

Reduced-form factor augmented VAR - Exploiting sparsity to include meaningful factors

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Webappendix

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W1 Posterior distributions

W1.1 The factor loadings λ^*

To simplify notation let $\lambda^* = [\lambda^{*f} \quad \lambda^{*Y}]$ and $\mathcal{F}_t^* = [f_t^{*f} \quad Y_t^*]'$. The first step to get the posterior for the factor loadings $\pi(\lambda_{ij}^* | \mathcal{F}^{*T}, X^T, Y^T, \Psi(L), \Omega)$ is to integrate out the variable specific prior probability of zero loading for each factor j . The prior described above implies a common base rate of non-zero factor loading of $E(\beta_{ij}) = \rho_j b$ across variables. The marginal distribution then becomes

$$\pi(\lambda_{ij}^* | \rho_j, \tau_j) \sim (1 - \rho_j b) \delta_0(\lambda_{ij}^*) + \rho_j b N(0, \tau_j)$$

To isolate the effect of factor j on variable i we transform the variables to

$$x_{it}^* = \psi_i(L)x_{it} - \sum_{l=1, l \neq j}^{k+m} \lambda_{il}^* \psi_i(L) \mathcal{F}_{jt}^* + \varepsilon_{it}$$

Now we combine the marginal prior with data to sample independently across i from

$$\begin{aligned} \pi(\lambda_{ij}^* | \cdot) &= \prod_{t=q+1}^T \pi(x_{it}^* | \cdot) \{ (1 - \rho_j b) \delta_0(\lambda_{ij}^*) + \rho_j b N(0, \tau_j) \} \\ &= P(\lambda_{ij}^* = 0 | \cdot) \delta_0(\lambda_{ij}^*) + P(\lambda_{ij}^* \neq 0 | \cdot) N(m_{ij}, M_{ij}) \end{aligned}$$

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with observation density $\pi(x_{it}^*|\cdot) = N(\lambda_{ij}^*\psi_i(L)\mathcal{F}_{jt}^*, \omega_i^2)$ and where

$$M_{ij} = \left(\frac{1}{\omega_i^2} \sum_{t=q+1}^T (\psi_i(L)f_{jt}^*)^2 + \frac{1}{\tau_j} \right)^{-1}, \quad m_{ij} = M_{ij} \left(\frac{1}{\omega_i^2} \sum_{t=q+1}^T (\psi_i(L)f_{jt}^*)x_{it}^* \right)$$

To obtain the posterior odds $P(\lambda_{ij}^* \neq 0|\cdot)/P(\lambda_{ij}^* = 0|\cdot)$ the prior odds of the non-zero factor loading are updated:

$$\frac{P(\lambda_{ij}^* \neq 0|\cdot)}{P(\lambda_{ij}^* = 0|\cdot)} = \frac{\pi(\lambda_{ij}^*)|_{\lambda_{ij}^*=0} \rho_j b}{\pi(\lambda_{ij}^*|\cdot)|_{\lambda_{ij}^*=0} 1 - \rho_j b} = \frac{N(0; 0, \tau_j) \rho_j b}{N(0; m_{ij}, M_{ij}) 1 - \rho_j b}$$

Conditional on λ_{ij}^* , we obtain an update of hyperparameters β_{ij} , ρ_j and τ_j :

$$\pi(\beta_{ij}|\lambda_{ij}^*, \rho_j) = \frac{1 - \rho_j}{1 - b\rho_j} I\{\lambda_{ij}^* = 0\} \delta_0(\beta_{ij}) + \left(1 - \frac{1 - \rho_j}{1 - b\rho_j} I\{\lambda_{ij}^* = 0\} \right) B(\bar{a}_{ij}, \bar{b}_{ij})$$

with $\bar{a}_{ij} = ab + I\{\lambda_{ij}^* \neq 0\}$, $\bar{b}_{ij} = a(1 - b) + I\{\lambda_{ij}^* = 0\}$

$$\pi(\rho_j|\beta_{.j}) = B(r_{1j}, r_{2j}), \quad r_{1j} = r_0 s_0 + S_j, \quad r_{2j} = r_0(1 - s_0) + N - S_j, \quad S_j = \sum_i I\{\beta_{ij} \neq 0\}$$

$$\pi(\tau_j|\lambda_{.j}^*) = IG(g_j, G_j), \quad g_j = g_0 + 0.5 \sum_i I\{\lambda_{ij}^* \neq 0\}, \quad G_j = G_0 + 0.5 \sum_i \lambda_{ij}^{*2}$$

W1.2 The idiosyncratic components

The posterior simulation of the parameters is divided in two blocks. The dynamics of the idiosyncratic components $\psi_i = (\psi_{i1}, \dots, \psi_{iq})'$ are sampled individually.

$$\pi(\psi_i|X_i, \mathcal{F}^*, \theta_{-\Psi}) = N(q_i, Q_i), \quad i = 1, \dots, N$$

where

$$\begin{aligned} Q_i &= \left(\omega_i^{-2} \tilde{X}_i^{-'} \tilde{X}_i^- + Q_0^{-1} \right)^{-1} \\ q_i &= Q_i \left(\sigma_i^{-2} \tilde{X}_i^{-'} \tilde{X} + Q_0^{-1} q_0 \right) \\ \tilde{X}_i &= \begin{bmatrix} X_{iq+1} - \lambda_i^* \mathcal{F}_{q+1}^* \\ \vdots \\ X_{iT} - \lambda_i^* \mathcal{F}_T^* \end{bmatrix} \\ \tilde{X}_i^- &= \begin{bmatrix} X_{iq} - \lambda_i^* \mathcal{F}_q^* & \cdots & X_{i1} - \lambda_i^* \mathcal{F}_1^* \\ \vdots & & \vdots \\ X_{iT-1} - \lambda_i^* \mathcal{F}_{T-1}^* & \cdots & X_{iT-q} - \lambda_i^* \mathcal{F}_{T-q}^* \end{bmatrix} \end{aligned}$$

The variance of the idiosyncratic component, ω_i^2 , is simulated from independent inverse Gamma distributions $IG(u_i, U_i)$, $i = 1, \dots, N$ with $u_i = u_0 + 0.5(T - p)$ and $U_i = U_0 + 0.5(\tilde{X}_i - \tilde{X}_i^- \psi_i)'(\tilde{X}_i - \tilde{X}_i^- \psi_i)$.

W1.3 The parameters for the factor dynamics

The dynamics of the unobserved factors f_t^* and observed variables Y_t are jointly sampled from

$$\pi(\text{vec}(\Phi^{*'})|X, \mathcal{F}^*, \Sigma^*) = N(p, P)I_{\{Z(\Phi^*) > 1\}}$$

where

$$P = ([I_{k+m} \otimes f^{*-}]'[I_{k+m} \otimes f^{*-}] + P_0^{-1})^{-1}$$

$$p = P ([I_{k+m} \otimes f^{*-}]'\text{vec}(f^*) + P_0^{-1}p_0)$$

where $f^* = [\mathcal{F}_{p+1}^*, \dots, \mathcal{F}_T^*]'$ and

$$f^{*-} = \begin{bmatrix} \mathcal{F}_p^{*'} & \dots & \mathcal{F}_1^{*'} \\ \vdots & & \vdots \\ \mathcal{F}_{T-1}^{*'} & \dots & \mathcal{F}_{T-p}^{*'} \end{bmatrix}$$

W1.4 The error covariance matrix of factors Σ^*

We depart from the assumption of independent factor innovations and allow for a full covariance matrix Σ^* . To achieve factor normalization for the unobserved factors, the first k diagonal elements of Σ^* are restricted to one. Hence, we need to adapt the sampler to allow for this step. Following Conti et al. (2014) we rely on marginal data augmentation techniques and temporarily expand the parameter space of the model with the variances of the unobserved latent factors as working parameters when it comes to sampling Σ^* . Using the decomposition $\hat{\Sigma} = V^{\frac{1}{2}}\Sigma^*V^{\frac{1}{2}}$, any covariance matrix can be decomposed into two parts, a correlation matrix Σ^* and a matrix V that contains the variances on its diagonal. Assuming a hierarchical inverse Wishart prior distribution $\hat{\Sigma}|S \sim IW(\nu, S)$, the joint distribution of V and S can be factored as $p(V, S|\Sigma^*) = p(V|S, \Sigma^*)p(S)$, and it can be shown that each diagonal element of V , v_j , follows an inverse Gamma distribution

$$v_j|\Sigma^*, s_j \sim IG\left(\frac{\nu}{2}, \frac{s_j\sigma_j^{*-}}{2}\right)$$

where s_j and σ_j^{*-} are the j th diagonal elements of, respectively, S and Σ^{*-1} . For S we impose the Huang and Wand (2013) prior as in Conti et al. (2014), hence S is a nonsingular diagonal matrix with its non-zero elements following a Gamma distribution¹

$$s_j \sim G\left(\frac{1}{2}, \frac{1}{2\nu^*C_j^2}\right)$$

Since we only normalize the unobserved factors and keep the original scale of observed factors Y_t we separate V into two blocks,

$$V = \begin{bmatrix} V^f & 0 \\ 0 & V^Y \end{bmatrix} \text{ with } V^Y = I_m.$$

¹Parameterized as $\nu^* = \nu - k + 1$ and $E(s_j) = \nu^*C_j^2$.

At iteration (m), we proceed as follows:

(i) Sample V_{prior}^f from (W1.4) and (W1.4), set $V_{prior} = \begin{bmatrix} V_{prior}^f & 0 \\ 0 & I_m \end{bmatrix}$.

(ii) Expand the model

$$\begin{aligned}\hat{f}_t^{(m)} &= V_{prior}^{f\frac{1}{2}} f_t^{*(m)}, \quad \hat{\lambda}^{f(m)} = \lambda^{*f(m)} V_{prior}^{f-\frac{1}{2}} \\ \hat{\Phi}_l^{(m)} &= V_{prior}^{\frac{1}{2}} \Phi_l^{*(m)} V_{prior}^{-\frac{1}{2}} \text{ for } l = 1, \dots, p\end{aligned}$$

In this expanded model the residuals are distributed as $\hat{\eta}_t^{(m)} \sim N(0, \hat{\Sigma}^{(m)})$ with

$$\hat{\Sigma}^{(m)} = V_{prior}^{\frac{1}{2}} \Sigma^{*(m)} V_{prior}^{\frac{1}{2}}$$

(iii) Update the covariance matrix

$$\hat{\Sigma}^{(m)} | S \sim IW \left(\nu + 0.5(T - p), S + 0.5 \sum_{t=p+1}^T \hat{\eta}_t^{(m)} \hat{\eta}_t^{(m)'} \right)$$

and update the working parameter to $V_{post} = \begin{bmatrix} V_{post}^f & 0 \\ 0 & I_m \end{bmatrix}$, with diagonal elements in V_{post}^f equal to the first k diagonal elements of $\hat{\Sigma}^{(m)}$.

(iv) Transform back to the identified model

$$\begin{aligned}f_t^{*(m)} &\leftarrow V_{post}^{f-\frac{1}{2}} \hat{f}_t^{(m)}, \quad \lambda^{*f(m)} \leftarrow \hat{\lambda}^{f(m)} V_{post}^{f\frac{1}{2}} \\ \Phi_l^{*(m)} &\leftarrow V_{post}^{-\frac{1}{2}} \hat{\Phi}_l^{(m)} V_{post}^{\frac{1}{2}}, \quad l = 1, \dots, p \\ \Sigma^{*(m)} &= V_{post}^{-\frac{1}{2}} \hat{\Sigma}^{(m)} V_{post}^{-\frac{1}{2}}\end{aligned}$$

W2 Choosing the number of factors, convergence

Table W2.1: DIC and marginal likelihood

Number of factors	3	4	5	6	7	8	9	10	11	12	13
$\text{DIC}(k)_2 (\times 10^4)$	5.99	5.67	5.48	5.27	5.09	4.87	4.75	4.58	4.47	4.43	4.35
p_D	73.08	87.37	260.15	189.86	298.25	192.93	284.23	280.61	283.43	448.46	645.19
$\text{DIC}(k)_3 (\times 10^4)$	6.00	5.67	5.47	5.27	5.09	4.88	4.75	4.60	4.48	4.43	4.34
p_D	101.61	123.25	197.77	251.53	357.42	356.09	273.92	449.76	395.47	521.73	518.39
$\text{DIC}(k+1)/\text{DIC}(k)$.95	.96	.96	.97	.96	.97	.97	.97	.99	.98
$\hat{\pi}(\tilde{\mathbf{X}}) (\times 10^4)$	-3.24	-3.10	-2.89	-2.59	-2.48	-2.26	-2.12	-1.93	-1.83	-1.70	-1.57
$(k+1)/k$.96	.93	.90	.96	.91	.94	.91	.95	.93	.92

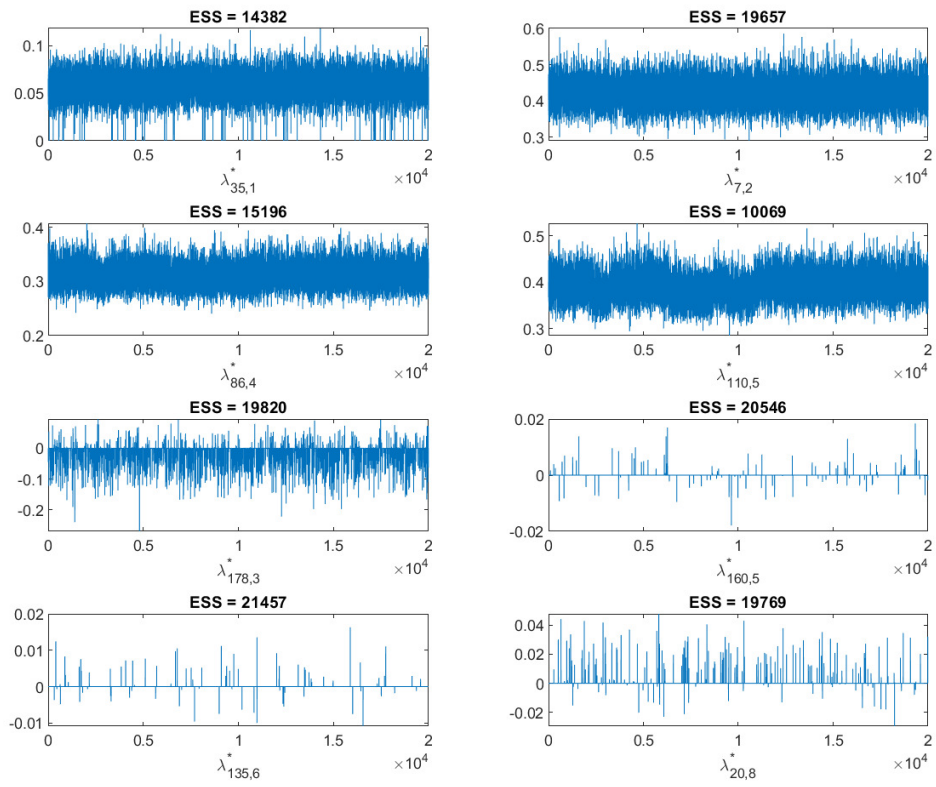


Figure W2.1: Convergence: Retained posterior draws of selected factor loadings with effective sample size (ESS).

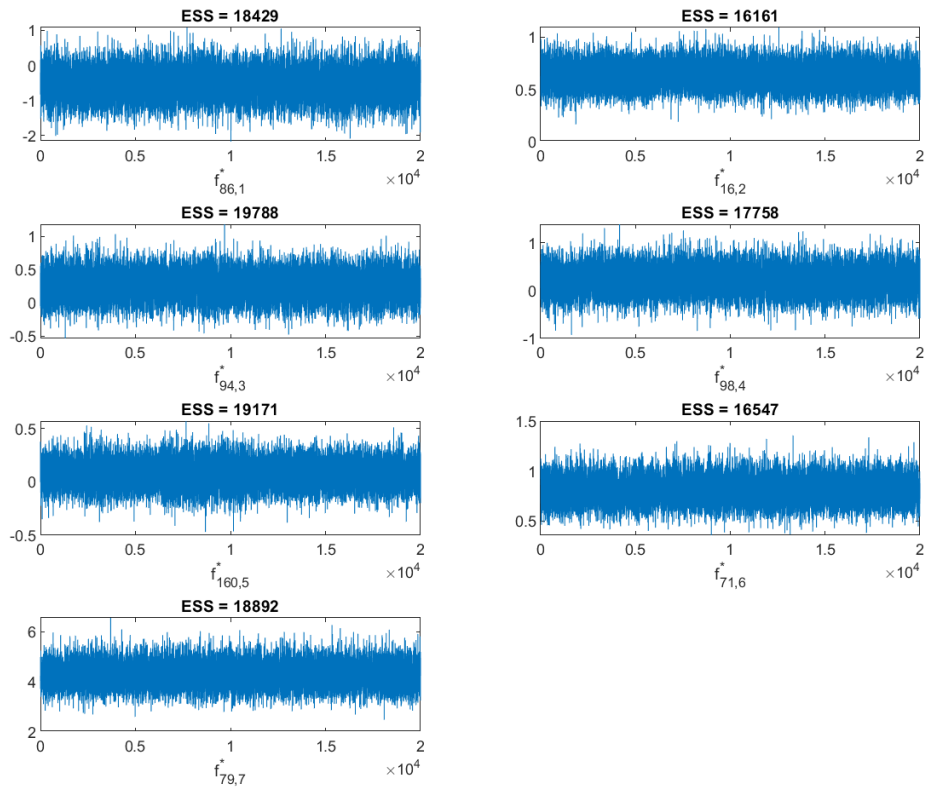


Figure W2.2: Convergence: Retained posterior draws of selected factors with effective sample size (ESS).

W3 Additional results: 1959Q1-2007Q3

Table W3.1: Series most correlated with unobserved factors, correlation coefficient in brackets.

Factor 1	USGOOD (0.96) USPRIV (0.95) MANEMP (0.93) HOANBS (0.93) PAYEMS (0.92) DMANEMP (0.92) INDPRO (0.92) IPMANSICS (0.92) HOABS (0.91) IPMAT (0.88) IPFINAL (0.87) IPDMAT (0.85) IPBUSEQ (0.84) USTPU (0.83) NDMANEMP (0.81)
Factor 2	USWTRADE (0.72) SRVPRD (0.71) USTPU (0.69) PAYEMS (0.66) A014RE1Q156NBEA (0.65) USPRIV (0.64) CUMFNS (0.62) USPBS (0.62) BUSINV _x (0.59) USGOOD (0.56) DMANEMP (0.56) BUSLOANS _x (0.55) MANEMP (0.53) USTRADE (0.53) USSERV (0.53)
Factor 3	PERMIT (0.93) HOUST (0.9) PERMITS (0.87) PERMITW (0.83) HOUSTS (0.82) HOUSTW (0.78) PERMITMW (0.77) PRFI _x (0.72) PERMITNE (0.63) HOUST5F (0.63) HOUSTMW (0.62) M2REAL (0.59) MZMREAL (0.55) T5YFFM (0.53) M1REAL (0.52)
Factor 4	PCEPILFE (0.99) DSERRG3Q086SBEA (0.97) DHCERG3Q086SBEA (0.96) GDPCTPI (0.95) IPDBS (0.94) PCECTPI (0.93) CPILFESL (0.92) DDURRG3Q086SBEA (0.89) DHLCRG3Q086SBEA (0.86) CUSR0000SAD (0.86) CUSR0000SAS (0.86) DFDHRG3Q086SBEA (0.86) CPIAUCSL (0.86) DFSARG3Q086SBEA (0.85) CPIULFSL (0.85)
Factor 5	DNDGRG3Q086SBEA (0.98) CUSR0000SAC (0.96) DGDSRG3Q086SBEA (0.94) CUSR0000SA0L2 (0.93) WPSFD49502 (0.89) WPSFD49207 (0.88) CPITRNSL (0.88) CUSR0000SA0L5 (0.87) CPIAUCSL (0.86) PPIIDC (0.86) PPIACO (0.84) DGOERG3Q086SBEA (0.83) PCECTPI (0.82) WPSID61 (0.81) CPIULFSL (0.81)
Factor 6	OPHPBS (0.93) OPHNFB (0.91) OUTBS (0.75) GDPC1 (0.75) OUTNFB (0.73) TFP (0.51) GPDIC1 (0.5) UNLPNBS (0.49) PCECC96 (0.48) PCDG _x (0.47) PRFI _x (0.37) IPB51110SQ (0.36) IPDCONGD (0.35) PCND _x (0.35) CMRMTSPL _x (0.33)
Factor 7	GS1TB3M _x (0.75) T5YFFM (0.71) GS10TB3M _x (0.65) AAFFM (0.52) TB6M3M _x (0.51) GS10 (0.44) AAA (0.44) BAA (0.43) GS5 (0.39) COMPAPFF (0.39) TB3SMFFM (0.39) PERMITS (0.38) HOUSTS (0.36) PERMIT (0.35) HOUST (0.34)
Factor 8	FEDFUNDS (1) TB3MS (0.99) TB6MS (0.98) GS1 (0.97) GS5 (0.9) GS10 (0.85) AAA (0.8) BAA (0.79) CPILFESL (0.75) CUSR0000SAS (0.71) DHLCRG3Q086SBEA (0.71) PCEPILFE (0.71) DHCERG3Q086SBEA (0.71) DSERRG3Q086SBEA (0.7) CPF3MTB3M _x (0.66)

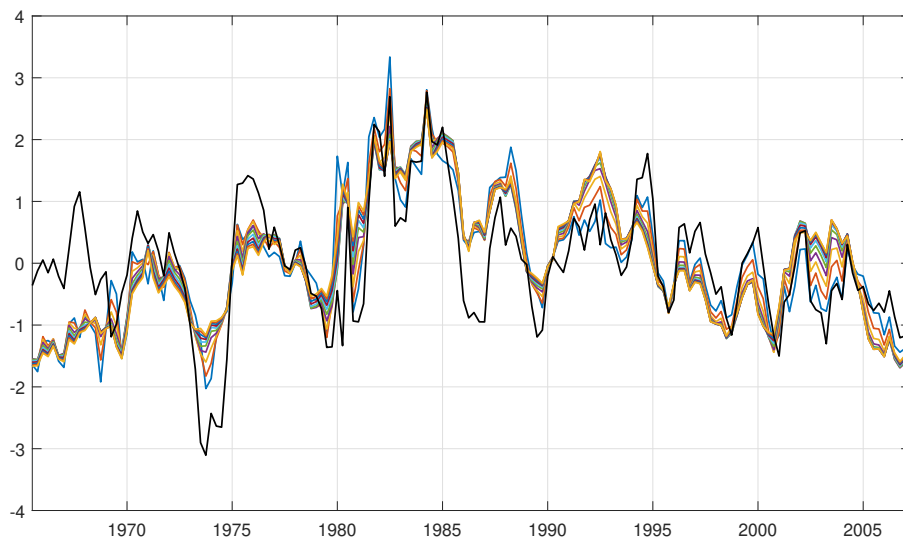


Figure W3.1: The figure plots the median of the term premium factor (in black) against different measures of the term premium for government bonds available on the website of the Federal Reserve Bank of New York. For expositional convenience, all series including the factor have been standardized.

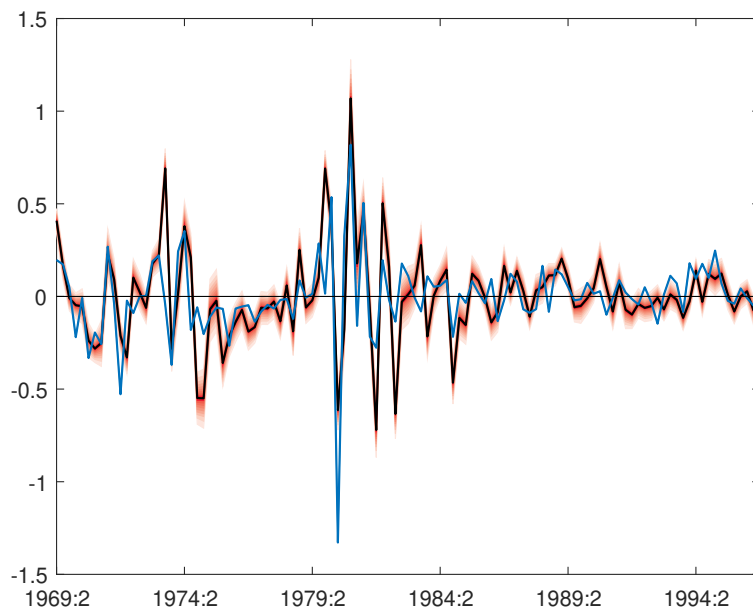


Figure W3.2: Identified monetary policy shock against Romer and Romer (2004) monetary shock (blue line).

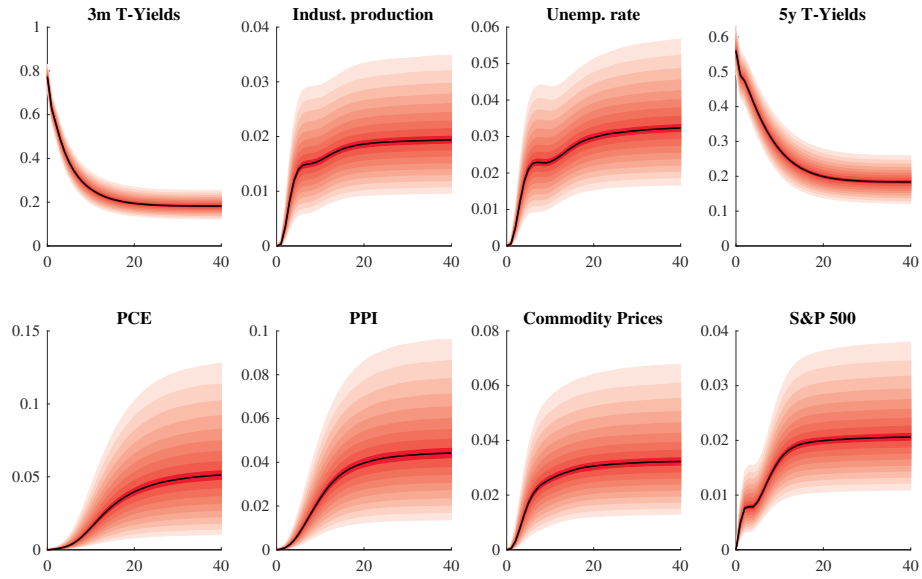


Figure W3.3: Share of the forecast error variance in selected variables explained by the FFR shock.

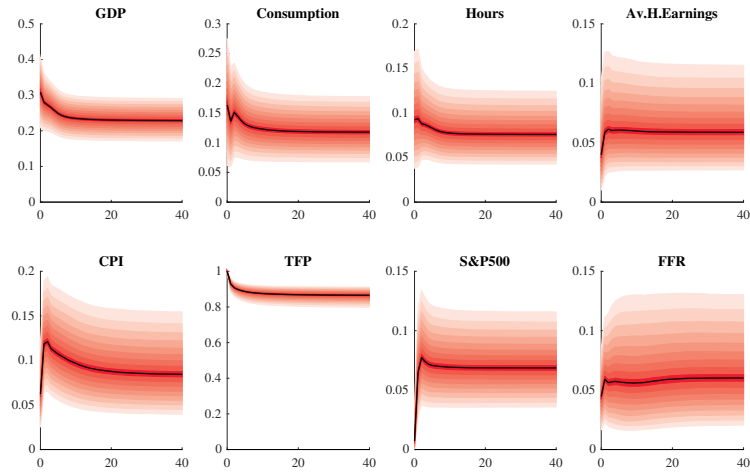


Figure W3.4: Share of the forecast error variance in selected variables explained by the technology shock.

W4 Additional results: 2007Q4-2019Q4

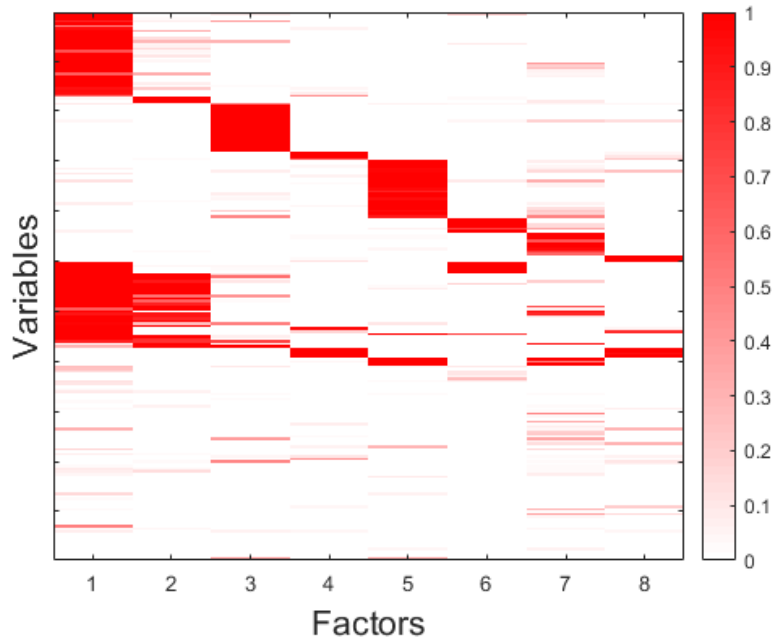


Figure W4.1: Posterior probabilities of a non-zero factor loading for the post-crisis sample. The loadings are sorted such that variables loading only on the first factor are ordered first, followed by those that load only on Factor 2 and on Factors 1 and 2 and so on.

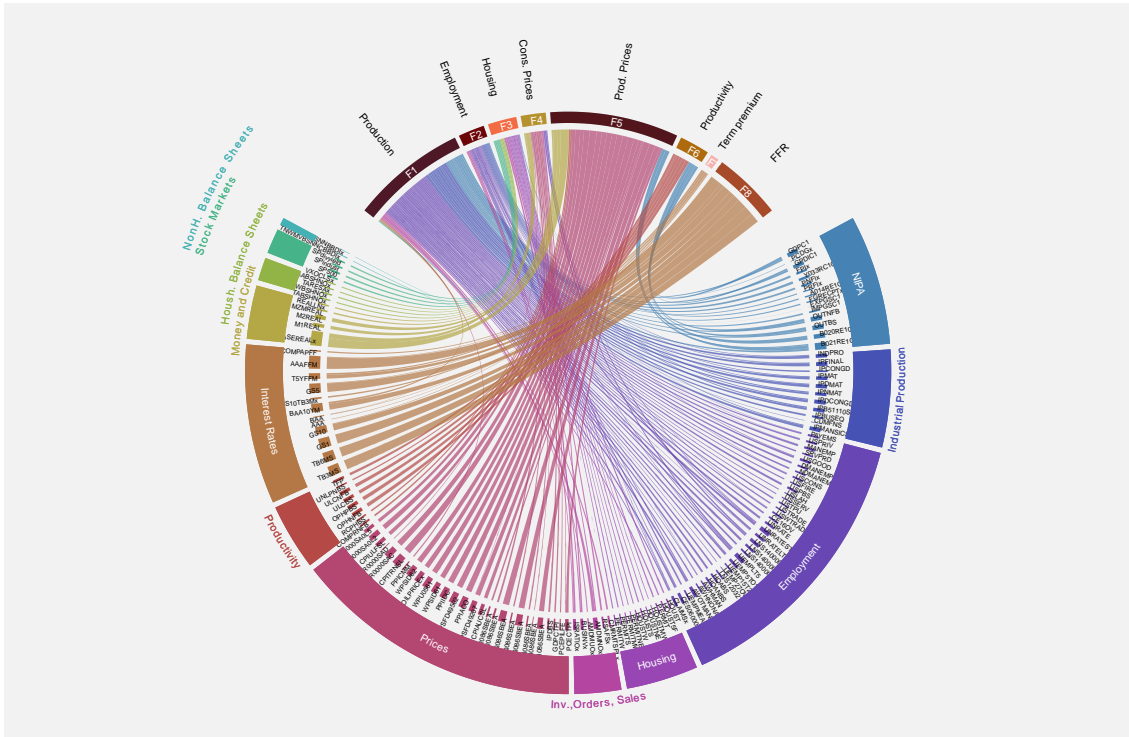


Figure W4.2: Circos: Factor association, evaluated at the median factor loading for the post-crisis sample.

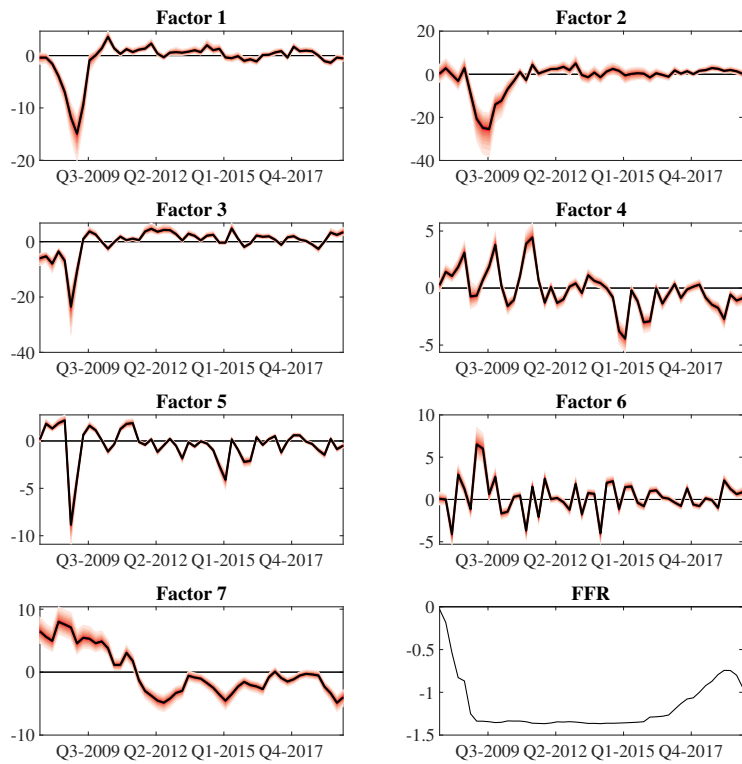


Figure W4.3: Estimated unobserved factors median along with 68% HPDI and FFR (observed factor) for the post-crisis sample.

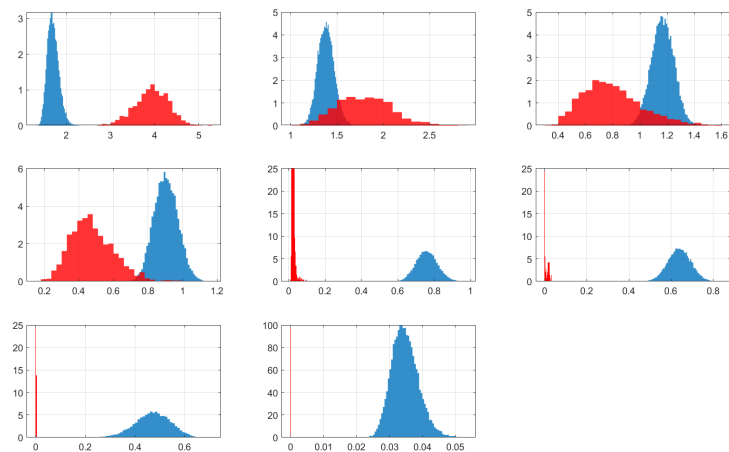


Figure W4.4: Posterior distributions of the eigenvalues of the factor correlation matrix for the first (blue) and the post-crisis sample (red).

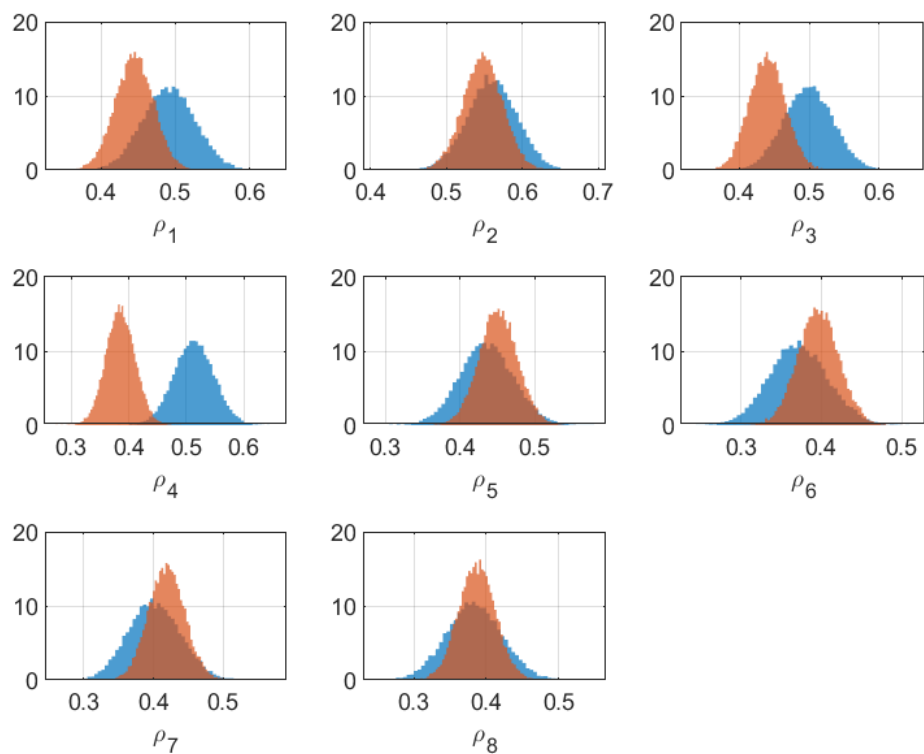


Figure W4.5: Posterior distribution of ρ_j for the pre- (blue) and the post-crisis sample.

W5 Comparison to other factor estimates

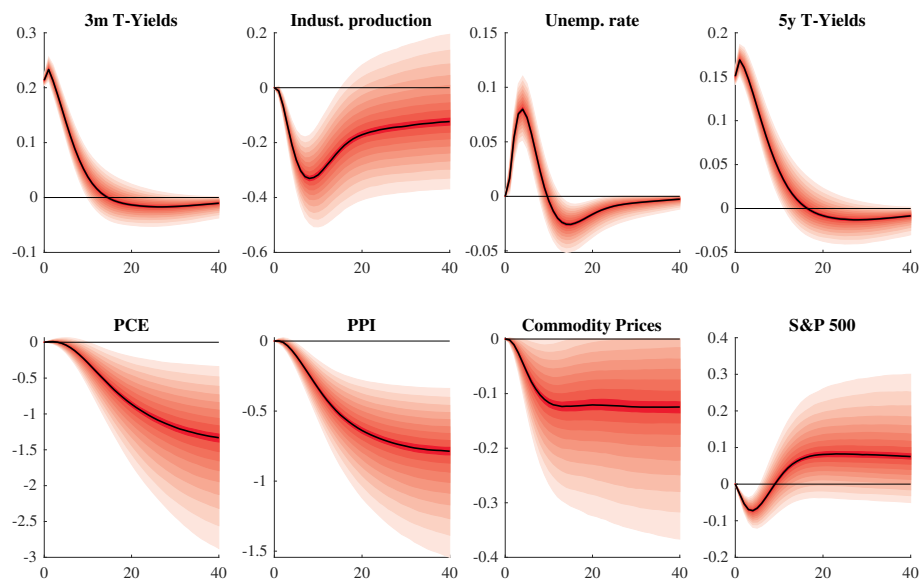


Figure W5.1: Impulse responses of selected variables to an unanticipated change in the FFR (median along with 68% HPDI) estimated with a block-diagonal covariance matrix for the pre-crisis period.

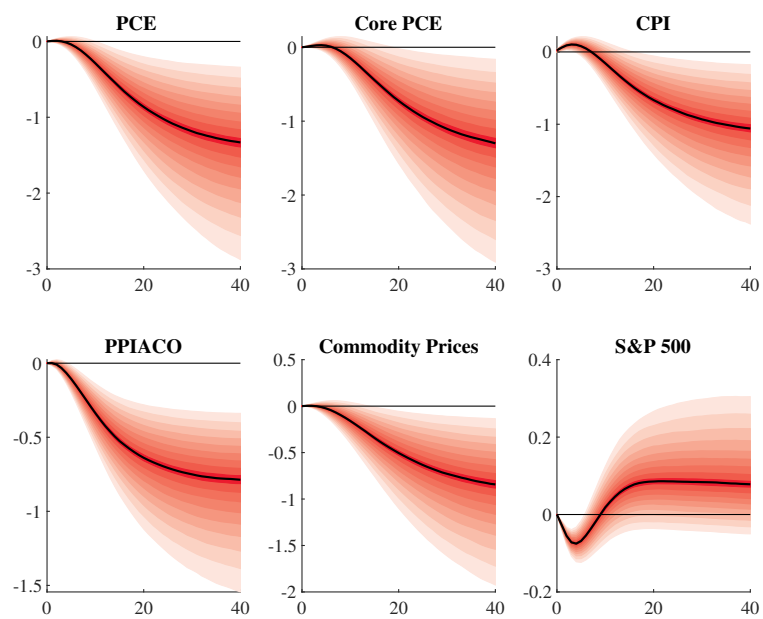


Figure W5.2: Impulse responses of selected price variables to an unanticipated change in the FFR (median along with 68% HPDI) estimated with a block-diagonal covariance matrix for the pre-crisis period.

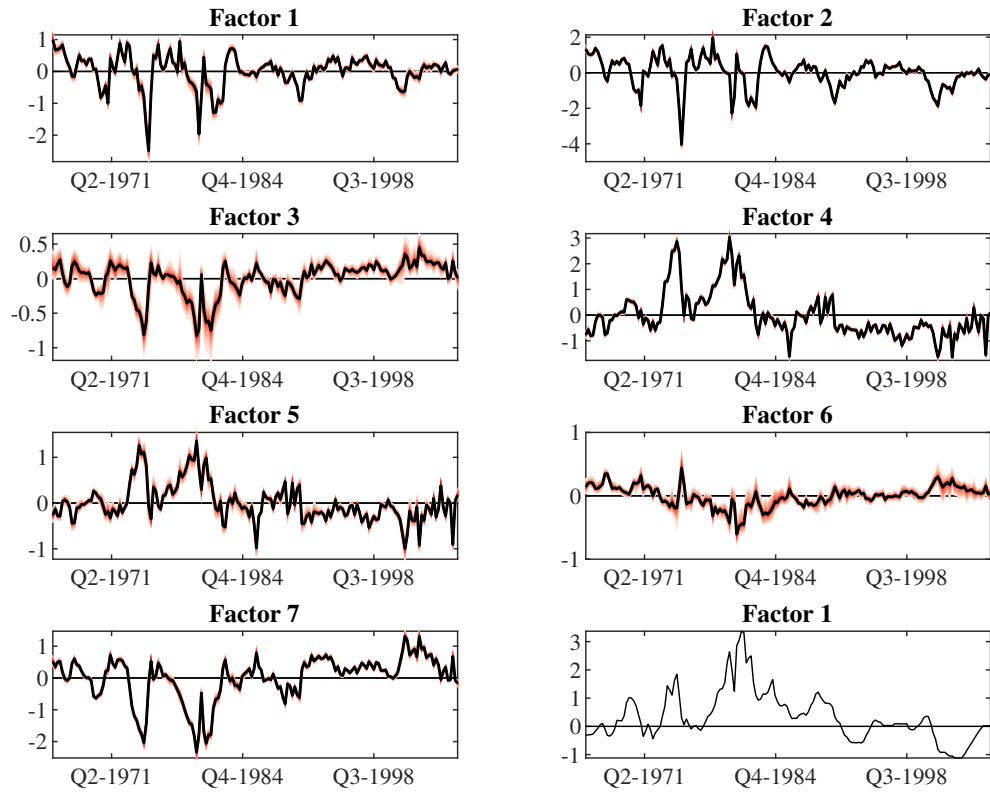


Figure W5.3: Estimated unobserved factors median along with 68% HPDI and FFR (observed factor) estimated with a normal prior for the pre-crisis sample.

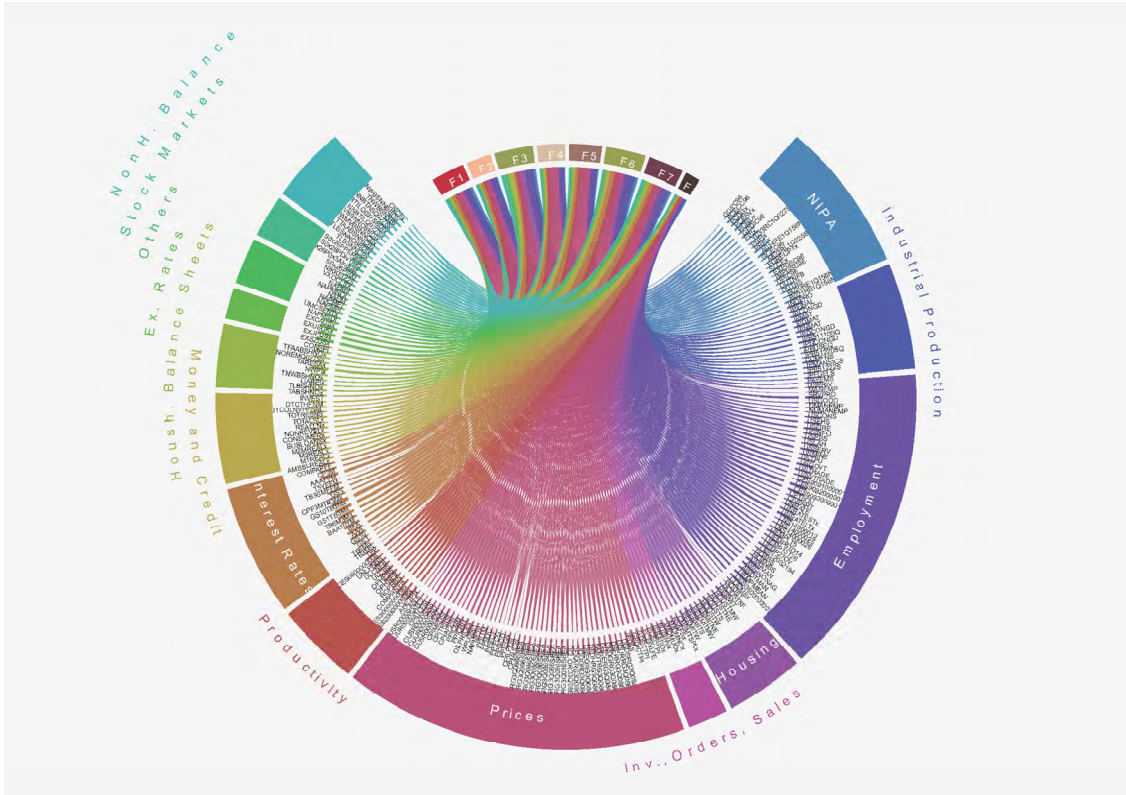


Figure W5.4: Circos: Factor association under normal prior, evaluated at the median factor loading.

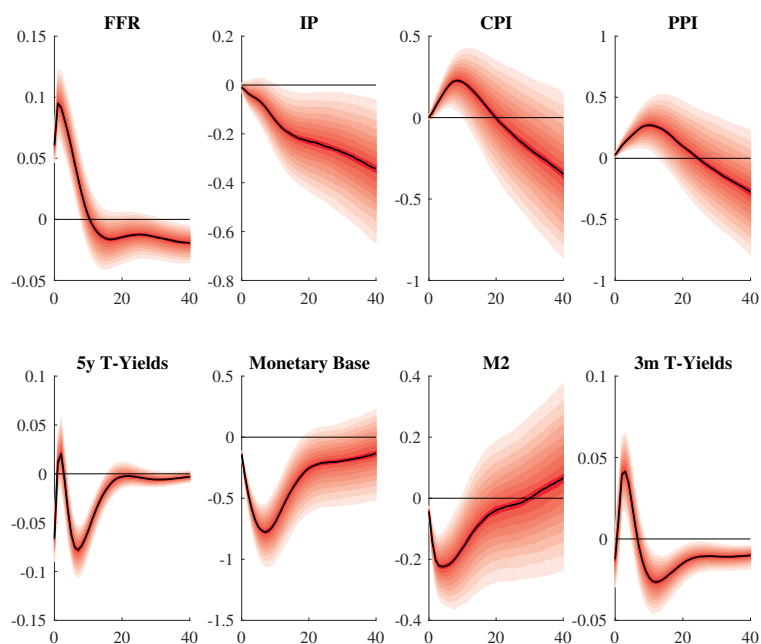


Figure W5.5: Impulse responses of selected variables to an unanticipated change in the FFR (median along with 68% HPDI) estimated with a normal prior for the pre-crisis period.

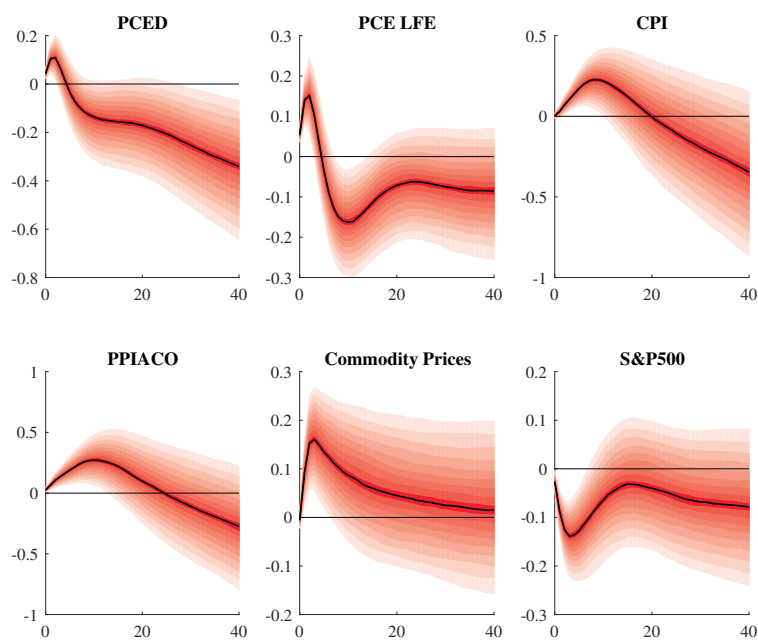


Figure W5.6: Impulse responses of selected price variables to an unanticipated change in the FFR (median along with 68% HPDI) estimated with a normal prior for the pre-crisis period.

W6 Data

Table W6.1: Time series. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
1	GDPC96	Real Gross Domestic Product, 3 Decimal (Billions of Chained 2009 Dollars)	fl	NIPA
2	PCECC96	Real Personal Consumption Expenditures (Billions of Chained 2009 Dollars)	fl	NIPA
3	PCDGx	Real personal consumption expenditures: Durable goods (Billions of Chained 2009 Dollars), deflated using PCE	fl	NIPA
4	PCESVx	Real Personal Consumption Expenditures: Services (Billions of 2009 Dollars), deflated using PCE	fl	NIPA
5	PCNDx	Real Personal Consumption Expenditures: Non-durable Goods (Billions of 2009 Dollars), deflated using PCE	fl	NIPA
6	GPDIC96	Real Gross Private Domestic Investment, 3 decimal (Billions of Chained 2009 Dollars)	fl	NIPA
7	FPIx	Real private fixed investment (Billions of Chained 2009 Dollars), deflated using PCE	fl	NIPA
8	Y033RC1Q027SBEAx	Real Gross Private Domestic Investment: Fixed Investment: Nonresidential: Equipment (Billions of Chained 2009 Dollars), deflated using PCE	fl	NIPA
9	PNFIx	Real private fixed investment: Nonresidential (Billions of Chained 2009 Dollars), deflated using PCE	fl	NIPA
10	PRFIx	Real private fixed investment: Residential (Billions of Chained 2009 Dollars), deflated using PCE	fl	NIPA
11	A014RE1Q156NBEA	Shares of gross domestic product: Gross private domestic investment: Change in private inventories (Percent)	lv	NIPA
12	GCEC96	Real Government Consumption Expenditures ++ Gross Investment (Billions of Chained 2009 Dollars)	fl	NIPA
13	A823RL1Q225SBEA	Real Government Consumption Expenditures and Gross Investment: Federal (Percent Change from Preceding Period)	lv	NIPA
14	FGRECPTx	Real Federal Government Current Receipts (Billions of Chained 2009 Dollars), deflated using PCE	fl	NIPA
15	SLCEx	Real government state and local consumption expenditures (Billions of Chained 2009 Dollars), deflated using PCE	fl	NIPA
16	EXPGSC96	Real Exports of Goods ++ Services, 3 Decimal (Billions of Chained 2009 Dollars)	fl	NIPA
17	IMPGSC96	Real Imports of Goods ++ Services, 3 Decimal (Billions of Chained 2009 Dollars)	fl	NIPA
18	DPIC96	Real Disposable Personal Income (Billions of Chained 2009 Dollars)	fl	NIPA
19	OUTNFB	Nonfarm Business Sector: Real Output (Index 2009=100)	fl	NIPA
20	OUTBS	Business Sector: Real Output (Index 2009=100)	fl	NIPA
21	INDPRO	Industrial Production Index (Index 2012=100)	fl	Industrial Production
22	IPFINAL	Industrial Production: Final Products (Market Group) (Index 2012=100)	fl	Industrial Production
23	IPCONGD	Industrial Production: Consumer Goods (Index 2012=100)	fl	Industrial Production
24	IPMAT	Industrial Production: Materials (Index 2012=100)	fl	Industrial Production
25	IPDMAT	Industrial Production: Durable Materials (Index 2012=100)	fl	Industrial Production
26	IPNMAT	Industrial Production: Nondurable Materials (Index 2012=100)	fl	Industrial Production
27	IPDCONGD	Industrial Production: Durable Consumer Goods (Index 2012=100)	fl	Industrial Production
28	IPB51110SQ	Industrial Production: Durable Goods: Automotive products (Index 2012=100)	fl	Industrial Production

Table W6.1: Time series, continued. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
29	IPNCONGD	Industrial Production: Nondurable Consumer Goods (Index 2012=100)	fl	Industrial Production
30	IPBUSEQ	Industrial Production: Business Equipment (Index 2012=100)	fl	Industrial Production
31	IPB51220SQ	Industrial Production: Consumer energy products (Index 2012=100)	fl	Industrial Production
32	CUMFNS	Capacity Utilization: Manufacturing (SIC) (Percent of Capacity)	lv	Industrial Production
33	PAYEMS	All Employees: Total nonfarm (Thousands of Persons)	fl	Employment
34	USPRIV	All Employees: Total Private Industries (Thousands of Persons)	fl	Employment
35	MANEMP	All Employees: Manufacturing (Thousands of Persons)	fl	Employment
36	SRVPRD	All Employees: Service-Providing Industries (Thousands of Persons)	fl	Employment
37	USGOOD	All Employees: Goods-Producing Industries (Thousands of Persons)	fl	Employment
38	DMANEMP	All Employees: Durable goods (Thousands of Persons)	fl	Employment
39	NDMANEMP	All Employees: Nondurable goods (Thousands of Persons)	fl	Employment
40	USCONS	All Employees: Construction (Thousands of Persons)	fl	Employment
41	USEHS	All Employees: Education ++ Health Services (Thousands of Persons)	fl	Employment
42	USFIRE	All Employees: Financial Activities (Thousands of Persons)	fl	Employment
43	USINFO	All Employees: Information Services (Thousands of Persons)	fl	Employment
44	USPBS	All Employees: Professional ++ Business Services (Thousands of Persons)	fl	Employment
45	USLAH	All Employees: Leisure ++ Hospitality (Thousands of Persons)	fl	Employment
46	USSERV	All Employees: Other Services (Thousands of Persons)	fl	Employment
47	USMINE	All Employees: Mining and logging (Thousands of Persons)	fl	Employment
48	USTPU	All Employees: Trade, Transportation ++ Utilities (Thousands of Persons)	fl	Employment
49	USGOVT	All Employees: Government (Thousands of Persons)	fl	Employment
50	USTRADE	All Employees: Retail Trade (Thousands of Persons)	fl	Employment
51	USWTRADE	All Employees: Wholesale Trade (Thousands of Persons)	fl	Employment
52	CES9091000001	All Employees: Government: Federal (Thousands of Persons)	fl	Employment
53	CES9092000001	All Employees: Government: State Government (Thousands of Persons)	fl	Employment
54	CES9093000001	All Employees: Government: Local Government (Thousands of Persons)	fl	Employment
55	CE16OV	Civilian Employment (Thousands of Persons)	fl	Employment
56	CIVPART	Civilian Labor Force Participation Rate (Percent)	fd	Employment
57	UNRATE	Civilian Unemployment Rate (Percent)	fd	Employment
58	UNRATESTx	Unemployment Rate less than 27 weeks (Percent)	fd	Employment
59	UNRATELTx	Unemployment Rate for more than 27 weeks (Percent)	fd	Employment
60	LNS14000012	Unemployment Rate - 16 to 19 years (Percent)	fd	Employment
61	LNS14000025	Unemployment Rate - 20 years and over, Men (Percent)	fd	Employment
62	LNS14000026	Unemployment Rate - 20 years and over, Women (Percent)	fd	Employment
63	UEMPLT5	Number of Civilians Unemployed - Less Than 5 Weeks (Thousands of Persons)	fl	Employment

Table W6.1: Time series, continued. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
64	UEMP5TO14	Number of Civilians Unemployed for 5 to 14 Weeks (Thousands of Persons)	fl	Employment
65	UEMP15T26	Number of Civilians Unemployed for 15 to 26 Weeks (Thousands of Persons)	fl	Employment
66	UEMP27OV	Number of Civilians Unemployed for 27 Weeks and Over (Thousands of Persons)	fl	Employment
67	LNS12032194	Employment Level - Part-Time for Economic Reasons, All Industries (Thousands of Persons)	fl	Employment
68	HOABS	Business Sector: Hours of All Persons (Index 2009=100)	fl	Employment
69	HOANBS	Nonfarm Business Sector: Hours of All Persons (Index 2009=100)	fl	Employment
70	AWHMAN	Average Weekly Hours of Production and Non-supervisory Employees: Manufacturing (Hours)	lv	Employment
71	AWHNONAG	Average Weekly Hours Of Production And Non-supervisory Employees: Total private (Hours)	fd	Employment
72	AWOTMAN	Average Weekly Overtime Hours of Production and Nonsupervisory Employees: Manufacturing (Hours)	fd	Employment
73	HOUST	Housing Starts: Total: New Privately Owned Housing Units Started (Thousands of Units)	fl	Housing
74	HOUST5F	Privately Owned Housing Starts: 5-Unit Structures or More (Thousands of Units)	fl	Housing
75	PERMIT	New Private Housing Units Authorized by Building Permits (Thousands of Units)	fl	Housing
76	HOUSTMW	Housing Starts in Midwest Census Region (Thousands of Units)	fl	Housing
77	HOUSTNE	Housing Starts in Northeast Census Region (Thousands of Units)	fl	Housing
78	HOUSTS	Housing Starts in South Census Region (Thousands of Units)	fl	Housing
79	HOUSTW	Housing Starts in West Census Region (Thousands of Units)	fl	Housing
80	CMRMTSPLx	Real Manufacturing and Trade Industries Sales (Millions of Chained 2009 Dollars)	fl	Inv.,Orders, Sales
81	RSAFSx	Real Retail and Food Services Sales (Millions of Chained 2009 Dollars), deflated by Core PCE	fl	Inv.,Orders, Sales
82	AMDMNOx	Real Manufacturers? New Orders: Durable Goods (Millions of 2009 Dollars), deflated by Core PCE	fl	Inv.,Orders, Sales
83	AMDMUOx	Real Value of Manufacturers? Unfilled Orders for Durable Goods Industries (Million of 2009 Dollars), deflated by Core PCE	fl	Inv.,Orders, Sales
84	NAPMSDI	ISM Manufacturing: Supplier Deliveries Index (lin)	lv	Others
85	PCECTPI	Personal Consumption Expenditures: Chain-type Price Index (Index 2009=100)	fl	Prices
86	PCEPILFE	Personal Consumption Expenditures Excluding Food and Energy (Chain-Type Price Index) (Index 2009=100)	fl	Prices
87	GDPCTPI	Gross Domestic Product: Chain-type Price Index (Index 2009=100)	fl	Prices
88	GPDICTPI	Gross Private Domestic Investment: Chain-type Price Index (Index 2009=100)	fl	Prices
89	IPDBS	Business Sector: Implicit Price Deflator (Index 2009=100)	fl	Prices
90	DGDSRG3Q086SBEA	Personal consumption expenditures: Goods (chain-type price index)	fl	Prices
91	DDURRG3Q086SBEA	Personal consumption expenditures: Durable goods (chain-type price index)	fl	Prices
92	DSERRG3Q086SBEA	Personal consumption expenditures: Services (chain-type price index)	fl	Prices
93	DNDGRG3Q086SBEA	Personal consumption expenditures: Nondurable goods (chain-type price index)	fl	Prices

Table W6.1: Time series, continued. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
94	DHCERG3Q086SBEA	Personal consumption expenditures: Services: Household consumption expenditures (chain-type price index)	fl	Prices
95	DMOTRG3Q086SBEA	Personal consumption expenditures: Durable goods: Motor vehicles and parts (chain-type price index)	fl	Prices
96	DFDHRG3Q086SBEA	Personal consumption expenditures: Durable goods: Furnishings and durable household equipment (chain-type price index)	fl	Prices
97	DREQRG3Q086SBEA	Personal consumption expenditures: Durable goods: Recreational goods and vehicles (chain-type price index)	fl	Prices
98	DODGRG3Q086SBEA	Personal consumption expenditures: Durable goods: Other durable goods (chain-type price index)	fl	Prices
99	DFXARG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Food and beverages purchased for off-premises consumption (chain-type price index)	fl	Prices
100	DCLORG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Clothing and footwear (chain-type price index)	fl	Prices
101	DGOERG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Gasoline and other energy goods (chain-type price index)	fl	Prices
102	DONGRG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Other nondurable goods (chain-type price index)	fl	Prices
103	DHUTRG3Q086SBEA	Personal consumption expenditures: Services: Housing and Utilities (chain-type price index)	fl	Prices
104	DHLCRG3Q086SBEA	Personal consumption expenditures: Services: Health care (chain-type price index)	fl	Prices
105	DTRSRG3Q086SBEA	Personal consumption expenditures: Transportation Services (chain-type price index)	fl	Prices
106	DRCARG3Q086SBEA	Personal consumption expenditures: Recreation Services (chain-type price index)	fl	Prices
107	DFSARG3Q086SBEA	Personal consumption expenditures: Services: Food Services and accommodations (chain-type price index)	fl	Prices
108	DIFSRG3Q086SBEA	Personal consumption expenditures: Financial Services and insurance (chain-type price index)	fl	Prices
109	DOTSRG3Q086SBEA	Personal consumption expenditures: Other Services (chain-type price index)	fl	Prices
110	CPIAUCSL	Consumer Price Index for All Urban Consumers: All Items (Index 1982-84=100)	fl	Prices
111	CPILFESL	Consumer Price Index for All Urban Consumers: All Items Less Food ++ Energy (Index 1982-84=100)	fl	Prices
112	PPIFGS	Producer Price Index by Commodity for Finished Goods (Index 1982=100)	fl	Prices
113	PPIACO	Producer Price Index for All Commodities (Index 1982=100)	fl	Prices
114	PPIFCG	Producer Price Index by Commodity for Finished Consumer Goods (Index 1982=100)	fl	Prices
115	PPIFCF	Producer Price Index by Commodity for Finished Consumer Foods (Index 1982=100)	fl	Prices
116	PPIIDC	Producer Price Index by Commodity Industrial Commodities (Index 1982=100)	fl	Prices
117	PPIITM	Producer Price Index by Commodity Intermediate Materials: Supplies ++ Components (Index 1982=100)	fl	Prices
118	NAPMPRI	ISM Manufacturing: Prices Index (Index)	lv	Prices
119	WPU0561	Producer Price Index by Commodity for Fuels and Related Products and Power: Crude Petroleum (Domestic Production) (Index 1982=100)	fl	Prices

Table W6.1: Time series, continued. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
120	OILPRICE _x	Real Crude Oil Prices: West Texas Intermediate (WTI) - Cushing, Oklahoma (2009 Dollars per Barrel), deflated by Core PCE	fl	Prices
121	AHETPI _x	Real Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private (2009 Dollars per Hour), deflated by Core PCE	fl	Productivity
122	CES2000000008 _x	Real Average Hourly Earnings of Production and Nonsupervisory Employees: Construction (2009 Dollars per Hour), deflated by Core PCE	fl	Productivity
123	CES3000000008 _x	Real Average Hourly Earnings of Production and Nonsupervisory Employees: Manufacturing (2009 Dollars per Hour), deflated by Core PCE	fl	Productivity
124	COMPRNFB	Nonfarm Business Sector: Real Compensation Per Hour (Index 2009=100)	fl	Productivity
125	RCPHBS	Business Sector: Real Compensation Per Hour (Index 2009=100)	fl	Productivity
126	OPHNFB	Nonfarm Business Sector: Real Output Per Hour of All Persons (Index 2009=100)	fl	Productivity
127	OPHPBS	Business Sector: Real Output Per Hour of All Persons (Index 2009=100)	fl	Productivity
128	ULCBS	Business Sector: Unit Labor Cost (Index 2009=100)	fl	Productivity
129	ULCNFB	Nonfarm Business Sector: Unit Labor Cost (Index 2009=100)	fl	Productivity
130	UNLPNBS	Nonfarm Business Sector: Unit Nonlabor Payments (Index 2009=100)	fl	Productivity
131	FEDFUNDS	Effective Federal Funds Rate (Percent)	lv	Interest Rates
132	TB3MS	3-Month Treasury Bill: Secondary Market Rate (Percent)	lv	Interest Rates
133	TB6MS	6-Month Treasury Bill: Secondary Market Rate (Percent)	lv	Interest Rates
134	GS1	1-Year Treasury Constant Maturity Rate (Percent)	lv	Interest Rates
135	GS10	10-Year Treasury Constant Maturity Rate (Percent)	lv	Interest Rates
136	AAA	Moodys Seasoned Aaa Corporate Bond Yield (Percent)	lv	Interest Rates
137	BAA	Moodys Seasoned Baa Corporate Bond Yield (Percent)	lv	Interest Rates
138	BAA10YM	Moodys Seasoned Baa Corporate Bond Yield Relative to Yield on 10-Year Treasury Constant Maturity (Percent)	lv	Interest Rates
139	TB6M3M _x	6-Month Treasury Bill Minus 3-Month Treasury Bill, secondary market (Percent)	lv	Interest Rates
140	GS1TB3M _x	1-Year Treasury Constant Maturity Minus 3-Month Treasury Bill, secondary market (Percent)	lv	Interest Rates
141	GS10TB3M _x	10-Year Treasury Constant Maturity Minus 3-Month Treasury Bill, secondary market (Percent)	lv	Interest Rates
142	CPF3MTB3M _x	3-Month Commercial Paper Minus 3-Month Treasury Bill, secondary market (Percent)	lv	Interest Rates
143	AMBSLREAL _x	St. Louis Adjusted Monetary Base (Billions of 1982-84 Dollars), deflated by CPI	fl	Money and Credit
144	M1REAL _x	Real M1 Money Stock (Billions of 1982-84 Dollars), deflated by CPI	fl	Money and Credit
145	M2REAL _x	Real M2 Money Stock (Billions of 1982-84 Dollars), deflated by CPI	fl	Money and Credit
146	MZMREAL _x	Real MZM Money Stock (Billions of 1982-84 Dollars), deflated by CPI	fl	Money and Credit
147	BUSLOANS _x	Real Commercial and Industrial Loans, All Commercial Banks (Billions of 2009 U.S. Dollars), deflated by Core PCE	fl	Money and Credit
148	CONSUMER _x	Real Consumer Loans at All Commercial Banks (Billions of 2009 U.S. Dollars), deflated by Core PCE	fl	Money and Credit

Table W6.1: Time series, continued. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
149	NONREVSLx	Total Real Nonrevolving Credit Owned and Securitized, Outstanding (Billions of Dollars), deflated by Core PCE	fl	Money and Credit
150	REALLNx	Real Real Estate Loans, All Commercial Banks (Billions of 2009 U.S. Dollars), deflated by Core PCE	fl	Money and Credit
151	TOTALSLx	Total Consumer Credit Outstanding, deflated by Core PCE	fl	Money and Credit
152	TABSHNOx	Real Total Assets of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE	fl	Housh. Balance Sheets
153	TLBSHNOx	Real Total Liabilities of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE	fl	Housh. Balance Sheets
154	LIABPIx	Liabilities of Households and Nonprofit Organizations Relative to Personal Disposable Income (Percent)	fl	Housh. Balance Sheets
155	TNWSHNOx	Real Net Worth of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE	fl	Housh. Balance Sheets
156	NWPIx	Net Worth of Households and Nonprofit Organizations Relative to Disposable Personal Income (Percent)	lv	Housh. Balance Sheets
157	TARESAx	Real Assets of Households and Nonprofit Organizations excluding Real Estate Assets (Billions of 2009 Dollars), deflated by Core PCE	fl	Housh. Balance Sheets
158	HNOREMQ027Sx	Real Real Estate Assets of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE	fl	Housh. Balance Sheets
159	TFAABSHNOx	Real Total Financial Assets of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE	fl	Housh. Balance Sheets
160	VXOCLSX	CB OE S++P 100 Volatility Index: VXO	lv	Stock Markets
161	EXSZUSx	Switzerland / U.S. Foreign Exchange Rate	lv	Ex. Rates
162	EXJPUSx	Japan /U.S. Foreign Exchange Rate	lv	Ex. Rates
163	EXUSUKx	U.S. / U.K. Foreign Exchange Rate	lv	Ex. Rates
164	EXCAUSx	Canada / U.S. Foreign Exchange Rate	lv	Ex. Rates
165	UMCSENTx	University of Michigan: Consumer Sentiment (Index Ist Quarter 1966=100)	lv	Others
166	B020RE1Q156NBEA	Shares of gross domestic product: Exports of goods and Services (Percent)	fd	NIPA
167	B021RE1Q156NBEA	Shares of gross domestic product: Imports of goods and Services (Percent)	fd	NIPA
168	IPMANSICS	Industrial Production: Manufacturing (SIC) (Index 2012=100)	fl	Industrial Production
169	IPB51222S	Industrial Production: Residential Utilities (Index 2012=100)	fl	Industrial Production
170	IPFUELS	Industrial Production: Fuels (Index 2012=100)	fl	Industrial Production
171	NAPMPI	ISM Manufacturing: Production Index	lv	Others
172	UEMPMEAN	Average (Mean) Duration of Unemployment (Weeks)	fd	Employment
173	CES0600000007	Average Weekly Hours of Production and Non-supervisory Employees: Goods-Producing	fd	Employment
174	NAPMEI	ISM Manufacturing: Employment Index	lv	Others
175	NAPM	ISM Manufacturing: PMI Composite Index	lv	Others
176	NAPMNOI	ISM Manufacturing: New Orders Index	lv	Others
177	NAPMII	ISM Manufacturing: Inventories Index	lv	Others
178	TOTRESNS	Total Reserves of Depository Institutions (Billions of Dollars)	fl	Money and Credit
179	GS5	5-Year Treasury Constant Maturity Rate	lv	Interest Rates
180	TB3SMFFM	3-Month Treasury Constant Maturity Minus Federal Funds Rate	lv	Interest Rates
181	T5YFFM	5-Year Treasury Constant Maturity Minus Federal Funds Rate	lv	Interest Rates

Table W6.1: Time series, continued. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
182	AAAFFM	Moodys Seasoned Aaa Corporate Bond Minus Federal Funds Rate	lv	Interest Rates
183	PPICRM	Producer Price Index: Crude Materials for Further Processing (Index 1982=100)	fl	Prices
184	PPICMM	Producer Price Index: Commodities: Metals and metal products: Primary nonferrous metals (Index 1982=100)	fl	Prices
185	CPIAPPSL	Consumer Price Index for All Urban Consumers: Apparel (Index 1982-84=100)	fl	Prices
186	CPITRNSL	Consumer Price Index for All Urban Consumers: Transportation (Index 1982-84=100)	fl	Prices
187	CPIMEDSL	Consumer Price Index for All Urban Consumers: Medical Care (Index	fl	Prices
188	CUSR0000SAC	Consumer Price Index for All Urban Consumers: Commodities (Index 1982-84=100)	fl	Prices
189	CUUR0000SAD	Consumer Price Index for All Urban Consumers: Durables (Index 1982-84=100)	fl	Prices
190	CUSR0000SAS	Consumer Price Index for All Urban Consumers: Services (Index 1982-84=100)	fl	Prices
191	CPIULFSL	Consumer Price Index for All Urban Consumers: All Items Less Food (Index 1982-84=100)	fl	Prices
192	CUUR0000SA0L2	Consumer Price Index for All Urban Consumers: All items less shelter (Index 1982-84=100)	fl	Prices
193	CUSR0000SA0L5	Consumer Price Index for All Urban Consumers: All items less medical care (Index 1982-84=100)	fl	Prices
194	CES0600000008	Average Hourly Earnings of Production and Non-supervisory Employees: Goods-Producing (Dollars per Hour)	fl	Productivity
195	DTCOLNVHFNM	Consumer Motor Vehicle Loans Outstanding Owned by Finance Companies (Millions of Dollars)	fl	Money and Credit
196	DTCTHFNM	Total Consumer Loans and Leases Outstanding Owned and Securitized by Finance Companies (Millions of Dollars)	fl	Money and Credit
197	INVEST	Securities in Bank Credit at All Commercial Banks (Billions of Dollars)	fl	Money and Credit
198	CLAIMSx	Initial Claims	fl	Employment
199	BUSINVx	Total Business Inventories (Millions of Dollars)	fl	Inv.,Orders, Sales
200	ISRATIOx	Total Business: Inventories to Sales Ratio	fd	Inv.,Orders, Sales
201	CONSPI	Nonrevolving consumer credit to Personal Income	fd	Housh. Balance Sheets
202	CP3M	3-Month AA Financial Commercial Paper Rate	fd	Interest Rates
203	COMPAPFF	3-Month Commercial Paper Minus Federal Funds Rate	lv	Interest Rates
204	PERMITNE	New Private Housing Units Authorized by Building Permits in the Northeast Census Region (Thousands, SAAR)	fl	Housing
205	PERMITMW	New Private Housing Units Authorized by Building Permits in the Midwest Census Region (Thousands, SAAR)	fl	Housing
206	PERMITS	New Private Housing Units Authorized by Building Permits in the South Census Region (Thousands, SAAR)	fl	Housing
207	PERMITW	New Private Housing Units Authorized by Building Permits in the West Census Region (Thousands, SAAR)	fl	Housing
208	NIKKEI225	Nikkei Stock Average	fl	Stock Markets
209	TLBSNNCBx	Real Nonfinancial Corporate Business Sector Liabilities (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS	fl	NonH. Balance Sheets
210	TLBSNNCBBDIx	Nonfinancial Corporate Business Sector Liabilities to Disposable Business Income (Percent)	lv	NonH. Balance Sheets
211	TTAABSNNCBx	Real Nonfinancial Corporate Business Sector Assets (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS	fl	NonH. Balance Sheets

Table W6.1: Time series, continued. Transformations: level (lv), first difference (fd), first log difference (fl).

ID	MNEMONIC	Description	TCode	Group
212	TNWMVBSNNCBx	Real Nonfinancial Corporate Business Sector Net Worth (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS	fl	NonH. Balance Sheets
213	TNWMVBSNNCBBDIx	Nonfinancial Corporate Business Sector Net Worth to Disposable Business Income (Percent)	fd	NonH. Balance Sheets
214	NNBTILQ027Sx	Real Nonfinancial Noncorporate Business Sector Liabilities (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS	fl	NonH. Balance Sheets
215	NNBTILQ027SBDIx	Nonfinancial Noncorporate Business Sector Liabilities to Disposable Business Income (Percent)	lv	NonH. Balance Sheets
216	NNBTASQ027Sx	Real Nonfinancial Noncorporate Business Sector Assets (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS	fl	NonH. Balance Sheets
217	TNWBSNNBx	Real Nonfinancial Noncorporate Business Sector Net Worth (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS	fl	NonH. Balance Sheets
218	TNWBSNNBBDIx	Nonfinancial Noncorporate Business Sector Net Worth to Disposable Business Income (Percent)	fd	NonH. Balance Sheets
219	CNCFx	Real Disposable Business Income, Billions of 2009 Dollars (Corporate cash flow with IVA minus taxes on corporate income, deflated by Implicit Price Deflator for Business Sector IPDBS)	fl	NonH. Balance Sheets
220	S0x26P500	S++P Common Stock Price Index: Composite	fl	Stock Markets
221	S0x26P0x3AIndust	S++P Common Stock Price Index: Industrials	fl	Stock Markets
222	S0x26PDivYield	S++P Composite Common Stock: Dividend Yield	fd	Stock Markets
223	S0x26PPERatio	S++P Composite Common Stock: Price-Earnings Ratio	fl	Stock Markets
224	TFP	Total Factor Productivity	lv	Productivity

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