = 6$	51.82	51.82	52.09	51.44	51.47	51.62	51.54	51.92	51.84	51.54	51.55	51.90	51.84	51.90	51.84
State variable z and lag order $p = 1$	54.36	54.47	54.51	53.42	53.52	53.51	53.50	54.45	54.47	53.51	53.54	54.35	54.37	54.26	54.30
State variable z and lag order $p = 6$	53.72	53.82	54.25	53.27	53.36	53.60	53.36	53.94	53.81	53.43	53.53	53.90	53.80	53.87	53.82
Linear	50.38	50.36	50.23	49.67	49.65	49.43	49.73	50.35	50.36	49.64	49.49	50.30	50.30	50.27	50.22

This table shows the mean CRPS for each estimation method when the true model's transition process is Markov-switching. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is MSVAR(4). An incorrect transition occurs with the threshold process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.9: CRPS across simulation specifications, $\frac{\delta}{\sigma_1} = -1$

Misspecification	True transition process: Markov-switching														
	VARs			**LPs**				**MAVG$_{\mathbf{VAR}}$**		**MAVG$_{\mathbf{LP}}$**		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	5.13	5.24	5.21	4.77	4.83	4.73	4.78	5.20	5.22	4.79	4.76	5.18	5.19	5.14	5.15
Transition process	4.51	4.54	4.53	4.19	4.20	4.24	4.19	4.53	4.53	4.21	4.23	4.49	4.49	4.47	4.48
State variable z	4.73	4.81	4.78	4.37	4.41	4.26	4.38	4.78	4.80	4.37	4.33	4.75	4.76	4.73	4.74
Lag order $p = 1$	5.17	5.27	5.19	4.85	4.91	4.87	4.86	5.21	5.26	4.88	4.87	5.21	5.25	5.24	5.25
Lag order $p = 6$	4.99	5.08	5.16	4.77	4.83	4.70	4.78	5.08	5.07	4.77	4.75	5.06	5.05	5.04	5.01
Transition process and state variable z	3.69	3.71	3.74	3.43	3.42	3.47	3.45	3.71	3.71	3.45	3.44	3.70	3.69	3.69	3.69
Transition process and lag order $p = 1$	4.72	4.78	4.77	4.57	4.59	4.67	4.56	4.76	4.76	4.61	4.64	4.77	4.79	4.82	4.85
Transition process and lag order $p = 6$	4.38	4.41	4.49	4.18	4.18	4.20	4.18	4.42	4.40	4.19	4.21	4.40	4.39	4.38	4.37
State variable z and lag order $p = 1$	4.72	4.79	4.72	4.52	4.56	4.42	4.52	4.74	4.77	4.51	4.47	4.74	4.76	4.75	4.76
State variable z and lag order $p = 6$	4.64	4.72	4.77	4.36	4.40	4.20	4.38	4.72	4.71	4.34	4.32	4.69	4.68	4.67	4.65
Linear	5.42	5.44	5.59	5.07	5.09	5.78	5.09	5.46	5.44	5.25	5.54	5.47	5.48	5.45	5.52

This table shows the mean CRPS for each estimation method when the true model's transition process is Markov-switching. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is MSVAR(4). An incorrect transition occurs with the threshold process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.10: CRPS across simulation specifications, $\frac{\delta}{\sigma_1} = -5$

Misspecification	True transition process: Markov-switching														
	VARs			**LPs**				**MAVG$_{\text{VAR}}$**		**MAVG$_{\text{LP}}$**		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	22.76	22.75	22.63	22.43	22.40	22.47	22.48	22.72	22.75	22.46	22.45	22.72	22.74	22.70	22.72
Transition process	23.99	23.98	24.00	23.49	23.45	23.71	23.56	23.99	23.98	23.57	23.66	23.95	23.95	23.94	23.96
State variable z	22.64	22.61	22.50	22.28	22.24	22.31	22.34	22.59	22.62	22.31	22.29	22.59	22.61	22.58	22.60
Lag order $p = 1$	22.34	22.31	22.31	22.45	22.42	22.41	22.50	22.32	22.32	22.45	22.40	22.39	22.38	22.47	22.38
Lag order $p = 6$	22.64	22.63	22.59	22.44	22.41	22.51	22.49	22.63	22.64	22.47	22.47	22.63	22.64	22.63	22.63
Transition process and state variable z	22.57	22.51	22.50	22.18	22.12	22.29	22.27	22.53	22.52	22.23	22.24	22.52	22.51	22.53	22.53
Transition process and lag order $p = 1$	23.42	23.39	23.47	23.33	23.30	23.39	23.38	23.43	23.41	23.36	23.38	23.46	23.46	23.50	23.50
Transition process and lag order $p = 6$	23.79	23.77	23.94	23.46	23.43	23.72	23.54	23.84	23.78	23.55	23.65	23.81	23.77	23.81	23.81
State variable z and lag order $p = 1$	22.18	22.11	22.08	22.32	22.29	22.30	22.37	22.13	22.12	22.33	22.28	22.22	22.20	22.27	22.25
State variable z and lag order $p = 6$	22.55	22.51	22.51	22.28	22.24	22.31	22.34	22.54	22.53	22.30	22.28	22.53	22.52	22.53	22.51
Linear	25.27	25.27	25.93	24.78	24.79	25.91	24.84	25.44	25.28	25.10	25.61	25.44	25.36	25.41	25.45

This table shows the mean CRPS for each estimation method when the true model's transition process is Markov-switching. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is MSVAR(4). An incorrect transition occurs with the threshold process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Table A.11: CRPS across simulation specifications, $\frac{\delta}{\sigma_1} = -10$

Misspecification	True transition process: Markov-switching														
	VARs			**LPs**				**$\mathbf{MAVG_{VAR}}$**		**$\mathbf{MAVG_{LP}}$**		$\boldsymbol{\alpha}_{\text{LP,MSPE}}$		$\boldsymbol{\alpha}_{\text{LP,RS}}$	
	Plain	BC	Bayes	Plain	BC	Bayes	Pen.	GMA	CVA	GMA	CVA	GMA	CVA	GMA	CVA
None	48.02	47.96	47.82	47.64	47.57	47.70	47.70	47.94	47.97	47.67	47.65	47.94	47.96	47.93	47.94
Transition process	49.51	49.48	49.51	48.90	48.85	49.18	48.99	49.50	49.48	49.00	49.10	49.46	49.45	49.45	49.46
State variable z	47.97	47.89	47.79	47.56	47.49	47.64	47.64	47.89	47.91	47.60	47.57	47.89	47.90	47.89	47.89
Lag order $p = 1$	47.53	47.44	47.48	47.66	47.60	47.60	47.72	47.48	47.46	47.65	47.59	47.57	47.54	47.64	47.54
Lag order $p = 6$	47.90	47.84	47.81	47.64	47.58	47.75	47.71	47.86	47.86	47.69	47.68	47.87	47.86	47.86	47.85
Transition process and state variable z	48.03	47.94	47.94	47.56	47.48	47.69	47.65	47.98	47.96	47.61	47.62	47.97	47.95	47.97	47.96
Transition process and lag order $p = 1$	48.81	48.75	48.84	48.73	48.68	48.78	48.79	48.80	48.77	48.76	48.76	48.85	48.83	48.88	48.88
Transition process and lag order $p = 6$	49.28	49.25	49.45	48.87	48.83	49.20	48.96	49.34	49.26	48.99	49.09	49.31	49.25	49.31	49.29
State variable z and lag order $p = 1$	47.56	47.45	47.43	47.59	47.53	47.58	47.66	47.48	47.46	47.60	47.55	47.57	47.54	47.61	47.58
State variable z and lag order $p = 6$	47.87	47.80	47.81	47.55	47.49	47.65	47.63	47.84	47.82	47.60	47.56	47.84	47.82	47.83	47.81
Linear	50.72	50.72	51.46	50.17	50.18	51.41	50.22	50.92	50.73	50.53	51.07	50.92	50.82	50.89	50.92

This table shows the mean CRPS for each estimation method when the true model's transition process is Markov-switching. I compute the overall CRPS as the average over all horizons, dependent variables, and regimes. All values divided by CRPS of plain VAR(4) under a threshold transition process at $\delta = 1$ (benchmark = 1). The true model is MSVAR(4). An incorrect transition occurs with the threshold process. The incorrect state variable is uncorrelated with the true z_t. Linear displays CRPS when I compute the true non-linear model with LSVAR(4).

Appendix B Additional Empirical Results

This appendix reports additional empirical results for uncertainty shocks. For monetary policy shocks, the responses are statistically insignificant and do not differ across states.

Appendix B.1 Good vs. Bad inflation: GIRF

Figure B.1 reports impulse response results when the VAR(12) specification is replaced with the generalized impulse response function (GIRF), which measures impulse responses as causal effects under the potential outcome framework.

Good vs. Bad inflation regimes:
The impact of the uncertainty shock, GIRF

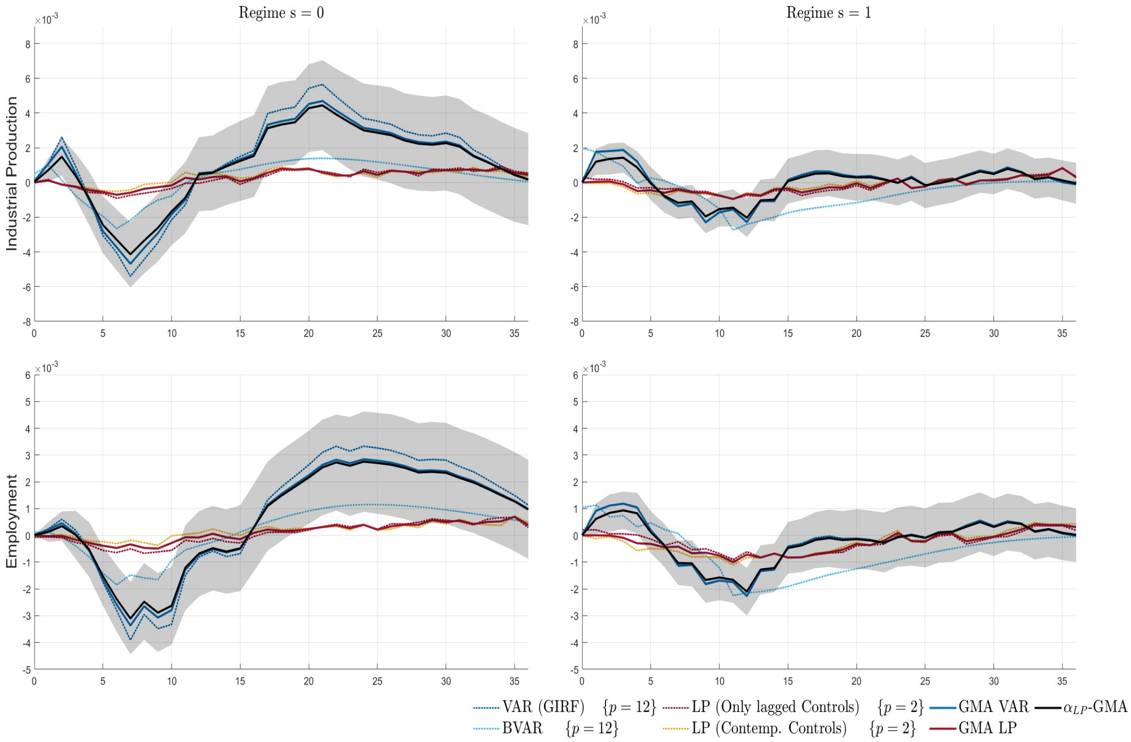
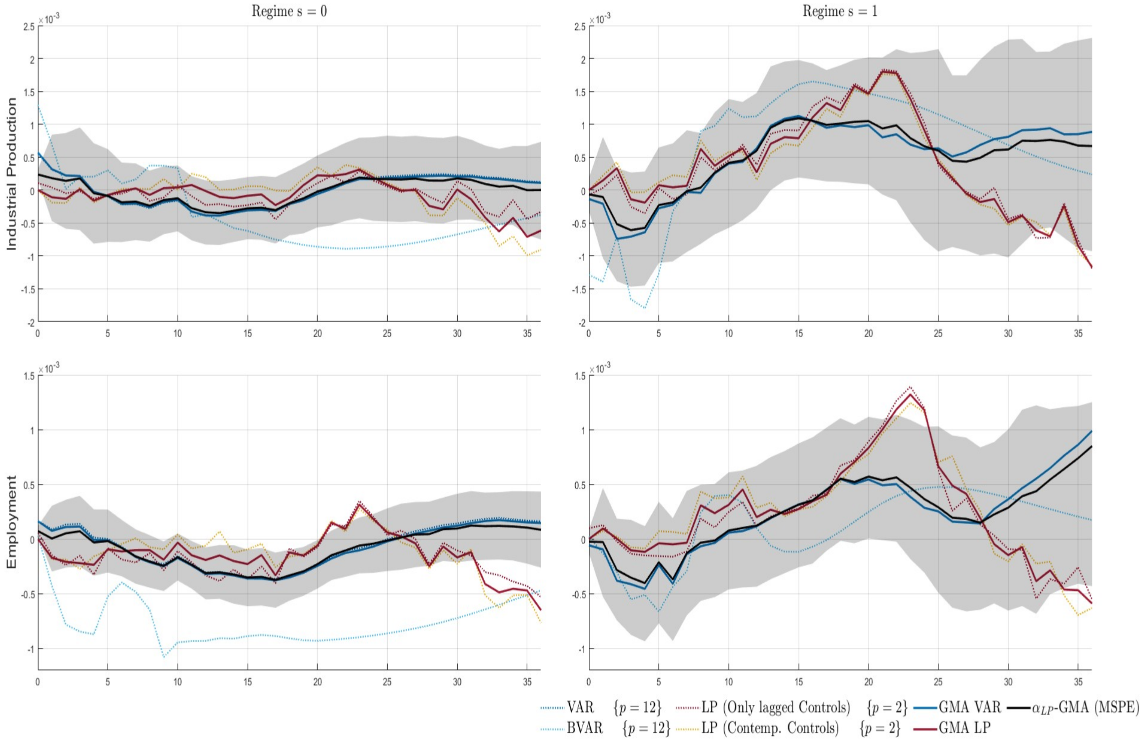


Figure B.1: Impulse responses of industrial production and employment for an uncertainty shock when $s = 1$ (good inflation) and $s = 0$ (bad inflation). VAR(12) is replaced with GIRF. Shaded areas show 68% bands from the $\alpha_{\text{LP,MSPE}}$-GMA estimator.

Appendix B.2 Anchored vs. Unanchored expectations: GIRF and households vs. professionals

Figure B.2 reports impulse responses when the transition variable is the interquartile range (IQR) from the Michigan Survey of Consumers' household responses and from the Survey of Professional Forecasters. The sample spans July 1981 to June 2008. Figure B.3 reports impulse response results when VAR (12) specification is replaced with GIRF.

Anchored vs. Unanchored expectation regimes:
The impact of the uncertainty shock, Households



The impact of the uncertainty shock, Professionals

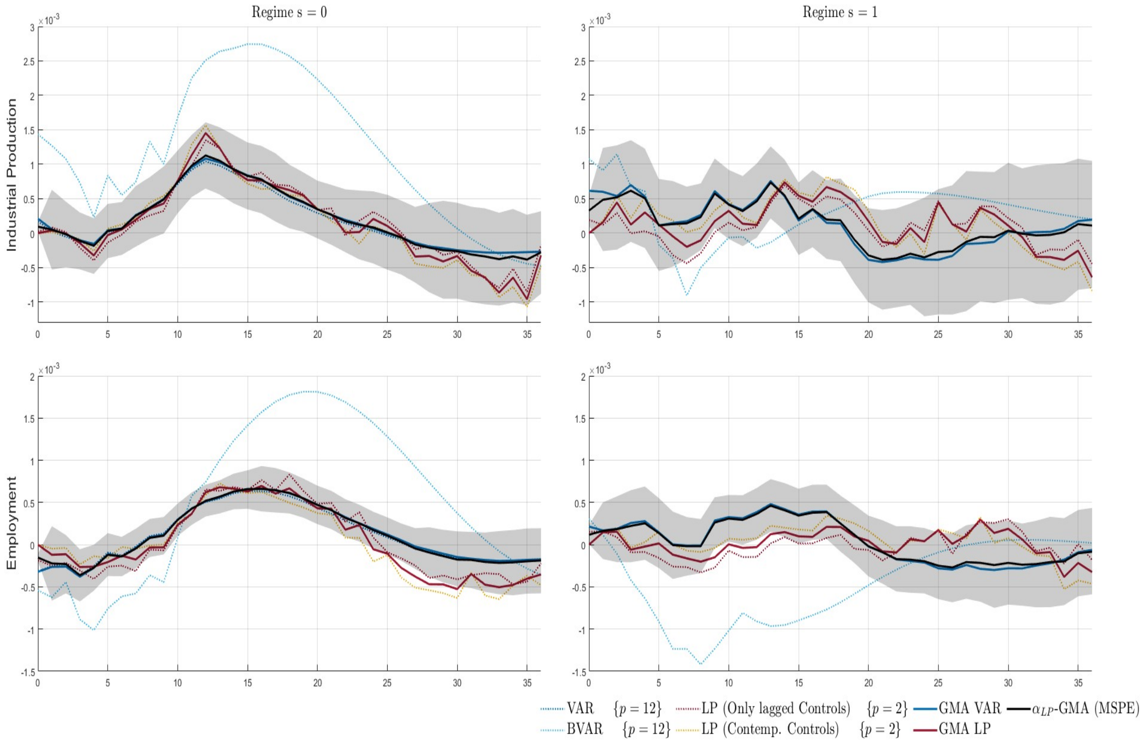


Figure B.2: Impulse responses of industrial production and employment for an uncertainty shock when $s = 1$ (anchored expectation) and $s = 0$ (unanchored expectation). VAR(12) is replaced with GIRF. Shaded areas show 68% bands from the $\alpha_{\mathrm{LP,MSPE}}$-GMA estimator.

Anchored vs. Unanchored expectation regimes:
The impact of the uncertainty shock, GIRF

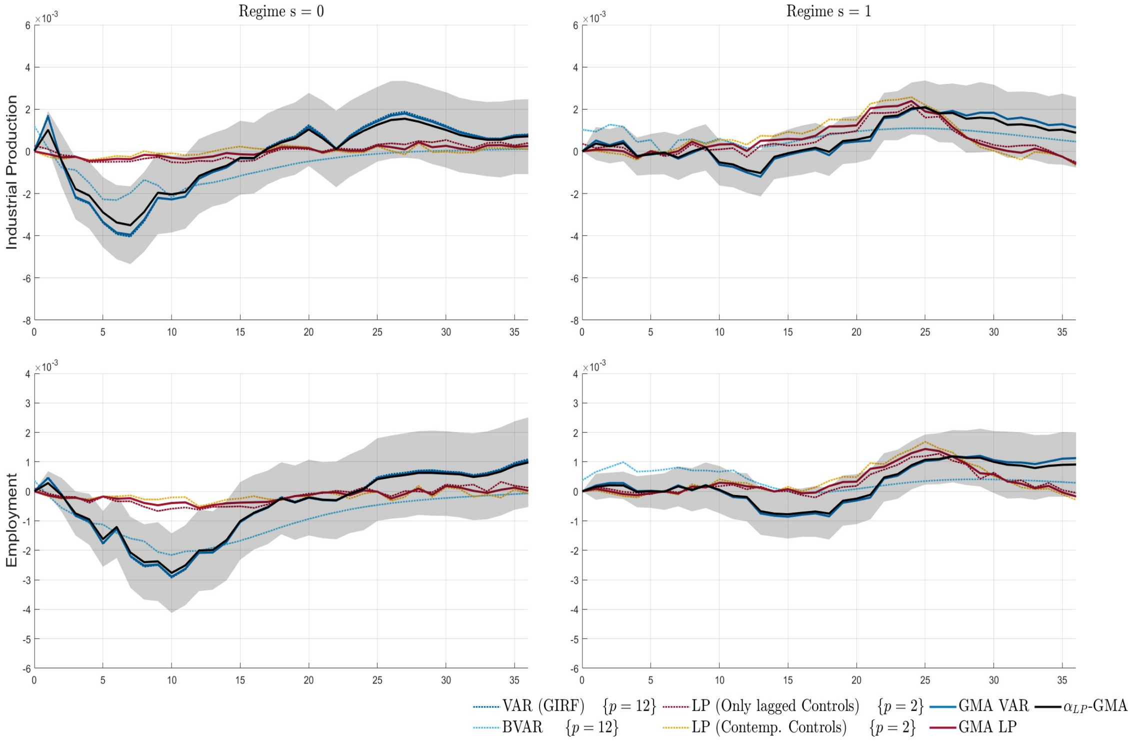


Figure B.3: Impulse responses of industrial production and employment across horizons when $s = 1$ (anchored expectation) and $s = 0$ (unanchored expectation) under uncertainty shock. Shaded areas denote 68% bands from the $\alpha_{\mathrm{LP,MSPE}}$-GMA estimator.

Appendix B.3 Low vs. High inflation volatility: GIRF

Figure B.4 reports impulse response results when VAR (12) specification is replaced with GIRF.

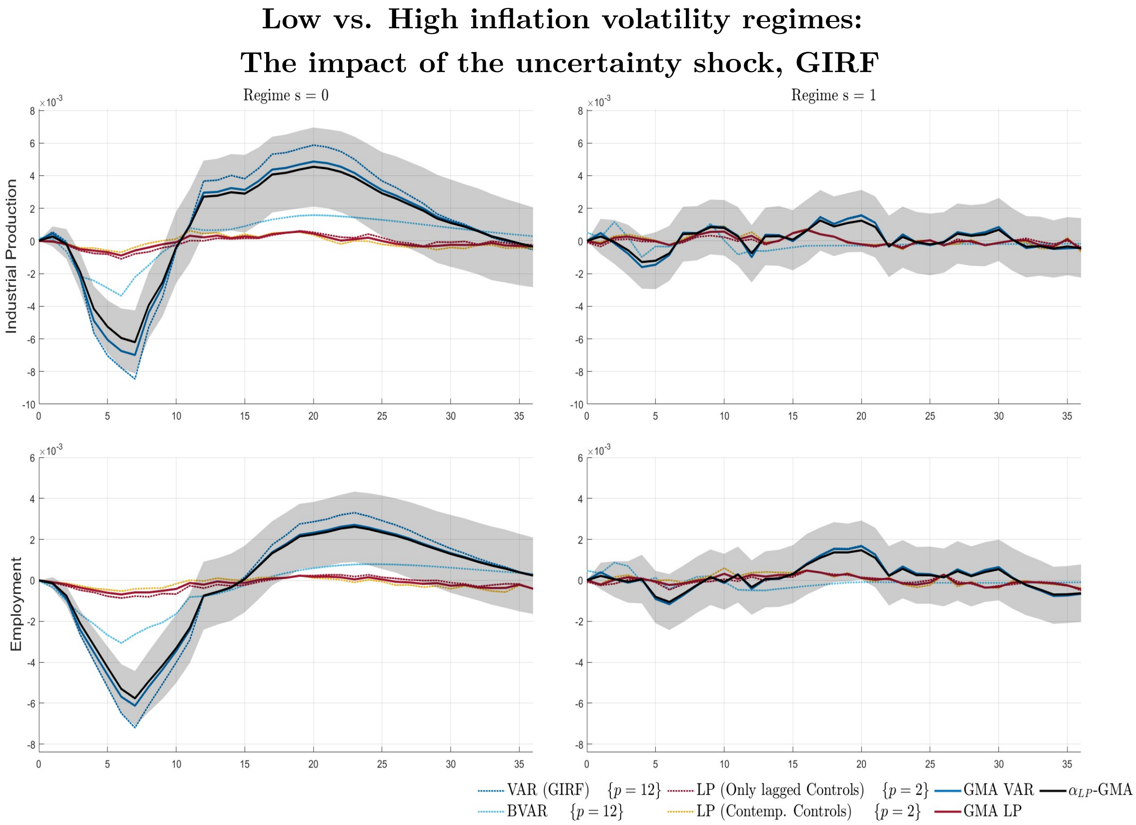


Figure B.4: Impulse responses of industrial production and employment for an uncertainty shock when $s = 1$ (low volatility) and $s = 0$ (high volatility). VAR(12) is replaced with GIRF. Shaded areas show 68% bands from the $\alpha_{\mathrm{LP,MSPE}}$-GMA estimator.

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