Online Appendix to Estimating Macroeconomic News and Surprise Shocks

Lutz Kilian, Michael D. Plante and Alexander W. Richter
Online Appendix:
Estimating Macroeconomic News and Surprise Shocks*

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ABSTRACT

This appendix provides our data sources, a proof of orthogonality of the rotation matrix in the VAR, a description of the baseline and KS DSGE models, and additional estimation results.

*The views expressed in this paper are our own and do not necessarily reflect the views of the Federal Reserve Bank of Dallas or the Federal Reserve System.
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A DATA SOURCES

We use the following time-series provided by Haver Analytics:

1. **Civilian Noninstitutional Population: 16 Years & Over**
   Not Seasonally Adjusted, Quarterly, Thousands (LN16N@USECON)

2. **Gross Domestic Product: Implicit Price Deflator**
   Seasonally Adjusted, Quarterly, 2012=100 (DGDP@USNA)

3. **Real Gross Domestic Product**
   Seasonally Adjusted, Quarterly, Billions of Chained 2012$ (GDPH@USECON)

4. **Real Personal Consumption Expenditures**
   Seasonally Adjusted, Quarterly, Billions of Chained 2012$ (CH@USECON)

5. **Real Private Fixed Investment**
   Seasonally Adjusted, Quarterly, Billions of Chained 2012$ (FH@USECON)

6. **Hours: Private Sector, Nonfarm Payrolls**
   Seasonally Adjusted, Quarterly, Billions of Hours (LHTPRIVA@USECON)

7. **Utilization-Adjusted Total Factor Productivity**
   Quarterly, Percent, Annual Rate (TFPMQ@USECON)

8. **Capital Share of Income**, Quarterly (TFPJQ@USECON)

9. **Effective Federal Funds Rate**
   Quarterly Average, Annual Percent (FFED@USECON)

10. **S&P 500 Stock Price Index**, Quarterly Average (SP500@USECON)

11. **Real Research and Development**
    Seasonally Adjusted, Quarterly, Billions of Chained 2012$ (FNPRH@USECON)

12. **Net Stock: Private Fixed Assets**, Annual, Billions of Dollars (EPT@CAPSTOCK)

13. **Net Stock: Durable Goods**, Annual, Billions of Dollars (EDT@CAPSTOCK)

14. **Depreciation: Private Fixed Assets**, Annual, Billions of Dollars (KPT@CAPSTOCK)

15. **Depreciation: Durable Goods**, Annual, Billions of Dollars (KDT@CAPSTOCK)

We also used the following data from other sources:

1. **Information & Communication Technologies Standards Index** from Baron and Schmidt (2019). Data is available at https://www.law.northwestern.edu/research-faculty/clbe/innovationeconomics/data/technologystandards.
2. **Patent-Based Innovation Index** from Cascaldi-Garcia and Vukotić (2022). This is a quarterly version of the Kogan et al. (2017) annual index, which is based on counts of patents where each patent is weighted by its impact on the firm’s stock price. Data is available at https://sites.google.com/site/cascaldigarcia/research.


4. **Macroeconomic Forecasts** from the Survey of Professional Forecasters (SPF). We use the one and four-quarter ahead mean predictions for the unemployment rate (UNEMP), the GDP deflator (PGDP), real non-residential fixed investment (RNRESIN), and corporate profits (CPROF). These are used to construct the exogenous patent-innovation series of Miranda-Agrippino et al. (2022) that controls for SPF forecasts but not for exogenous policy shocks. Details about the construction are in Section 2.2 of Miranda-Agrippino et al. (2022). For the SPF data, see https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/survey-of-professional-forecasters.

**B Orthogonality Conditions**

Observe that either $\gamma_{n,2}\gamma_{n,3} > 0$ and $\gamma_{\ell,2}\gamma_{\ell,3} < 0$ or $\gamma_{n,2}\gamma_{n,3} < 0$ and $\gamma_{\ell,2}\gamma_{\ell,3} > 0$. Using (R1-1) and the solution for $\gamma_s$, $\gamma_{\ell,2}$, and $\gamma_{\ell,3}$ in Section 2.3 of the main text implies

\[
\gamma_{s,1} + \frac{\gamma_{s,2} + \gamma_{s,3}}{1 - \frac{\gamma_{n,1} \gamma_{n,3}}{\gamma_{s,1}}} = 1 - \left(\gamma_{n,1} + \gamma_{s,1}\right)^2 + \left(\gamma_{n,2} + \gamma_{s,2}\right)^2 + \left(\gamma_{n,3} + \gamma_{s,3}\right)^2
\]

and

\[
\gamma_{\ell,1} + \frac{\gamma_{\ell,2} + \gamma_{\ell,3}}{1 - \frac{\gamma_{n,1} \gamma_{n,3}}{\gamma_{\ell,1}}} = 1 - \left(\gamma_{n,1} + \gamma_{\ell,1}\right)^2 + \left(\gamma_{n,2} + \gamma_{\ell,2}\right)^2 + \left(\gamma_{n,3} + \gamma_{\ell,3}\right)^2
\]
We detrend the model by writing trending variables in terms of TFP, since
\[ γ_s = \sqrt{\gamma_n^2} \] is orthogonal. Thus, (R1-1)-(R1-6) and (R2-1)-(R2-6) are satisfied, and there exists a $Q$ that is orthogonal.

**C Baseline DSGE Model**

We detrend the model by writing trending variables in terms of TFP, $\tilde{x}_t \equiv x_t / z_t^{1/(1-\alpha)}$. The equilibrium system is given by

\[ ρ^k_t = \alpha mc_t s_t g_t (\tilde{k}_{t-1}/n_t)^{\alpha-1} \]  
\[ \tilde{w}_t = (1 - \alpha) mc_t s_t g_t^{\alpha/(1-\alpha)} (\tilde{k}_{t-1}/n_t)^{\alpha} \]  
\[ \Delta^p \tilde{y}_t = s_t g_t^{\alpha/(1-\alpha)} (\tilde{k}_{t-1}/n_t)^{1-\alpha} \]  
\[ \tilde{w}_t = \chi n_t^{\eta} \tilde{c}_t \]  
\[ 1 = E_t [x_{t+1} / \pi_{t+1}] \]  
\[ \tilde{c}_t + \bar{c}_t = \tilde{y}_t \]  
\[ \tilde{k}_t = (1 - \delta) \tilde{k}_{t-1} / g_{y,t} + \mu \bar{c}_t \]  
\[ 1 / \mu_t = E_t [x_{t+1} (r^k_{t+1} + (1 - \delta) / \mu_{t+1})] \]  
\[ p_{f,t} = \frac{\epsilon}{\epsilon-1} (\tilde{f}_{1,t} / \tilde{f}_{2,t}) \]
\[ \tilde{f}_{1,t} = m c_t \tilde{y}_t + \theta_p E_t [g_{y,t+1} x_{t+1} (\pi_{t+1}/\bar{\pi})^{\epsilon_p} \tilde{f}_{1,t+1}] \]  
\[ \tilde{f}_{2,t} = \tilde{y}_t + \theta_p E_t [g_{y,t+1} x_{t+1} (\pi_{t+1}/\bar{\pi})^{\epsilon_p} \tilde{f}_{2,t+1}] \]  
\[ \Delta_p^\pi = (1 - \theta_p) p_{f,t}^{1-\epsilon_p} + \theta_p (\pi_t/\bar{\pi})^{\epsilon_p} \Delta_p^\pi \]  
\[ 1 = (1 - \theta_p) p_{f,t}^{1-\epsilon_p} + \theta_p (\pi_t/\bar{\pi})^{\epsilon_p - 1} \]  
\[ x_t = \beta \tilde{c}_{t-1} / (\tilde{c}_g g_{y,t}) \]  
\[ r_t = \tilde{r} (\pi_t/\bar{\pi})^{\phi \alpha} \]  
\[ g_{y,t} = g_t^{1/(1-\alpha)} \]  
\[ \ln s_t = \rho_s \ln s_{t-1} + \sigma_s \varepsilon_{s,t} \]  
\[ \ln g_t = (1 - \rho_g) \ln \tilde{g} + \rho_g \ln g_{t-1} + \sigma_g \varepsilon_{g,t} \]  
\[ \ln \mu_t = \rho_\mu \ln \mu_{t-1} + \sigma_\mu \varepsilon_{\mu,t} \]

\textbf{Table 1:} Baseline DSGE model calibration at quarterly frequency.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount Factor ((\beta))</td>
<td>0.995</td>
<td>Steady-State Hours ((\bar{n}))</td>
<td>0.3333</td>
</tr>
<tr>
<td>Cost Share of Capital ((\alpha))</td>
<td>0.3343</td>
<td>Steady-State TFP Growth Rate ((\bar{g}))</td>
<td>1.0026</td>
</tr>
<tr>
<td>Capital Depreciation Rate ((\delta))</td>
<td>0.025</td>
<td>TFP News Shock Persistence ((\rho_p))</td>
<td>0.6</td>
</tr>
<tr>
<td>Frisch Labor Supply Elasticity (1/(\eta))</td>
<td>0.5</td>
<td>TFP Surprise Shock Persistence ((\rho_s))</td>
<td>0.8</td>
</tr>
<tr>
<td>Goods Elasticity of Substitution ((\epsilon_p))</td>
<td>11</td>
<td>MEI Shock Persistence ((\rho_\mu))</td>
<td>0.9</td>
</tr>
<tr>
<td>Calvo Price Stickiness ((\epsilon_p))</td>
<td>0.75</td>
<td>TFP News Shock SD ((\sigma_g))</td>
<td>0.003</td>
</tr>
<tr>
<td>Taylor Rule Inflation Response ((\phi_\pi))</td>
<td>1.5</td>
<td>TFP Surprise Shock SD ((\sigma_s))</td>
<td>0.007</td>
</tr>
<tr>
<td>Steady-State Inflation Rate ((\bar{\pi}))</td>
<td>1.005</td>
<td>MEI Shock SD ((\sigma_\mu))</td>
<td>0.007</td>
</tr>
</tbody>
</table>

\textbf{D \text{ KS DSGE Model}}

We detrend in the same way as our baseline model except \(\tilde{\lambda}_t \equiv \lambda_t z_{t}^{1/(1-\alpha)}\), \(\tilde{f}_{1,w} \equiv f_{1,w} / z_{t}^{(1+\epsilon_w)/(1-\alpha)}\), and \(\tilde{f}_{2,w} \equiv f_{2,w} / z_{t}^{\epsilon_w/(1-\alpha)}\). The labor share \(\omega_{t,t} = w_{t,t} s_{t,t} / y_{t}\). The equilibrium system is given by

\[ r_{k,t} = \alpha c_t s_t (\tilde{k}_{s,t} / l_{s,t})^{\alpha - 1} \]  
\[ \tilde{w}_{t,t} = (1 - \alpha) m c_t s_t (\tilde{k}_{s,t} / l_{s,t})^{\alpha} \]  
\[ \Delta_p^\pi \tilde{y}_t = s_t \tilde{\lambda}_t^{1 - \alpha} - \tilde{F} \]  
\[ \tilde{\lambda}_t = (\tilde{c}_t - b \tilde{c}_{t-1} / g_{y,t})^{-1} - \beta b E_t [(\tilde{c}_{t+1} g_{y,t+1} - b \tilde{c}_t)^{-1}] \]  
\[ 1 = E_t [x_{t+1} r_t / \pi_{t+1}] \]  
\[ r_{k,t} = \gamma_1 + \gamma_2 (u_t - 1) \]  
\[ \theta \kappa_3 e^{\Delta t} - 1 = \tilde{\lambda}_t \tilde{w}_t h_t \]
\begin{align*}
\theta_k \kappa_1 h_t^{\kappa_2 - 1} &= \lambda_t \tilde{w}_t e_t \\
\theta \left( \kappa_0 + (\kappa_1 / \kappa_2) h_t^{\kappa_2} + (\kappa_3 / \kappa_4) e_t^{\kappa_4} \right) \\
&= \tilde{\lambda}_t \tilde{w}_t \left[ e_t h_t - \frac{\psi}{2} (n_t/n_t - 1)^2 - \psi (n_t/n_{t-1} - 1)(n_t/n_{t-1}) \right] \\
&\quad + \beta \psi E_t \left[ \lambda_{t+1} \tilde{w}_{t+1} (n_{t+1}/n_t - 1)(n_{t+1}/n_t)^2 \right] \\
&\quad + \lambda \psi E_t \left[ (\Phi_{t+1} - \delta) \tilde{w}_t + \mu \tilde{w}_t \right] \\
\kappa_t &= (1 - \delta) \kappa_{t-1} + \mu_t \tilde{w}_t \\
\mu_t &\equiv 1 + \varphi (\Phi_t - \delta) \\
q_t &= E_t \left[ x_{t+1} (r_{k,t+1} + \gamma_1 (u_{t+1} - 1) - \frac{\gamma_2}{2} (u_{t+1} - 1)^2 \\
&\quad - \frac{\gamma}{2} (\Phi_{t+1} - \delta)^2 + \varphi (\Phi_{t+1} - \delta) \Phi_{t+1} + (1 - \delta) q_{t+1}) \right] \\
\Phi_t &= \tilde{\gamma} g_{y,t} / \kappa_{t-1} \\
l_t &= \epsilon_t h_t n_t \\
l_t &= \Delta^w_l s_{t,t} \\
\tilde{k}_{s,t} &= u_t \kappa_{t-1} / g_{y,t} \\
x_t &= \beta \lambda_t / (\lambda_{t-1} g_{y,t}) \\
\tilde{p}_t &= \frac{\epsilon^p}{\epsilon^p - 1} \left( \tilde{f}_1^p / \tilde{f}_2^p \right) \\
\tilde{f}_1^p &= m c_t \tilde{y}_t + \theta_p E_t \left[ x_{t+1} \pi_t^{-\epsilon_p \gamma_p \bar{n} - \epsilon_p (1 - \gamma_p) \pi_t^{-\epsilon_p} \bar{n}_t+1 f_{1,t+1}^p g_{y,t+1} \right] \\
\tilde{f}_2^p &= \tilde{y}_t + \theta_p E_t \left[ x_{t+1} \pi_t^{-\epsilon_p \gamma_p \bar{n} - \epsilon_p (1 - \gamma_p) \pi_t^{-\epsilon_p} \bar{n}_t+1 f_{2,t+1}^p g_{y,t+1} \right] \\
\Delta^p_t &= (1 - \theta_p) \tilde{p}_t^{-\epsilon_p} + \theta_p \pi_t^{-\epsilon_p \gamma_p \bar{n} - \epsilon_p (1 - \gamma_p) \pi_t^{-\epsilon_p} \bar{n}_t+1} \Delta^p_t \\
l_k &= (1 - \theta_k) (\tilde{w}_t^{\epsilon_k} / \tilde{w}_t) + \theta_k \gamma_{w,t} \pi_t^{-\epsilon_k \gamma_k \bar{n} - \epsilon_k (1 - \gamma_k) \pi_t^{-\epsilon_k} \bar{n}_t+1} \Delta^w_t \\
l_{\epsilon_w}^{\epsilon_w} &= (1 - \theta_{\epsilon_w}) (\tilde{w}_t^{\epsilon_k} / \tilde{w}_t) + \theta_{\epsilon_w} \gamma_{\epsilon_w} \pi_t^{-\epsilon_k \gamma \bar{n} - \epsilon_k (1 - \gamma) \pi_t^{-\epsilon_k} \bar{n}_t+1} \Delta^w_t \\
\gamma_{\epsilon_w} &= \gamma_{\epsilon_w} \pi_t^{-\epsilon_k \gamma \bar{n} - \epsilon_k (1 - \gamma) \pi_t^{-\epsilon_k} \bar{n}_t+1} \Delta^w_t \\
\gamma_{\epsilon_w} &= (1 - \theta_{\epsilon_w}) (\tilde{w}_t^{\epsilon_k} / \tilde{w}_t) + \theta_{\epsilon_w} \gamma_{\epsilon_w} \pi_t^{-\epsilon_k \gamma \bar{n} - \epsilon_k (1 - \gamma) \pi_t^{-\epsilon_k} \bar{n}_t+1} \Delta^w_t \\
r_t &= \frac{\rho^{\phi_t}}{\phi_t (\pi_t / \bar{n} \gamma_{\epsilon_w}) (\tilde{y}_t g_{y,t} / (\tilde{y}_t - \bar{g}_y))} \exp (\sigma_{r_t} \epsilon_{r,t}) \\
\tilde{c}_t + \tilde{c}_t + \frac{\gamma}{2} (n_t/n_{t-1} - 1)^2 \tilde{w}_t n_t + \frac{\gamma}{2} (\Phi_t - \delta)^2 \tilde{k}_{t-1} / g_{y,t} \\
+ (\gamma_1 (u_t - 1) + \frac{\gamma}{2} (u_t - 1)^2) \tilde{k}_{t-1} / g_{y,t} = \tilde{y}_t \\
g_{y,t} = g_t^{1/(1 - \alpha)} \\
\ln s_t = \rho_s \ln s_{t-1} + \sigma_s \epsilon_{s,t} \\
\ln g_t = (1 - \rho_g) \ln g + \rho_g \ln g_{t-1} + \sigma_g \epsilon_{g,t} \\
\ln \mu_t = \rho_\mu \ln \mu_{t-1} + \sigma_\mu \epsilon_{\mu,t} \\
\end{align*}
### Table 2: KS DSGE model parameterization at quarterly frequency.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount Factor ($\beta$)</td>
<td>0.99</td>
<td>Taylor Rule Inflation Response ($\phi_{\pi}$)</td>
<td>1.5</td>
</tr>
<tr>
<td>Cost Share of Capital ($\alpha$)</td>
<td>0.3333</td>
<td>Taylor Rule Output Response ($\phi_{y}$)</td>
<td>0.5</td>
</tr>
<tr>
<td>Capital Depreciation Rate ($\delta$)</td>
<td>0.025</td>
<td>Taylor Rule Smoothing ($\rho_r$)</td>
<td>0.8</td>
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<tr>
<td>Utilization Function Curvature ($\gamma_2$)</td>
<td>0.01</td>
<td>Steady-State Inflation Rate ($\bar{\pi}$)</td>
<td>1</td>
</tr>
<tr>
<td>Internal Habit Persistence ($b$)</td>
<td>0.8</td>
<td>Steady-State Employment Share ($\bar{n}$)</td>
<td>3/5</td>
</tr>
<tr>
<td>Capital Adjustment Cost ($\varphi$)</td>
<td>2</td>
<td>Steady-State Labor Preference ($\bar{G}$)</td>
<td>1/3</td>
</tr>
<tr>
<td>Employment Adjustment Cost ($\psi$)</td>
<td>2</td>
<td>Steady-State Effort ($\bar{e}$)</td>
<td>5</td>
</tr>
<tr>
<td>Frisch Elasticity of Hours ($\eta$)</td>
<td>1</td>
<td>Steady-State Hours ($\bar{h}$)</td>
<td>3/5</td>
</tr>
<tr>
<td>Elasticity of Effort to Hours ($\epsilon_{eh}$)</td>
<td>4</td>
<td>Steady-State Output Growth Rate ($\bar{g}_y$)</td>
<td>1.0026</td>
</tr>
<tr>
<td>Goods Elasticity of Substitution ($\epsilon_p$)</td>
<td>11</td>
<td>TFP News Shock Persistence ($\rho_g$)</td>
<td>0.7</td>
</tr>
<tr>
<td>Labor Elasticity of Substitution ($\epsilon_w$)</td>
<td>11</td>
<td>TFP Surprise Shock Persistence ($\rho_s$)</td>
<td>0.9</td>
</tr>
<tr>
<td>Calvo Price Stickiness ($\theta_p$)</td>
<td>0.75</td>
<td>MEI Shock Persistence ($\rho_\mu$)</td>
<td>0.8</td>
</tr>
<tr>
<td>Calvo Wage Stickiness ($\theta_w$)</td>
<td>0.9</td>
<td>TFP News Shock SD ($\sigma_g$)</td>
<td>0.002125</td>
</tr>
<tr>
<td>Price Indexation ($\gamma_p$)</td>
<td>0</td>
<td>TFP Surprise Shock SD ($\sigma_s$)</td>
<td>0.000425</td>
</tr>
<tr>
<td>Wage Indexation ($\gamma_w$)</td>
<td>1</td>
<td>MEI Shock SD ($\sigma_\mu$)</td>
<td>0.000425</td>
</tr>
</tbody>
</table>

### E Additional Results

This section presents several additional results:

- Impulse responses based on the KS estimator and $y_t = (a_t, y_t, i_t)'$ using data simulated from our baseline DSGE model with the KS TFP process and $T = 10,000$ (Figure 1).

- Impulse responses based on the Cholesky news estimator and $y_t = (z_{t+1}, a_t, y_t)'$ using simulated data from our baseline DSGE model with $T = 10,000$ (Figure 2).

- Impulse responses based on the Cholesky news estimator and $y_t = (z_{t+1}, TFP_u, y_t, i_t)'$ using simulated data from the KS DSGE model with $T = 10,000$ (Figure 3).

- Root mean squared errors based on the max share news and Cholesky news estimators, where the news variable is measured with error and the data is simulated from the KS DSGE model with calibrated shock processes and TFP measurement error (Table 3).

- Empirical impulse responses from 9-variable VAR models with alternative TFP news series of different lengths (Figure 4-Figure 7).

- Comparison of the empirical impulse responses from the 9-variable ICT model identified by Cholesky news to the 8-variable KS VAR model identified by TFP max share (Figure 8).
Figure 1: KS max-share identified responses based on the baseline DSGE model with KS TFP

(a) News shock

(b) Surprise shock

Notes: VAR(4) model with $T = 10,000$ and $y_t = (a_t, y_t, i_t)'$. The responses are scaled so the estimated response of TFP matches the population value when the shock first takes effect.

Table 3: RMSE over 40 quarters based on the KS DSGE model with calibrated shock processes

<table>
<thead>
<tr>
<th>Estimator</th>
<th>TFP</th>
<th>Output</th>
<th>Investment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS Max Share</td>
<td>10.3</td>
<td>10.4</td>
<td>19.3</td>
<td>40.0</td>
</tr>
<tr>
<td>Max Share News ($\sigma_n = 0$)</td>
<td>6.4</td>
<td>2.8</td>
<td>7.6</td>
<td>16.8</td>
</tr>
<tr>
<td>Max Share News ($\sigma_n = 0.2\sigma_g$)</td>
<td>6.4</td>
<td>3.0</td>
<td>8.1</td>
<td>17.4</td>
</tr>
<tr>
<td>Max Share News ($\sigma_n = 0.5\sigma_g$)</td>
<td>6.4</td>
<td>3.6</td>
<td>9.1</td>
<td>19.1</td>
</tr>
<tr>
<td>Cholesky News ($\sigma_n = 0$)</td>
<td>6.4</td>
<td>2.7</td>
<td>7.5</td>
<td>16.6</td>
</tr>
<tr>
<td>Cholesky News ($\sigma_n = 0.2\sigma_g$)</td>
<td>5.9</td>
<td>2.9</td>
<td>7.8</td>
<td>16.6</td>
</tr>
<tr>
<td>Cholesky News ($\sigma_n = 0.5\sigma_g$)</td>
<td>4.2</td>
<td>3.8</td>
<td>8.6</td>
<td>16.6</td>
</tr>
</tbody>
</table>

Notes: VAR(4) model with $T = 10,000$, where $y_t = (TPF_u, y_t, i_t)'$ for the KS estimator and $y_t = (z_{t+1}^n, TFP_u, y_t, i_t)'$ for the max share news and Cholesky news estimators.
Figure 2: Cholesky news identified impulse responses based on the baseline DSGE model

(a) News shock

(b) Surprise shock

Notes: VAR(4) model with $T = 10,000$ and $y_t = (z_{t+1}, a_t, y_t)'$. The responses are scaled so the estimated response of TFP matches the population value when the shock first takes effect.
Figure 3: Cholesky news identified responses to news shocks based on the KS DSGE model

(a) KS model with measurement error

(b) KS model with calibrated shock processes and measurement error

Notes: VAR(4) model with $T = 10,000$ and $y_t = (z_{t+1}, \text{TFP}_t^u, y_t, i_t)'$. The responses are not scaled since the estimated responses of TFP tend to be close to zero when the shock first takes effect.
Figure 4: Impulse responses with real R&D expenditures

(a) Cholesky news identified VAR model

(b) Max share news identified VAR model

Notes: Shaded regions represent 1-standard deviation error bands computed by bootstrap.
Figure 5: Impulse responses with the ICT index

(a) Cholesky news identified VAR model

(b) Max share news identified VAR model

Notes: Shaded regions represent 1-standard deviation error bands computed by bootstrap.
Figure 6: Impulse responses with the CGV series

(a) Cholesky news identified VAR model

(b) Max share news identified VAR model

Notes: Shaded regions represent 1-standard deviation error bands computed by bootstrap.
**Figure 7:** Impulse responses with the MAHB series

(a) Cholesky news identified VAR model

(b) Max share news identified VAR model

*Notes:* Shaded regions represent 1-standard deviation error bands computed by bootstrap.
**Figure 8:** Comparison of Cholesky news and TFP max share identified impulse responses

*Notes:* VAR(4) models estimated on identical samples from 1960-2014. Shaded regions represent 1-standard deviation error bands computed by bootstrap for the ICT news model.
REFERENCES


