Can News Be a Major Source of Aggregate Fluctuations?

A Bayesian DSGE Approach

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Outline

Contributions of this paper

- Empirically examine the role of news shocks in explaining the business cycles
  - Previous analyses used bivariate VAR approach to identify the news shocks
  - We instead use a fully specified structural DSGE model to identify the news shocks
  - We apply our procedure to both Japanese and US economies
- Advantages of our approach
  1. Based on standard New Keynesian or New Neoclassical Synthesis models with rich features of frictions in the economy
  2. This class of model can generate expectation-driven cycles (not all model can generate such cycles)
  3. We can rely on setting priors based on former Bayesian estimates

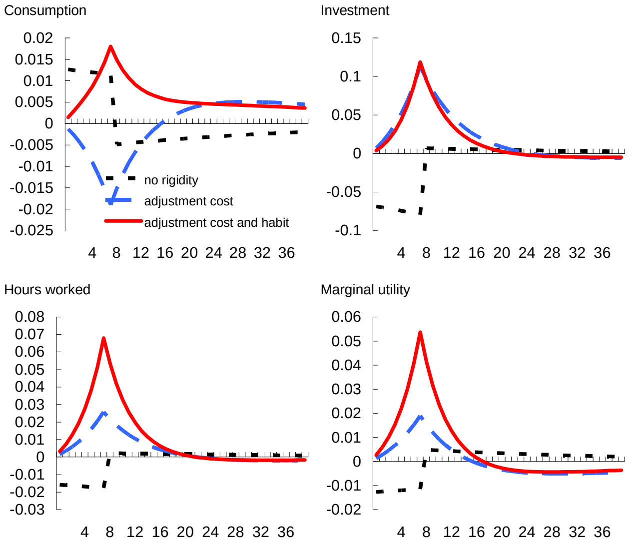
Related literature

- **Pigou cycles (Expectation-driven cycles)**
  - Theoretical analysis
    - Pigou(1926),Barro-King(1984),Beaudry-Portier(2005)
    - Beaudry-Collard-Portier(2006),Jaimovich-Rebelo(2006), Christiano-Ilut-Motto-Rostagno(2007), Denhaan-Kaltenbrunner(2007), Fujiwara(2007),Kobayashi-Nakajima-Inaba(2007)
  - Empirical analysis (based on bivariate VAR)
    - Beaudry-Portier(2005) for Japan
    - Beaudry-Portier(2006) for US
- **Bayesian estimation of CEE type DSGE model**
  - CEE model (a standard New-Keynesian model?)
    - Christiano-Eichenbaum-Evans(2005)
    - Bayesian estimation
    - Smets-Wouters(2003) for Euro and Smets-Wouters(2007) for US
    - Sugo-Ueda(2008) for Japan
- No empirical work of news shock under DSGE framework!

Expectation-driven cycles - how does it work?

- News about future rise in TFP (e.g., 8-period ahead)
- Frictionless economy (standard RBC model)
  - If income effect dominates, $c \uparrow$, $l \downarrow$, $y \downarrow$, $i = y - c \downarrow$
  - (If substitution effect dominates, $i, l \uparrow\uparrow$, $y \uparrow$, $c = y - i \downarrow$)
  - negative c-i correlation, negative c-l correlation
  - cannot produce business cycles (Barro-King, 1984)
- Economy with frictions
  - introduce **(1) adjustment cost to change investment, and (2) consumption habit**
  - with (1) $i \uparrow\uparrow$ and $c = y - i \downarrow$ but (2) implies consumption smoothing and $c = y - i \uparrow$
  - CEE model has this feature (Christiano-Ilut-Motto-Rostagno,2007)

Figure: Expectation driven cycles



Beaudry-Portier's VAR approach

- Bivariate VAR system of TFP and stock price

$$\begin{bmatrix} a_{1,1}(L) & a_{1,2}(L) \\ a_{2,1}(L) & a_{2,2}(L) \end{bmatrix} \begin{bmatrix} \Delta TFP_t \\ \Delta Stock\ Price_t \end{bmatrix} = \begin{bmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{bmatrix}$$

  - stock price is forward-looking variable
  - **identifying restriction**: stock price innovation $\epsilon_{2,t}$ has no contemporaneous impact on TFP (but has a long-run impact)

$$a_{1,2}^{(0)} = 0$$

  - alternative identifying assumption using a long-run restriction $a_{1,2}(1) = 0$ then use $\epsilon_{1,t}$
  - can be generalized to 3-variable and 4-variable VARs
- For both Japan and US, identified shock $\epsilon_{2,t}$ generates hump-shaped response of consumption and hours $\Rightarrow$ evidence of news driven cycles
- In Japan, one half of the stock market fall in the 1990s is due to downward revisions for future TFP

Outline

1. Introduction
2. The Model
3. Estimation Strategy
4. Results
5. Conclusion

- Households
  - **consumption habit**: household j maximize $U(C, L) = \ln C^* - L^*$ where $C^* = \frac{1}{1-\sigma_c}\left(C_t(j) - \lambda C_{t-1}\right)^{1-\sigma_c}$ and $L^* = \frac{1-\sigma_c}{1+\sigma_l} L_t(j)^{1+\sigma_l}$
- Firms
  - final good producers use intermediate good i
  - producers of intermediate good i use capital and labor
  - **adjustment cost of investment**: $I_t - S\left(v_t I_t / I_{t-1}\right) I_t$
  - choose utilization rate of capital
  - **sticky price**: set prices monopolistically but cannot change with prob. ξ_p (with inflation indexation ι_p)
- Labor union
  - **sticky wage**: set wage monopolistically but cannot change with prob. ξ_w (with inflation indexation ι_w)
- Government (monetary authority)
  - controls interest rate using Taylor rule

News shocks in productivity

- Production function (in log deviations)

$$y_t = \phi_p \left[\alpha k_t^s + (1-\alpha)\, l_t + z_t\right]$$

ϕ_p: one plus the share of the fixed costs in production α: capital share

- Total factor productivity (TFP) follows an AR(1)

$$\begin{aligned} z_t &= \rho_z z_{t-1} + \varepsilon_t^z \\ &= \rho_z z_{t-1} + \nu_{0,t} + \nu_t^* \end{aligned}$$

- Technological innovation $\varepsilon_t^z \sim$ iid $N(0, \sigma_z^2)$ decomposed into
  1. Unexpected component

$$\nu_{0,t} \sim \text{iid } N(0, \sigma_{z0}^2)$$

  2. Expected component (news shocks)

$$\nu_t^* = \sum_{j=1}^{n} \nu_{j,t-j} \sim \text{iid } N(0, \sum_{j=1}^{n} \sigma_{zj}^2)$$

- When $n = 4$ (news shocks up to 4 period ahead)

$$z_t = \rho_z z_{t-1} + \nu_{0,t} + \nu_{1,t-1} + \nu_{2,t-2} + \nu_{3,t-3} + \nu_{4,t-4}$$

- Canonical form $\mathbf{s}_t = A\mathbf{s}_{t-1} + \varepsilon_t$

$$\mathbf{s}_t = \begin{bmatrix} z_t \\ \nu_{1,t} \\ \nu_{2,t} \\ \nu_{2,t-1} \\ \nu_{3,t} \\ \nu_{3,t-1} \\ \nu_{3,t-2} \\ \nu_{4,t} \\ \nu_{4,t-1} \\ \nu_{4,t-2} \\ \nu_{4,t-3} \end{bmatrix}, \quad \varepsilon_t = \begin{bmatrix} \nu_{0,t} \\ \nu_{1,t} \\ \nu_{2,t} \\ 0 \\ \nu_{3,t} \\ 0 \\ 0 \\ \nu_{4,t} \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$A = \begin{bmatrix} \rho_z & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

How does it work?

- When $n = 2$ (news shock at 2 period ahead only), at t

$$\begin{pmatrix} z_t \\ \nu_{2,t} \\ \nu_{2,t-1} \end{pmatrix} = \begin{pmatrix} \rho_z & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} z_{t-1} \\ \nu_{2,t-1} \\ \nu_{2,t-2} \end{pmatrix} + \begin{pmatrix} 0 \\ \nu_{2,t} \\ 0 \end{pmatrix}$$

then, forecasted value of z_{t+2} at t is given by

$$\begin{aligned} \mathrm{E}_t \begin{pmatrix} z_{t+2} \\ \nu_{2,t+1} \\ \nu_{2,t} \end{pmatrix} &= \begin{pmatrix} \rho_z & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}^2 \begin{pmatrix} z_t \\ \nu_{2,t} \\ \nu_{2,t-1} \end{pmatrix} \\ &= \begin{pmatrix} \rho_z^2 & 1 & \rho_z \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 \\ \nu_{2,t} \\ 0 \end{pmatrix} \end{aligned}$$

How does it differ?

- When $n = 0$ (no news shocks, unexpected part only)

$$z_t = \rho_z z_{t-1} + \nu_{0,t}$$

then,

$$\begin{aligned} E_t z_{t+1} &= \rho_z z_{t-1}, \quad E_t z_{t+2} = \rho_z^2 z_{t-1} \\ E_t z_{t+3} &= \rho_z^3 z_{t-1}, \quad E_t z_{t+4} = \rho_z^4 z_{t-1} \end{aligned}$$

- When $n = 4$ (news shocks up to 4 period ahead)

$$z_t = \rho_z z_{t-1} + \nu_{0,t} + \nu_{1,t-1} + \nu_{2,t-2} + \nu_{3,t-3} + \nu_{4,t-4}$$

then,

$$\begin{aligned} E_t z_{t+1} &= \rho_z z_{t-1} + (\nu_{1,t} + \nu_{2,t-1} + \nu_{3,t-2} + \nu_{4,t-3}) \\ E_t z_{t+2} &= \rho_z^2 z_{t-1} + \rho_z (\nu_{1,t} + \nu_{2,t-1} + \nu_{3,t-2} + \nu_{4,t-3}) \\ &\quad + (\nu_{2,t} + \nu_{3,t-1} + \nu_{4,t-2}) \\ E_t z_{t+3} &= \rho_z^3 z_{t-1} + \rho_z^2 (\nu_{1,t} + \nu_{2,t-1} + \nu_{3,t-2} + \nu_{4,t-3}) \\ &\quad + \rho_z (\nu_{2,t} + \nu_{3,t-1} + \nu_{4,t-2}) + (\nu_{3,t} + \nu_{4,t-1}) \\ E_t z_{t+4} &= \rho_z^4 z_{t-1} + \rho_z^3 (\nu_{1,t} + \nu_{2,t-1} + \nu_{3,t-2} + \nu_{4,t-3}) \\ &\quad + \rho_z^2 (\nu_{2,t} + \nu_{3,t-1} + \nu_{4,t-2}) + \rho_z (\nu_{3,t} + \nu_{4,t-1}) + \nu_{4,t} \end{aligned}$$

Other equations

- Remaining parts of the model is slightly simplified version of Smets and Wouters (2007)
- 13 equations (including production function)
    1. y_t: output
    2. c_t: consumption
    3. i_t: investment
    4. q_t: real value of existing capital
    5. k_t^s: current capital services in production
    6. k_t: physical capital
    7. u_t: capacity utilization rate
    8. r_t^k: rental rate of capital
    9. μ_t^p: price markup
    10. π_t: inflation rate
    11. w_t: nominal wage
    12. l_t: hours worked
    13. r_t: nominal interest rate

Other shocks

- 5 additional exogenous variables (other than technology related disturbances)
  1. g_t: government expenditure shock
  2. v_t: investment specific technology shock
  3. m_t: monetary policy shock
  4. a_t: cost push shock
  5. b_t: wage mark-up shock
- Each shock follows an AR(1) process

$$
\begin{aligned}
g_t &= \rho_g g_{t-1} + \varepsilon_t^g, \quad \varepsilon_t^g \sim \text{iid } N(0, \sigma_g^2) \\
v_t &= \rho_v v_{t-1} + \varepsilon_t^v, \quad \varepsilon_t^v \sim \text{iid } N(0, \sigma_v^2) \\
m_t &= \rho_m m_{t-1} + \varepsilon_t^m, \quad \varepsilon_t^m \sim \text{iid } N(0, \sigma_m^2) \\
a_t &= \rho_a a_{t-1} + \varepsilon_t^a, \quad \varepsilon_t^a \sim \text{iid } N(0, \sigma_a^2) \\
b_t &= \rho_b b_{t-1} + \varepsilon_t^b, \quad \varepsilon_t^b \sim \text{iid } N(0, \sigma_b^2)
\end{aligned}
$$

- When $n = 4$, total number of shocks is 10

- Current capital services used in production

$$k_t^s = k_{t-1} + u_t$$

- Capacity utilization rate

$$u_t = \frac{1-\psi}{\psi} r_t^k$$

$0 < \psi < 1$: fun. of elasticity of capacity utilization adjustment cost fun.

- Aggregate resource constraint

$$y_t = \frac{c}{y} c_t + \frac{i}{y} i_t + \frac{r^k k}{y} u_t + g_t$$

- Consumption Euler equation

$$c_t = \frac{\lambda}{\gamma\left(1+\frac{\lambda}{\gamma}\right)} c_{t-1} + \left[1 - \frac{\lambda}{\gamma\left(1+\frac{\lambda}{\gamma}\right)}\right] \mathrm{E}_t c_{t+1} + \frac{(\sigma_c - 1)\left(\frac{wl}{C}\right)}{\sigma_c\left(1+\frac{\lambda}{\gamma}\right)} (l_t - \mathrm{E}_t l_{t+1}) - \frac{1-\frac{\lambda}{\gamma}}{\sigma_c\left(1+\frac{\lambda}{\gamma}\right)} (r_t - \mathrm{E}_t \pi_{t+1})$$

λ: parameter on the external habit, γ: steady state growth rate, σ_c: inverse of the intertemporal elasticity of substitution

- Investment Euler equation

$$i_t = \frac{1}{1+\beta\gamma^{1-\sigma_c}} i_{t-1} + \left(1 - \frac{1}{1+\beta\gamma^{1-\sigma_c}}\right) \mathrm{E}_t i_{t+1} + \frac{1}{(1+\beta\gamma^{1-\sigma_c})\,\gamma^2\varphi} q_t + v_t$$

β: subjective discount factor, φ: steady state elasticity of the investment adjustment cost fun.

- Capital Euler equations

$$\begin{aligned} q_t &= \beta\gamma^{-\sigma_c}(1-\delta)\,\mathrm{E}_t q_{t+1} + \left[1-\beta\gamma^{-\sigma_c}(1-\delta)\right]\mathrm{E}_t r^k_{t+1} \\ &\quad -(r_t - \mathrm{E}_t\pi_{t+1}), \end{aligned}$$

δ: capital depreciation rate

- Capital accumulation

$$k_t = \frac{1-\delta}{\gamma}k_{t-1} + \left(1-\frac{1-\delta}{\gamma}\right)i_t + \left(1-\frac{1-\delta}{\gamma}\right)\left(1+\beta\gamma^{1-\sigma_c}\right)\gamma^2\varphi v_t$$

- Rental rate of capital

$$r^k_t = -\left(k^s_t - l_t\right) + w_t$$

- New Keynesian Phillips curve

$$\pi_t = \frac{\iota_p}{1+\beta\gamma^{1-\sigma_c}\iota_p}\pi_{t-1}\frac{\beta\gamma^{1-\sigma_c}}{1+\beta\gamma^{1-\sigma_c}\iota_p}\mathrm{E}_t\pi_{t+1} - \frac{\left(1-\beta\gamma^{1-\sigma_c}\xi_p\right)\left(1-\xi_p\right)}{\left(1+\beta\gamma^{1-\sigma_c}\iota_p\right)\xi_p\left[\left(\phi_p-1\right)\epsilon_p+1\right]}\mu_t^p + a_t$$

ι_p: degree of indexation to past inflation, ξ_p: degree of price stickiness, ϵ_p: curvature of goods market aggregator

- Price markup

$$\mu_t^p = \alpha\left(k_t^s - l_t\right) + z_t - w_t$$

- Monetary policy rule

$$r_t = \rho r_{t-1} + (1-\rho)\left(r_\pi \pi_t + r_y \Delta y_t\right) + m_t$$

ρ, r_π, r_y: positive policy parameters

- Wage Phillips curve

$$
\begin{aligned}
w_t \quad = \quad & \frac{1}{1+\beta\gamma^{1-\sigma_c}} w_{t-1} + \left(1 - \frac{1}{1+\beta\gamma^{1-\sigma_c}}\right)\left(\mathrm{E}_t w_{t+1} + \mathrm{E}_t \pi_{t+1}\right) \\
& - \frac{1+\beta\gamma^{1-\sigma_c}\iota_w}{1+\beta\gamma^{1-\sigma_c}} \pi_t + \frac{\iota_w}{1+\beta\gamma^{1-\sigma_c}} \pi_{t-1} \\
& - \frac{\left(1-\beta\gamma^{1-\sigma_c}\xi_w\right)\left(1-\xi_w\right)}{(1+\beta\gamma^{1-\sigma_c})\xi_w\left[\left(\phi_w - 1\right)\epsilon_w + 1\right]} \mu_t^w + b_t,
\end{aligned}
$$

ι_w: degree of indexation to past wage inflation, ξ_w: degree of nominal wage stickiness, ϵ_w: curvature of the labor market aggregator

- Wage markup

$$
\mu_t^w = w_t - \left[\sigma_l l_t + \frac{1}{1-\frac{\lambda}{\gamma}}\left(c_t - \frac{\lambda}{\gamma} c_{t-1}\right)\right]
$$

σ_l: elasticity of labor supply to the real wage

Outline

Solution of DSGE model

- Log-linearized rational expectations system

$$\Gamma_0(\theta)\,\mathbf{s}_t = \Gamma_1(\theta)\,\mathbf{s}_{t-1} + \Psi_0(\theta)\,\boldsymbol{\varepsilon}_t + \Pi_0(\theta)\,\boldsymbol{\eta}_t$$

  - $\mathbf{s}_t$: 36×1 endogenous variable vector (13 non-expectation variables, 6 shocks, 7 expectation variables, 10 news shocks)
  - $\boldsymbol{\varepsilon}_t$: 10×1 fundamental shock vector
  - $\widehat{\mathbf{s}}_t$: 7×1 subvector of $\mathbf{s}_t$ for expectation variables
  - $\boldsymbol{\eta}_t = \widehat{\mathbf{s}}_t - E_{t-1}\widehat{\mathbf{s}}_t$: 7×1 forecast errors
  - θ: 23×1 structural parameters

- RE solution takes the form

$$\mathbf{s}_t = \Gamma(\theta)\,\mathbf{s}_{t-1} + \Psi(\theta)\,\boldsymbol{\varepsilon}_t$$

- Only consider a space of θ that leads to equilibrium determinacy

$$\Gamma_0(\theta)\begin{bmatrix} y_t \\ c_t \\ i_t \\ q_t \\ k_t^s \\ k_t \\ u_t \\ r_t^k \\ \mu_t^p \\ \pi_t \\ w_t \\ l_t \\ r_t \\ z_t \\ g_t \\ v_t \\ m_t \\ a_t \\ b_t \\ E_t i_{t+1} \\ E_t r_{t+1}^k \\ E_t q_{t+1} \\ E_t c_{t+1} \\ E_t l_{t+1} \\ E_t \pi_{t+1} \\ E_t w_{t+1} \\ \nu_{1,t} \\ \nu_{2,t} \\ \nu_{2,t-1} \\ \nu_{3,t} \\ \nu_{3,t-1} \\ \nu_{3,t-2} \\ \nu_{4,t} \\ \nu_{4,t-1} \\ \nu_{4,t-2} \\ \nu_{4,t-3} \end{bmatrix} = \Gamma_1(\theta)\begin{bmatrix} y_{t-1} \\ c_{t-1} \\ i_{t-1} \\ q_{t-1} \\ k_{t-1}^s \\ k_{t-1} \\ u_{t-1} \\ r_{t-1}^k \\ \mu_{t-1}^p \\ \pi_{t-1} \\ w_{t-1} \\ l_{t-1} \\ r_{t-1} \\ z_{t-1} \\ g_{t-1} \\ v_{t-1} \\ m_{t-1} \\ a_{t-1} \\ b_{t-1} \\ E_{t-1} i_t \\ E_{t-1} r_t^k \\ E_{t-1} q_t \\ E_{t-1} c_t \\ E_{t-1} l_t \\ E_{t-1} \pi_t \\ E_{t-1} w_t \\ \nu_{1,t-1} \\ \nu_{2,t-1} \\ \nu_{2,t-2} \\ \nu_{3,t-1} \\ \nu_{3,t-2} \\ \nu_{3,t-3} \\ \nu_{4,t-1} \\ \nu_{4,t-2} \\ \nu_{4,t-3} \\ \nu_{4,t-4} \end{bmatrix} + \Psi_0(\theta)\begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^v \\ \varepsilon_t^m \\ \varepsilon_t^a \\ \varepsilon_t^b \\ \nu_{0,t} \\ \nu_{1,t} \\ \nu_{2,t} \\ \nu_{3,t} \\ \nu_{4,t} \end{bmatrix} + \Pi_0(\theta)\begin{bmatrix} i_t - E_{t-1} i_t \\ r_t^k - E_{t-1} r_t^k \\ q_t - E_{t-1} q_t \\ c_t - E_{t-1} c_t \\ l_t - E_{t-1} l_t \\ \pi_t - E_{t-1} \pi_t \\ w_t - E_{t-1} w_t \end{bmatrix}$$

Bayesian Estimation of DSGE model

- State-space representation
  1. Measurement equation
$$Y_t = \mu + W\mathbf{s}_t$$
     (Y_t = (7) observed variables, $\mathbf{s}_t$ = (36) latent variables)
  2. Transition equation (RE solution)
$$\mathbf{s}_t = \Gamma \mathbf{s}_{t-1} + \Psi \varepsilon_t, \quad \varepsilon_t \sim \text{iid } N(0, \Sigma_\varepsilon)$$
- Kalman filter
  1. Prediction ($\mathbf{s}_{t|t-1} = \mathrm{E}\left[\mathbf{s}_t | Y_1, ..., Y_{t-1}\right]$)
$$\begin{aligned} \mathbf{s}_{t|t-1} &= \Gamma \mathbf{s}_{t-1|t-1} \\ \mathbf{P}_{t|t-1} &= \Gamma \mathbf{P}_{t-1|t-1} \Gamma' + \Psi\Psi' \end{aligned}$$
  2. Updating ($\eta_{t|t-1} = Y_t - \mu - W\mathbf{s}_{t|t-1}$)
$$\begin{aligned} \mathbf{s}_{t|t} &= \mathbf{s}_{t-1|t-1} + K_t \eta_{t|t-1} \\ \mathbf{P}_{t|t} &= \mathbf{P}_{t|t-1} - K_t W \mathbf{P}_{t|t-1} \end{aligned}$$
     ($K_t = \mathbf{P}_{t|t-1} W' \left[W \mathbf{P}_{t|t-1} W' \right]^{-1}$ is Kalman gain)

- Likelihood function
  $\varepsilon_t \sim N(0, \Sigma_\varepsilon)$ implies $\eta_{t|t-1} \sim N(0, W\mathbf{P}_{t|t-1}W')$,

$$\begin{aligned} \ln L\left(\theta|Y^T\right) &= -\frac{nT}{2}\sum_{t=1}^{T}\ln 2\pi - \frac{1}{2}\sum_{t=1}^{T}\ln\left|W\mathbf{P}_{t|t-1}W'\right| \\ &\quad -\frac{1}{2}\sum_{t=1}^{T}\eta'_{t|t-1}\left[W\mathbf{P}_{t|t-1}W'\right]^{-1}\eta_{t|t-1} \end{aligned}$$

- Posterior distribution

$$p\left(\theta|Y^T\right) = \frac{L\left(\theta|Y^T\right)p\left(\theta\right)}{\int L\left(\theta|Y^T\right)p\left(\theta\right)d\theta}$$

  Draws from posterior = RW Metropolis-Hastings algorithm

- Marginal likelihood

$$p\left(Y^T\right) = \int L(\theta|Y^T)p(\theta)d\theta$$

Data and Priors

- 7 aggregate variables
  1. log difference of real GDP
  2. log difference of real consumption
  3. log difference of real investment
  4. log difference of real wage
  5. log of hours worked
  6. log difference of CPI (GDP deflators for US)
  7. overnight call rate (federal funds rate for US)
- Japan
  - Sugo and Ueda (2008) data and priors
  - Sample period: 1981:2 to 1998:4
  - Excludes zero interest rate policy period
- US
  - Smets and Wouters (2007) data and priors
  - Sample period: 1983:1 to 2004:4
  - Excludes period of indeterminacy (pre-Volcker)

Outline

Finding 1: Importance of the News Shock

"News shocks play an important role in business cycles."

- Variance decomposition
  $\Rightarrow$ Table 2
- Impulse Responses
  $\Rightarrow$ Figure 1
- Relative contribution
  $\Rightarrow$ Table 3

Table 2A: Variance Decomposition - Japan

Shock	Mean	90% interval	Shock	Mean	90% interval
Consumption			Inflation		
Unexpected productivity	41.01	[31.61, 51.61]	Unexpected productivity	16.74	[9.66, 23.20]
News 1 period ahead	1.07	[0.25, 1.84]	News 1 period ahead	0.74	[0.16, 1.32]
News 2 periods ahead	0.69	[0.18, 1.24]	News 2 periods ahead	1.92	[0.42, 3.34]
News 3 periods ahead	1.27	[0.27, 2.32]	News 3 periods ahead	5.23	[1.18, 9.30]
News 4 periods ahead	1.72	[0.36, 3.04]	News 4 periods ahead	7.49	[1.74, 12.86]
Exogenous spending	8.75	[5.46, 11.68]	Exogenous spending	2.30	[0.92, 3.63]
Investment	28.05	[18.25, 37.21]	Investment	33.89	[21.34, 45.73]
Monetary policy	3.84	[2.11, 5.59]	Monetary policy	20.87	[11.44, 30.10]
Price mark-up	2.81	[1.14, 4.39]	Price mark-up	7.26	[3.36, 10.52]
Wage mark-up	10.77	[5.41, 15.74]	Wage mark-up	3.55	[1.03, 5.94]
Investment			Wage		
Unexpected productivity	4.06	[1.71, 6.35]	Unexpected productivity	42.77	[31.94, 54.43]
News 1 period ahead	0.23	[0.04, 0.42]	News 1 period ahead	2.57	[0.65, 4.29]
News 2 periods ahead	0.18	[0.04, 0.35]	News 2 periods ahead	1.54	[0.39, 2.77]
News 3 periods ahead	0.31	[0.04, 0.58]	News 3 periods ahead	1.89	[0.35, 3.40]
News 4 periods ahead	0.47	[0.07, 0.86]	News 4 periods ahead	2.36	[0.54, 4.11]
Exogenous spending	0.61	[0.09, 1.09]	Exogenous spending	0.16	[0.02, 0.35]
Investment	90.62	[85.71, 95.93]	Investment	1.46	[0.22, 2.81]
Monetary policy	0.06	[0.01, 0.12]	Monetary policy	4.40	[1.68, 7.16]
Price mark-up	1.27	[0.20, 2.37]	Price mark-up	38.90	[27.85, 48.31]
Wage mark-up	2.18	[0.55, 3.98]	Wage mark-up	3.96	[1.82, 6.08]

Output			Interest rate		
Unexpected productivity	53.93	[43.38, 67.58]	Unexpected productivity	10.30	[5.04, 15.84]
News 1 period ahead	1.81	[0.46, 3.06]	News 1 period ahead	0.49	[0.11, 0.91]
News 2 periods ahead	1.11	[0.30, 2.01]	News 2 periods ahead	1.44	[0.33, 2.56]
News 3 periods ahead	1.89	[0.43, 3.45]	News 3 periods ahead	4.76	[1.09, 8.53]
News 4 periods ahead	2.63	[0.57, 4.65]	News 4 periods ahead	8.01	[1.51, 13.78]
Exogenous spending	4.58	[2.40, 7.00]	Exogenous spending	3.93	[1.96, 6.05]
Investment	6.22	[2.98, 9.08]	Investment	61.76	[49.28, 74.46]
Monetary policy	5.10	[3.10, 7.30]	Monetary policy	1.20	[0.35, 2.08]
Price mark-up	6.40	[3.44, 9.59]	Price mark-up	4.78	[2.07, 7.28]
Wage mark-up	16.34	[10.12, 23.18]	Wage mark-up	3.33	[0.78, 5.86]
Hours					
Unexpected productivity	3.01	[0.10, 6.57]			
News 1 period ahead	0.34	[0.01, 0.69]			
News 2 periods ahead	0.31	[0.02, 0.62]			
News 3 periods ahead	0.51	[0.02, 1.09]			
News 4 periods ahead	0.65	[0.02, 1.41]			
Exogenous spending	2.68	[0.27, 5.28]			
Investment	4.82	[0.86, 9.00]			
Monetary policy	0.55	[0.03, 1.02]			
Price mark-up	6.61	[0.23, 13.68]			
Wage mark-up	80.51	[64.06, 97.90]			

Table 2B: Variance Decomposition - US

Shock	Mean	90% interval	Shock	Mean	90% interval
Consumption			Inflation		
Unexpected productivity	17.17	[10.70, 24.42]	Unexpected productivity	8.48	[4.35, 12.48]
News 1 period ahead	5.07	[0.76, 9.15]	News 1 period ahead	0.82	[0.11, 1.52]
News 2 periods ahead	4.46	[0.63, 7.82]	News 2 periods ahead	2.18	[0.24, 4.03]
News 3 periods ahead	3.54	[0.32, 6.42]	News 3 periods ahead	5.62	[1.17, 9.83]
News 4 periods ahead	2.36	[0.29, 4.29]	News 4 periods ahead	8.10	[2.00, 13.62]
Exogenous spending	3.41	[1.19, 5.48]	Exogenous spending	3.60	[1.81, 5.29]
Investment	4.40	[0.85, 7.76]	Investment	20.39	[11.65, 27.95]
Monetary policy	6.78	[4.36, 9.25]	Monetary policy	23.44	[14.16, 31.59]
Price mark-up	7.32	[3.92, 10.46]	Price mark-up	13.88	[7.35, 19.50]
Wage mark-up	45.48	[37.20, 54.80]	Wage mark-up	13.49	[8.39, 18.42]
Investment			Wage		
Unexpected productivity	5.01	[1.66, 7.86]	Unexpected productivity	8.29	[4.02, 12.58]
News 1 period ahead	0.87	[0.09, 1.68]	News 1 period ahead	4.07	[0.53, 7.69]
News 2 periods ahead	0.79	[0.06, 1.56]	News 2 periods ahead	5.75	[1.09, 10.40]
News 3 periods ahead	0.92	[0.10, 1.71]	News 3 periods ahead	5.68	[0.79, 9.84]
News 4 periods ahead	1.27	[0.14, 2.28]	News 4 periods ahead	3.93	[0.58, 7.33]
Exogenous spending	2.61	[0.87, 4.43]	Exogenous spending	1.47	[0.38, 2.62]
Investment	69.00	[56.40, 80.37]	Investment	0.86	[0.26, 1.47]
Monetary policy	0.82	[0.16, 1.55]	Monetary policy	6.45	[3.63, 9.27]
Price mark-up	5.92	[1.85, 9.54]	Price mark-up	43.87	[33.09, 54.57]
Wage mark-up	12.77	[6.92, 18.71]	Wage mark-up	19.63	[13.01, 26.54]

Output			Interest rate		
Unexpected productivity	13.36	[7.32, 19.27]	Unexpected productivity	8.77	[4.57, 13.05]
News 1 period ahead	3.66	[0.52, 6.56]	News 1 period ahead	1.31	[0.17, 2.37]
News 2 periods ahead	3.18	[0.54, 5.77]	News 2 periods ahead	2.13	[0.32, 3.81]
News 3 periods ahead	2.38	[0.30, 4.28]	News 3 periods ahead	4.86	[0.78, 8.36]
News 4 periods ahead	1.57	[0.25, 2.76]	News 4 periods ahead	7.50	[1.36, 12.37]
Exogenous spending	21.09	[14.90, 26.42]	Exogenous spending	6.64	[3.63, 9.21]
Investment	4.55	[1.99, 7.13]	Investment	43.13	[27.39, 55.84]
Monetary policy	5.17	[3.26, 7.04]	Monetary policy	4.52	[2.10, 6.60]
Price mark-up	9.44	[5.21, 13.27]	Price mark-up	7.82	[3.94, 11.70]
Wage mark-up	35.60	[27.85, 43.67]	Wage mark-up	13.33	[8.04, 18.69]
Hours					
Unexpected productivity	5.39	[1.51, 9.38]			
News 1 period ahead	1.23	[0.06, 2.51]			
News 2 periods ahead	1.42	[0.22, 2.63]			
News 3 periods ahead	1.73	[0.18, 3.26]			
News 4 periods ahead	1.62	[0.19, 3.20]			
Exogenous spending	3.30	[1.26, 5.37]			
Investment	1.78	[0.59, 2.98]			
Monetary policy	0.42	[0.19, 0.64]			
Price mark-up	4.13	[1.06, 7.18]			
Wage mark-up	78.97	[68.26, 89.85]			

Figure 1: Impulse Responses - Japan

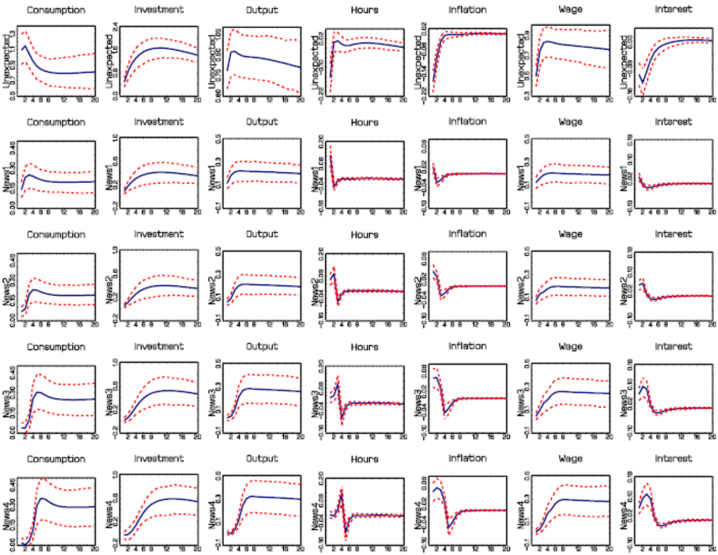


Table 3A: Marginal Likelihood and News Shocks

Japan

	Baseline	Case 1	Case 2	Case 3	Case 4	Case 5
Marginal likelihood: $\ln p(Y^T)$	-495.00	-524.59	-518.60	-507.69	-502.54	-528.00
			Output			
Unexpected shock	53.93	62.72	58.91	67.77	66.47	-
News shocks (in total)	7.44	8.68	6.44	6.16	7.17	42.93
News 1 period ahead	1.81	8.68	-	-	-	20.99
News 2 periods ahead	1.11	-	6.44	-	-	7.99
News 3 periods ahead	1.89	-	-	6.16	-	6.81
News 4 periods ahead	2.63	-	-	-	7.17	7.14
			Inflation			
Unexpected shock	16.74	32.63	20.88	19.56	17.44	-
News shocks (in total)	15.38	9.11	10.34	18.72	18.52	42.06
News 1 period ahead	0.74	9.11	-	-	-	11.17
News 2 periods ahead	1.92	-	10.34	-	-	7.02
News 3 periods ahead	5.23	-	-	18.72	-	10.56
News 4 periods ahead	7.49	-	-	-	18.52	13.31

Table 3B: Marginal Likelihood and News Shocks

US

	Baseline	Case 1	Case 2	Case 3	Case 4	Case 5
Marginal likelihood: $\ln p(Y^T)$	-445.58	-472.39	-485.31	-498.29	-496.05	-466.79
Output						
Unexpected shock	13.36	15.93	26.53	19.04	19.70	-
News shocks (in total)	10.79	24.26	12.07	7.16	6.45	23.93
News 1 period ahead	3.66	24.16	-	-	-	10.70
News 2 periods ahead	3.18	-	12.07	-	-	5.92
News 3 periods ahead	2.38	-	-	7.16	-	4.79
News 4 periods ahead	1.57	-	-	-	6.45	2.52
Inflation						
Unexpected shock	8.48	22.83	21.98	16.50	17.12	-
News shocks (in total)	16.72	13.44	11.46	21.37	22.00	24.02
News 1 period ahead	0.82	13.44	-	-	-	3.91
News 2 periods ahead	2.81	-	11.46	-	-	2.88
News 3 periods ahead	5.62	-	-	21.37	-	7.47
News 4 periods ahead	8.10	-	-	-	22.00	9.76

Finding 2: Asymmetric Response of Inflation

"A news shocks with a longer forecast horizon has larger effects on nominal variables."

- Importance of horizons in impulse responses
  $\Rightarrow$ Figure 1

Finding 3: Technology Shocks and Hours Worked

"Overall effect of the TFP on hours worked becomes ambiguous with news shocks."

- Output, hours, and productivity
  $\Rightarrow$ Figure 2

- TFP's effect on hours worked was a very hot economic issue in the US.
  - Keynesian vs Neoclassical, then SVAR vs BCA

1. Neoclassical: Kydlarnd and Prescott (1980)

$$\overset{\uparrow}{Y}_t = \overset{\Uparrow}{Z}_t \overset{\uparrow}{L}_t{}^{1-\alpha}\ \overline{K_t}{}^{\alpha}$$

2. Keynesian: Gali (1999)

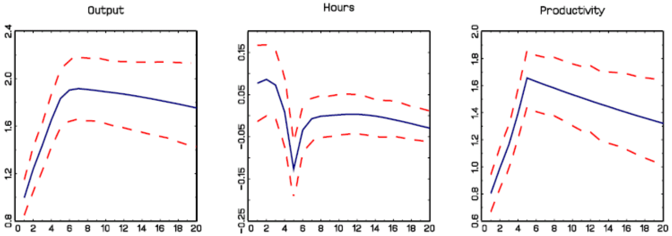
$$k\overline{M}_t/\overline{P}_t = \overline{Y_t} = \overset{\Uparrow}{Z}_t\ \overset{\downarrow}{L}_t{}^{1-\alpha}\ \overline{K_t}{}^{\alpha}$$

3. Neoclassical with habit and investment adjustment cost: Vigfusson (2004)

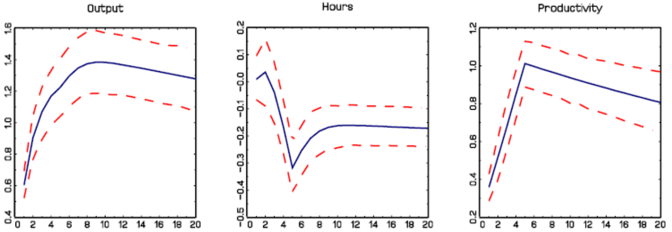
$$\overline{C_t} + \overline{I_t} = \overline{Y_t} = \overset{\Uparrow}{Z}_t\ \overset{\downarrow}{L}_t{}^{1-\alpha}\ \overline{K_t}{}^{\alpha}$$

Figure 2: Impulse Responses to Overall TFP Shocks

Japan



US



Outline

1. Introduction
2. The Model
3. Estimation Strategy
4. Results
5. Conclusion

Conclusion

1. Bayesian approach in the estimation of DSGE model provide a useful framework of identifying news shocks from data
2. News shocks seems to be one of the important driving forces of business cycles
3. The results are robust for both in Japan and US

- Possible extensions
  - news component in shocks other than TFP
  - business cycle accounting (BCA)
  - beyond CEE model, e.g., financial accelerator model

Appendix: Random-Walk Metropolis-Hastings algorithms

1. Use a numerical optimization routine to maximize $\ln L(\theta|Y) + \ln p(\theta)$ (posterior). Denote the posterior mode by $\widetilde{\theta}$
2. Let $\widetilde{\Sigma}$ be the inverse of the Hessian computed at the posterior mode $\widetilde{\theta}$
3. Draw $\theta^{(0)}$ from $N(\widetilde{\theta}, c^2\widetilde{\Sigma})$ or directly specify the starting value
4. For $s = 1, ..., n_{sim}$, draw θ from the proposal distribution $N(\theta^{(s-1)}, c^2\widetilde{\Sigma})$. The jump from $\theta^{(s-1)}$ is accepted ($\theta^{(s)} = \theta$) with probability $\min\left\{1, r(\theta^{(s-1)}, \theta|Y)\right\}$ and rejected ($\theta^{(s)} = \theta^{(s-1)}$) otherwise. Here
$$r(\theta^{(s-1)}, \theta|Y) = \frac{L(\theta|Y)p(\theta)}{L(\theta^{(s-1)}|Y)p(\theta^{(s-1)})}$$
5. Approximate the posterior expected value of a function $h(\theta)$ by $\frac{1}{n_{sim}} \sum_{s=1}^{n_{sim}} h(\theta^{(s)})$