10. STRUCTURAL VAR: APPLICATIONS

1 Monetary Policy Shocks (Christiano Eichenbaum and Evans, 1999 HoM)

• Monetary policy shocks is the unexpected part of the equation for the monetary policy instrument (S_t).

$$S_t = f(\mathcal{I}_t) + w_t^{mp}$$

$f(\mathcal{I}_t)$ represents the systematic response of the monetary policy to economic conditions, $\mathcal{I}_t$ is the information set at time t and w_t^{mp} is the monetary policy shock.

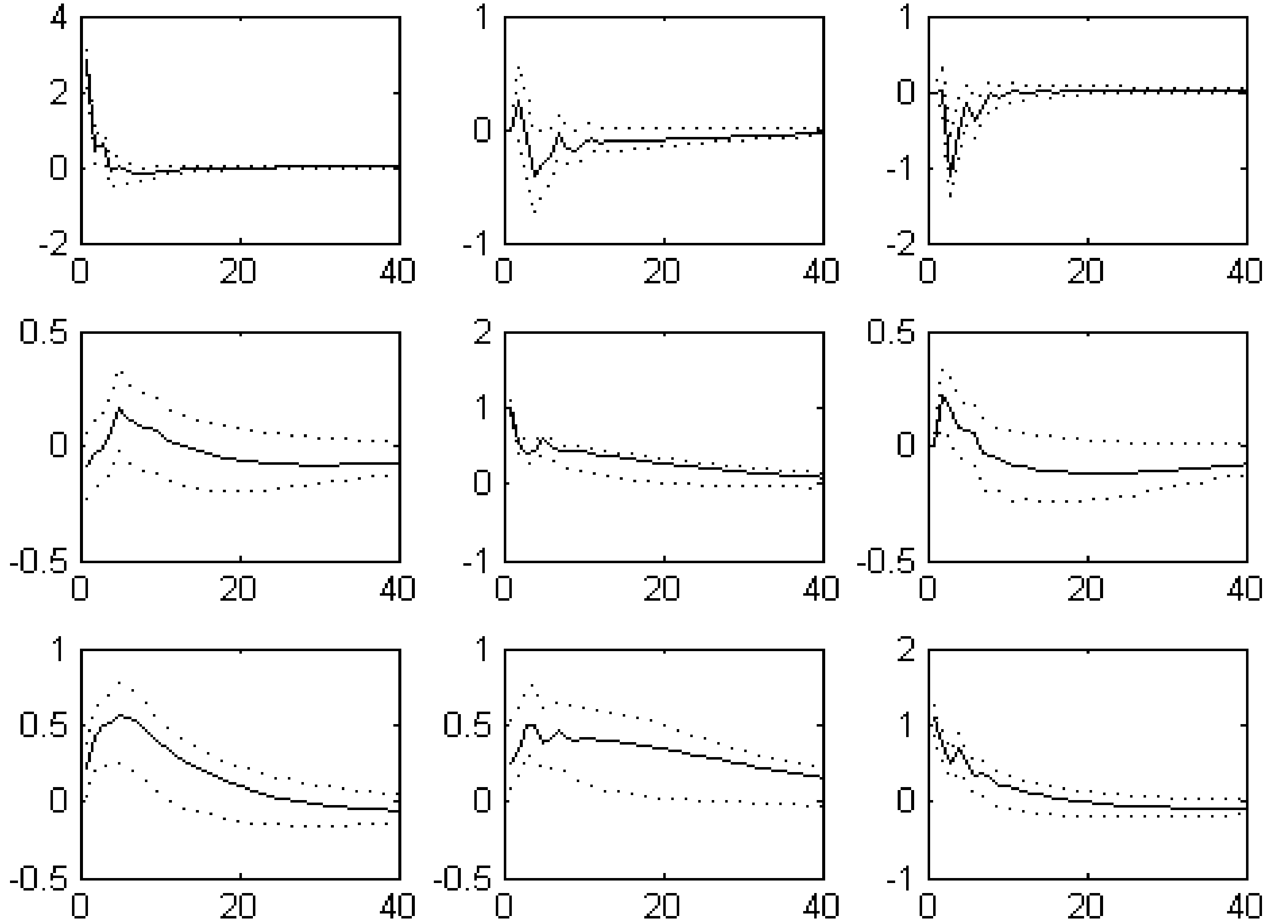
• The "standard" way to identify monetary policy shock is through zero contemporaneous restrictions. Using the standard monetary VAR (a simplified version of the CEE 98 VAR) including output growth, inflation and the federal funds rate we identify the monetary policy shock using the following restrictions:

1) Monetary policy shocks do not affect output within the same quarter

2) Monetary policy shocks do not affect inflation within the same quarter

• These two restrictions are not sufficient to identify all the shocks but are sufficient to identify the monetary policy shock.

• A simple way to implement the restrictions is to take simply the Cholesky decomposition of the variance covariance matrix in a system in which the federal funds rate is ordered last. The last column of the impulse response functions is the column of the monetary policy shock.



Cholesky impulse response functions of a system with GDP inflation and the federal funds rate. Monetary shock is in the third column.

• Notice that after a monetary tightening inflation goes up which is completely counterintuitive according to the standard transmission mechanism. This phenomenon if known as the *price puzzle*. Why is this the case?.

• *"Sims (1992) conjectured that prices appeared to rise after certain measures of a contractionary policy shock because those measures were based on specifications of $\mathcal{I}_t$ that did not include information about future inflation that was available to the Fed. Put differently, the conjecture is that policy shocks which are associated with substantial price puzzles are actually confounded with non-policy disturbances that signal future increases in prices."* (CEE 98)

• Sims shows that including commodity prices (signaling future inflation increases) may solve the puzzle.

2 Uhlig (JME 2006) monetary policy shocks

• Uhlig proposes a very different method to identify monetary policy shocks. Instead of using zero restrictions as in CEE he uses sign restrictions.

• He identifies the effects of a monetary policy shocks using restrictions which are implied by several economic models.

• In particular a contractionary monetary policy shock:

1. does not increase prices for k periods after the shock
2. does not increase money or monetary aggregates (i.e. reserves) for k periods after the shock
3. does not reduce short term interest rate for k periods after the shock.

• Since just one shock is identified only a column of H has to be identified, say column one.

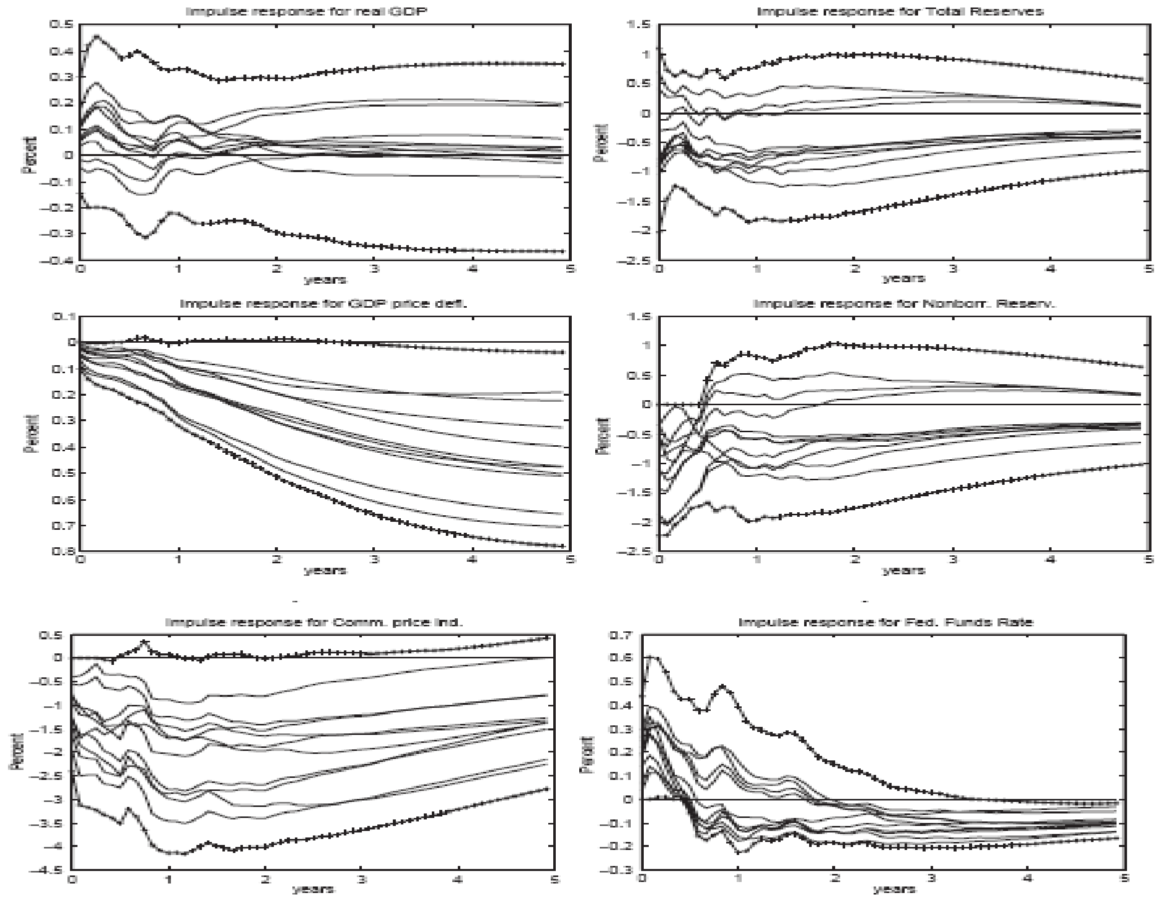
• If we order the variables in vector Y_t as follows: GDP inflation, money growth and the interest rate the restrictions imply $F_k^{i1} < 0$ for $i = 2, 3$ and $F_k^{41} > 0$.

- In order to draw impulse response functions he applies the following algorithm:

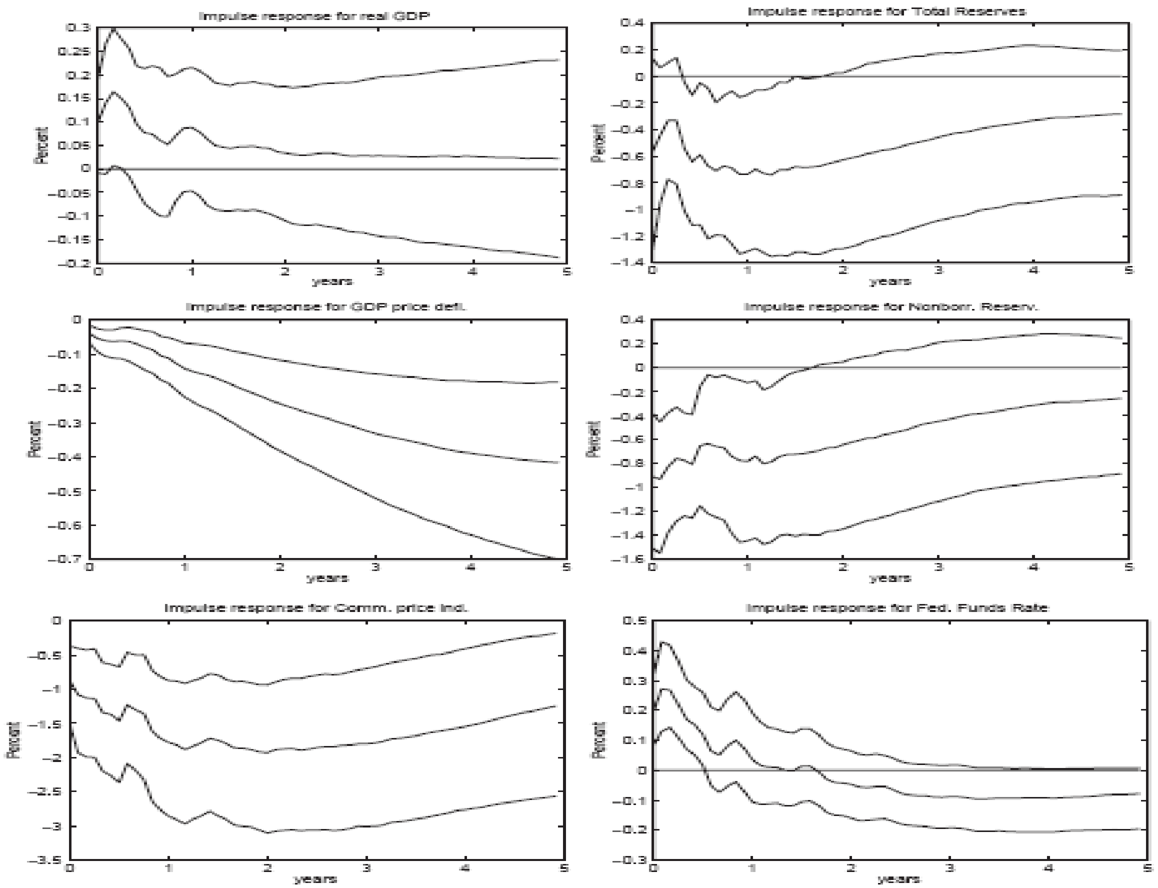
  1. He assumes that the column of H, H_1, represents the coordinate of a point uniformly distributed over the unit hypersphere (in case of bivariate VAR it represents a point in a circle). To draw such point he draws from a $N(0, I)$ and divide by the norm of the vector.

  2. Compute the impulse response functions $C_j S H_1$ for j=1,..,k.

  3. If the draw satisfies the restrictions keep it and go to 1), otherwise discard it and go to 1). Repeat 1)-3) a big number of timef L.



Source: What are the effects of a monetary policy shock... JME H. Uhlig (2006)



Source: What are the effects of a monetary policy shock... JME H. Uhlig (2006)

3 Blanchard Quah (AER 1989) aggregate demand and supply shocks

• Blanchard and Quah proposed an identification scheme based on long run restrictions.

• In their model there are two shocks: an aggregate demand and an aggregate supply disturbance.

• The restriction used to identify is that aggregate demand shocks have no effects on the long run levels of output, i.e. demand shocks are transitory on output. The idea behind of such a restriction is the existence of a vertical aggregate supply curve.

• Let us consider the following bivariate VAR

$$\begin{pmatrix} \Delta Y_t \\ U_t \end{pmatrix} = \begin{pmatrix} F_{11}(L) & F_{12}(L) \\ F_{21}(L) & F_{22}(L) \end{pmatrix} \begin{pmatrix} w_t^s \\ w_t^d \end{pmatrix}$$

where Y_t is output, U_t is the unemployment rate and w_t^s, w_t^d are two aggregate supply and demand disturbances respectively.

• The identification restriction is given by $F_{12}(1) = 0$.

- The restriction can be implemented in the following way. Let us consider the reduced form VAR

$$\begin{pmatrix} \Delta Y_t \\ U_t \end{pmatrix} = \begin{pmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{pmatrix} \begin{pmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{pmatrix}$$

where $E(\epsilon_t \epsilon_t') = \Omega$.

Let $S = chol(A(1)\Omega A(1)')$ and $K = A(1)^{-1}S$. The identified shocks are

$$w_t = K^{-1}\epsilon_t$$

and the resulting impulse response to structural shocks are

$$F(L) = A(L)K$$

notice that the restrictions are satisfied

$$\begin{aligned} F(1) &= A(1)K \\ &= A(1)A(1)^{-1}S \\ &= S \end{aligned}$$

which is lower triangular implying that $F_{12}(1) = 0$.

Moreover we have that shocks are orthogonal since

$$\begin{aligned} KK' &= A(1)^{-1}SS'A(1)^{-1\prime} && (1) \\ &= A(1)^{-1}A(1)\Omega A(1)'A(1)^{-1\prime} \\ &= \Omega \\ & && (2) \end{aligned}$$

And

$$\begin{aligned} E(w_t w_t') &= E(K^{-1}\epsilon_t\epsilon_t' K^{-1\prime}) \\ &= K^{-1}\Omega K^{-1\prime} \\ &= K^{-1}KK'K^{-1\prime} \end{aligned}$$

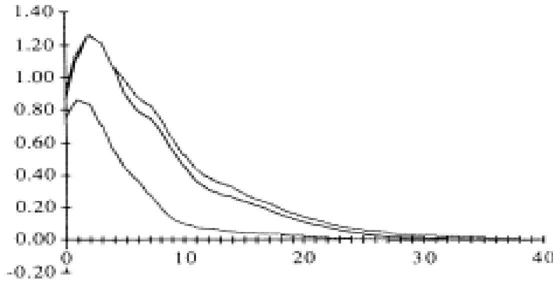


FIGURE 3. OUTPUT RESPONSE TO DEMAND

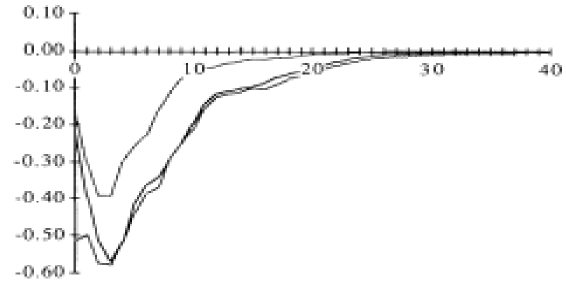


FIGURE 5. UNEMPLOYMENT RESPONSE TO DEMAND

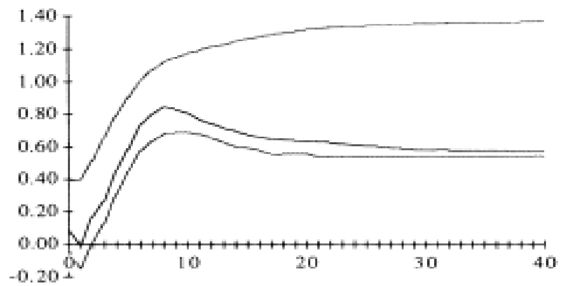


FIGURE 4. OUTPUT RESPONSE TO SUPPLY

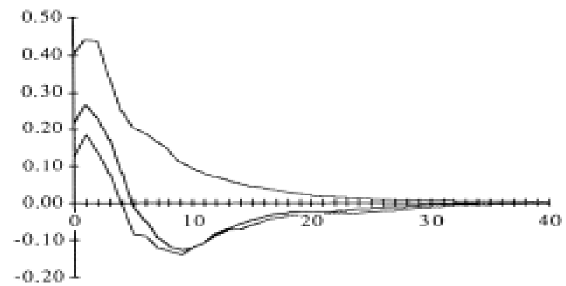


FIGURE 6. UNEMPLOYMENT RESPONSE TO SUPPLY

Source: The Dynamic Effects of Aggregate Demand and Supply Disturbances, (AER) Blanchard and Quah (1989):

TABLE 2—VARIANCE DECOMPOSITION OF OUTPUT AND UNEMPLOYMENT
(CHANGE IN OUTPUT GROWTH AT 1973/1974; UNEMPLOYMENT DETRENDED)

Percentage of Variance Due to Demand:

Horizon (Quarters)	Output	Unemployment
1	99.0	51.9
	(76.9, 99.7)	(35.8, 77.6)
2	99.6	63.9
	(78.4, 99.9)	(41.8, 80.3)
3	99.0	73.8
	(76.0, 99.6)	(46.2, 85.6)
4	97.9	80.2
	(71.0, 98.9)	(49.7, 89.5)
8	81.7	87.3
	(46.3, 87.0)	(53.6, 92.9)
12	67.6	86.2
	(30.9, 73.9)	(52.9, 92.1)
40	39.3	85.6
	(7.5, 39.3)	(52.6, 91.6)

Source: The Dynamic Effects of Aggregate Demand and Supply Disturbances, (AER) Blanchard and Quah (1989):

TABLE 2A—VARIANCE DECOMPOSITION OF OUTPUT AND UNEMPLOYMENT
(NO DUMMY BREAK, TIME TREND IN UNEMPLOYMENT)

Percentage of Variance Due to Demand:		
Horizon (Quarters)	Output	Unemployment
1	83.8	79.7
	(59.4, 93.9)	(55,3, 92.0)
2	87.5	88.2
	(62.8, 95.4)	(58.9, 95.2)
3	83.4	93.5
	(58.8, 93.3)	(61.3, 97.5)
4	78.9	95.7
	(53.5, 90.0)	(63.9, 98.2)
8	52.5	88.9
	(31.4, 68.6)	(63.5, 94.5)
12	37.8	79.7
	(21.3, 51.4)	(58.8, 90.3)
40	18.7	75.9
	(7.4, 23.5)	(56.9, 88.6)

Source: The Dynamic Effects of Aggregate Demand and Supply Disturbances, (AER) Blanchard and Quah (1989):

4 The technology shocks and hours debate Gali (AER 1999), Christiano, Eichenbaum and Vigfusson (NBER WP, 2003)

This is a nice example of how SVAR models can be used in order to distinguish among competing models of the business cycles.

1) RBC technology important source of business cycles.

2) Other models (sticky prices) tech shocks not so important.

Response of hours worked very important in distinguish among theories

1) RBC hours increase.

2) Other hours fall

4.1 The model

- Technology shock: $z_t = z_{t-1} + \eta_t$ η_t = technology shock

- Monetary Policy: $m_t = m_{t-1} + \xi_t + \gamma\eta_t$ where ξ_t = monetary policy shock.

- Equilibrium:

$$
\begin{aligned}
\Delta x_t &= \left(1 - \frac{1}{\varphi}\right)\Delta\xi_t + \left(\frac{1-\gamma}{\varphi} + \gamma\right)\eta_t + (1-\gamma)\left(1 - \frac{1}{\varphi}\right)\eta_{t-1} \\
n_t &= \frac{1}{\varphi}\xi_t - \frac{(1-\gamma)}{\varphi}\eta_t
\end{aligned}
$$

or

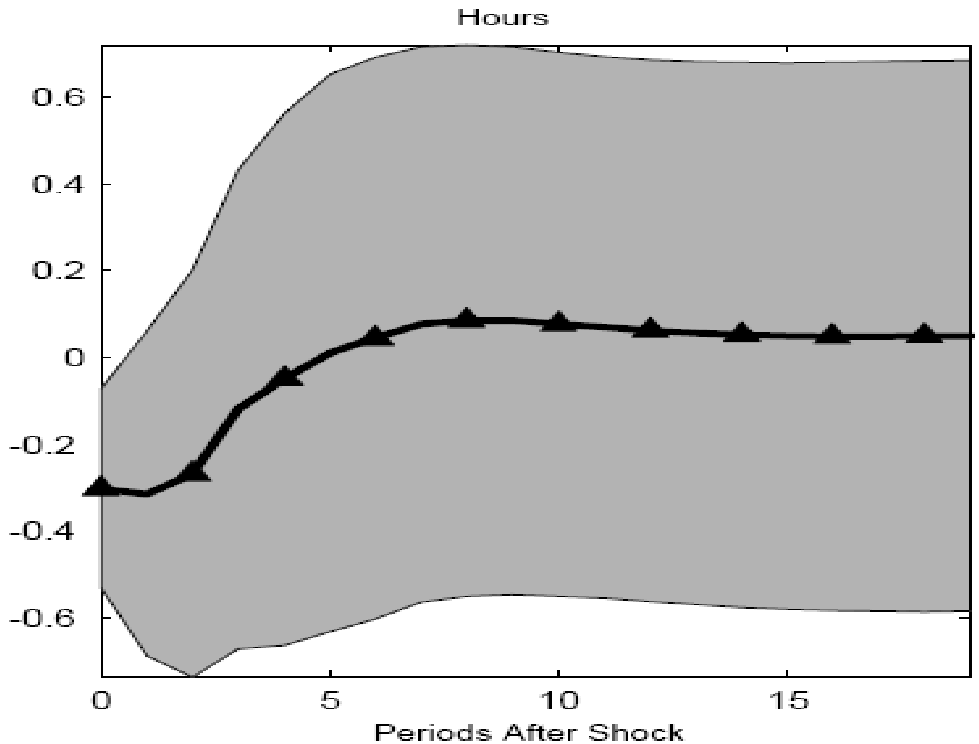
$$
\begin{pmatrix} \Delta x_t \\ n_t \end{pmatrix} = \begin{pmatrix} \left(\frac{1-\gamma}{\varphi} + \gamma\right) + (1-\gamma)\left(1 - \frac{1}{\varphi}\right)L & \left(1 - \frac{1}{\varphi}\right)(1-L) \\ \frac{-(1-\gamma)}{\varphi} & \frac{1}{\varphi} \end{pmatrix} \begin{pmatrix} \eta_t \\ \xi_t \end{pmatrix} \tag{3}
$$

In the long run $L = 1$

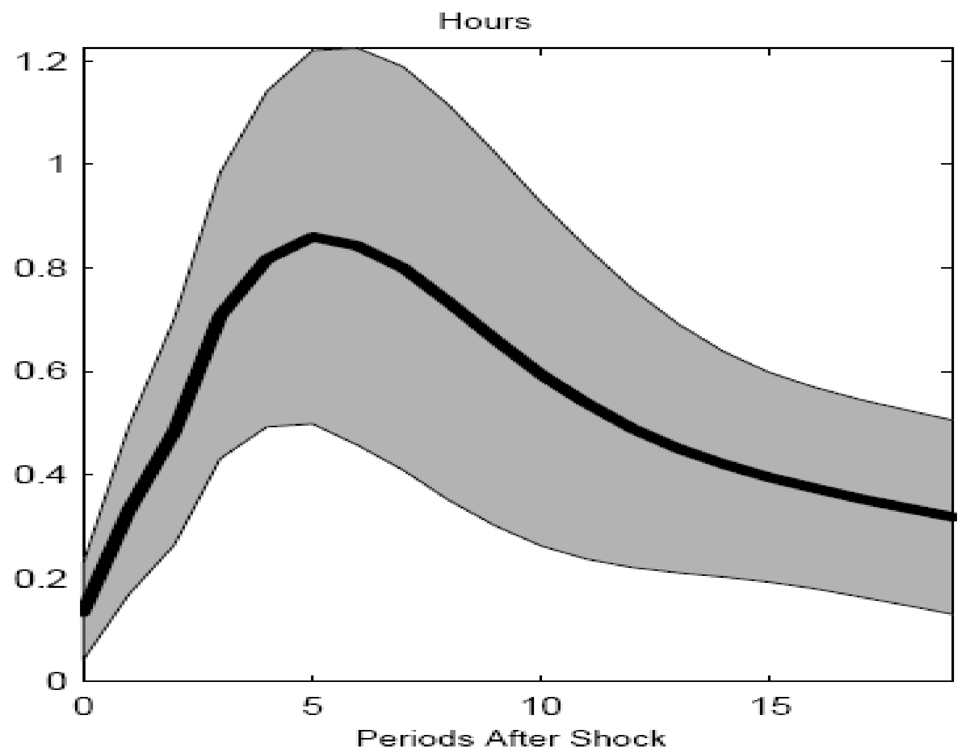
$$
\begin{pmatrix} \Delta x_t \\ n_t \end{pmatrix} = \begin{pmatrix} \left(\frac{1-\gamma}{\varphi} + \gamma\right) + (1-\gamma)\left(1 - \frac{1}{\varphi}\right) & 0 \\ \frac{-(1-\gamma)}{\varphi} & \frac{1}{\varphi} \end{pmatrix} \begin{pmatrix} \eta_t \\ \xi_t \end{pmatrix} \tag{4}
$$

that is only the technology shocks affects labor productivity.

Note the model prediction. If monetary policy is not completely accommodative $\gamma < 1$ then the response of hours to a technology shock $\frac{-(1-\gamma)}{\varphi}$ is negative.



Source: What Happens After a Technology Shock?... Christiano Eichenbaum and Vigfusson NBER WK (2003)



Source: What Happens After a Technology Shock?... Christiano Eichenbaum and Vigfusson NBER WK (2003)

Table 1: Contribution of Technology Shocks to Variance, Bivariate System

Level Specification

	Forecast Variance at Indicated Horizon					
Variable	1	4	8	12	20	50
Output	81.1	78.1	86.0	89.1	91.8	96
Hours	4.5	23.5	40.7	45.4	47.4	48.3

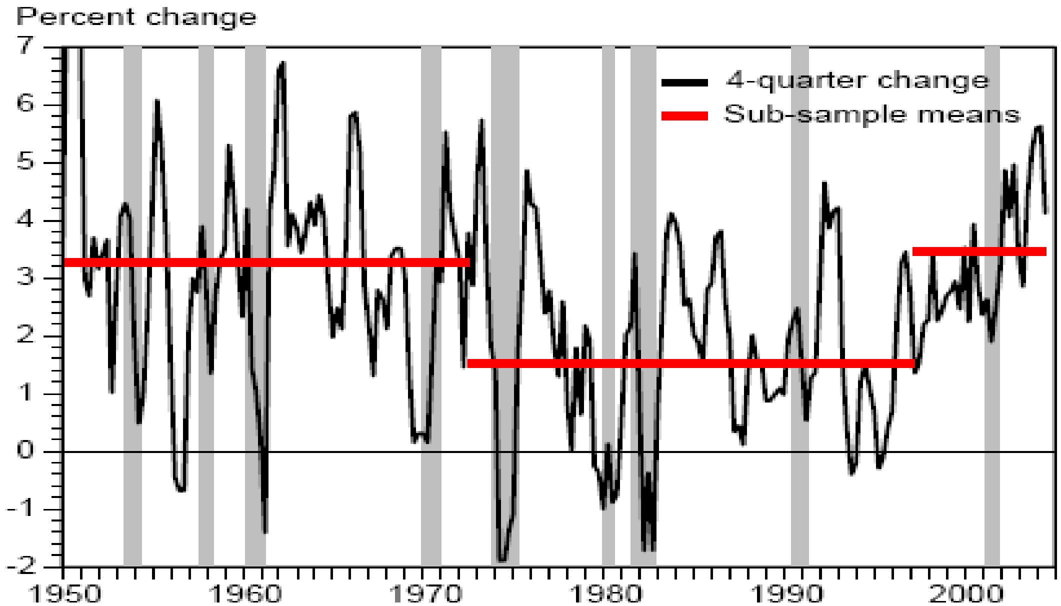
Difference Specification

	Forecast Variance at Indicated Horizon					
Variable	1	4	8	12	20	50
Output	16.5	11.7	17.9	20.7	22.3	23.8
Hours	21.3	6.4	2.3	1.6	1.0	0.5

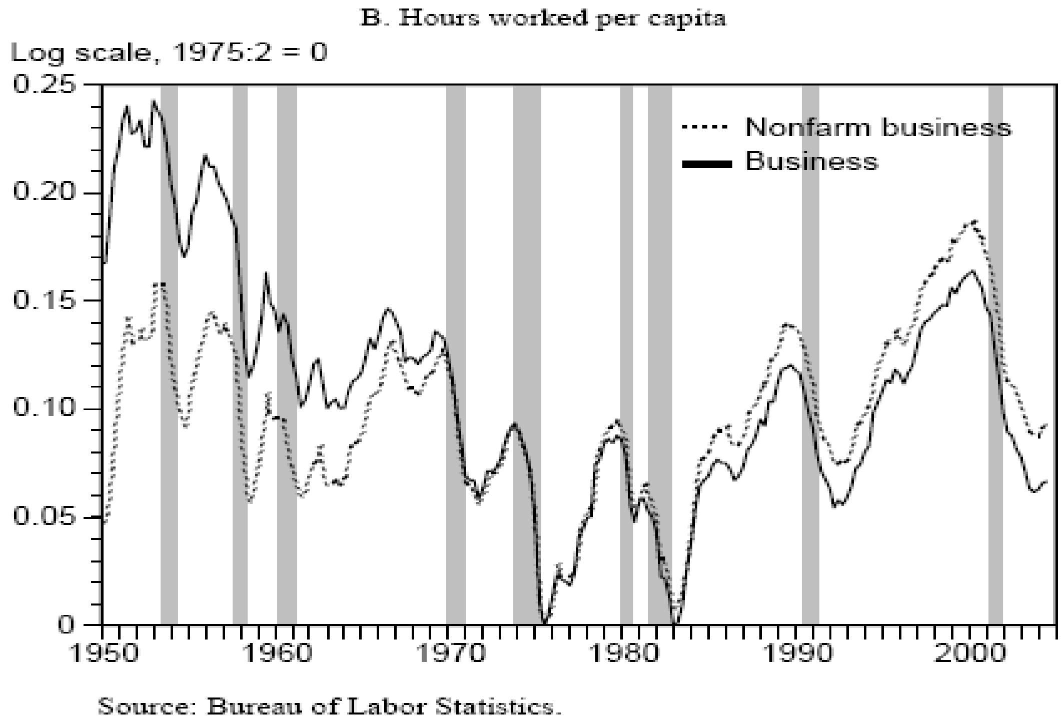
Source: What Happens After a Technology Shock?... Christiano Eichenbaum and Vigfusson NBER WK (2003)

Figure 1: Productivity and Hours

A. Labor productivity, business sector



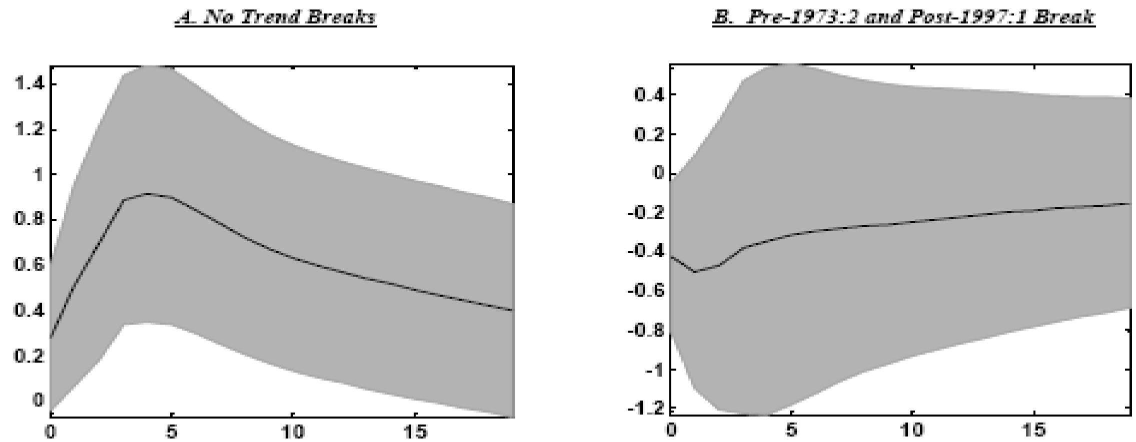
Source: Trend Breaks, Long-Run Restrictions, and Contractionary Technology Improvements, JME John Fernald (2007)



Source: Trend Breaks, Long-Run Restrictions, and Contractionary Technology Improvements, JME John Fernald (2007)

Figure 2. Impulse Responses from Bivariate Specification

Response of Hours to a Technology Shock



Source: Trend Breaks, Long-Run Restrictions, and Contractionary Technology Improvements, JME John Fernald (2007)

5 Government spending shocks

• Understanding the effects of government spending shocks is important for policy authorities but also to assess competing theories of the business cycle.

• Keynesian theory: $G \uparrow$, $Y \uparrow$, $C \uparrow$ because of the government spending multiplier.

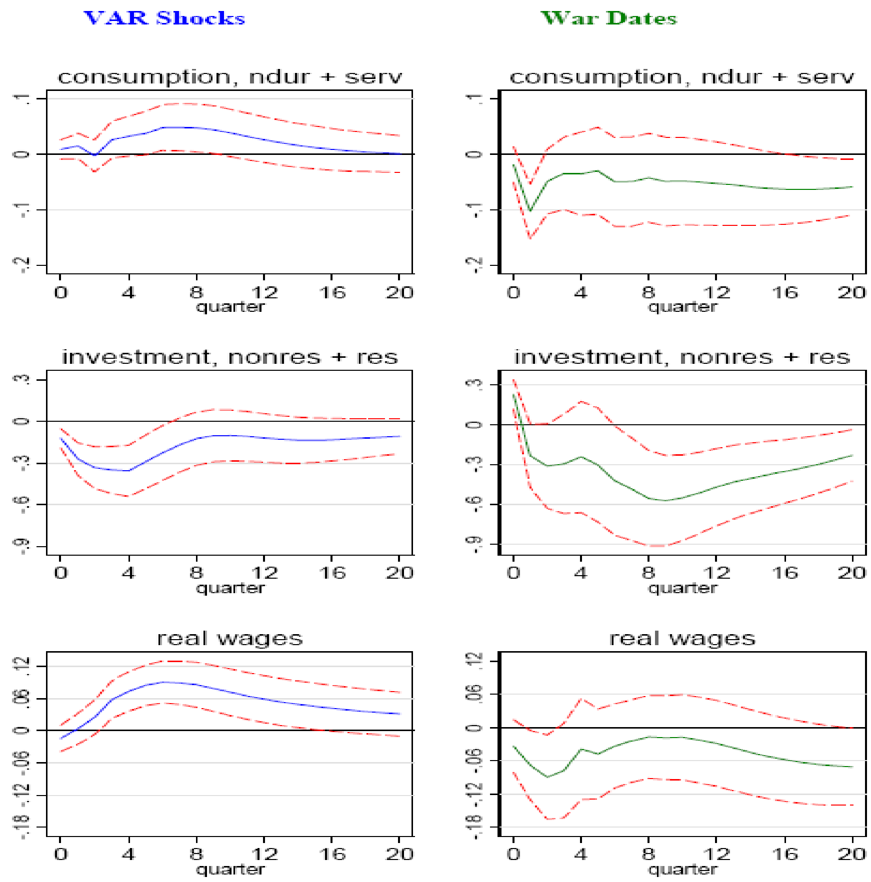
• RBC theory: $G \uparrow$, $C \downarrow$ because of a negative wealth effect.

• Empirical point of view disagreement.

5.1 Government spending shocks: Blanchard and Perotti (QJE 2002)

• BP (originally) use a VAR for real per capita taxes, government spending, and GDP with the restriction that government spending does not react to taxes and GDP contemporaneously, Cholesky identification with government spending ordered first. The government spending shock is the first one (quadratic trend four lags).

• When augmented with consumption consumption increases.



Source: IDENTIFYING GOVERNMENT SPENDING SHOCKS: IT'S ALL IN THE TIMING Valerie A. Ramey, QJE

5.2 Government spending shocks: Ramey and Shapiro (1998)

• Ramey and Shapiro (1998) use a narrative approach to identify shocks to government spending.

• Focus on episodes where Business Week suddenly forecast large rises in defense spending induced by major political events that were unrelated to the state of the U.S. economy (exogenous episodes of government spending).

• Three of such episodes: Korean War, The Vietnam War and the Carter-Reagan Buildup + 9/11.

• The military date variable takes a value of unity in 1950:3, 1965:1, 1980:1, and 2001:3, and zeros elsewhere.

• To identify government spending shocks, the military date variable is embedded in the standard VAR, but ordered before the other variables.

• Both methodologies have drawbacks.

• VARs: shocks are often anticipated (fiscal foresight shocks may be not invertible)

• War Dummy: few observations, subjective.

6 Monetary policy and housing

- Central question: how does monetary policy affects house prices?

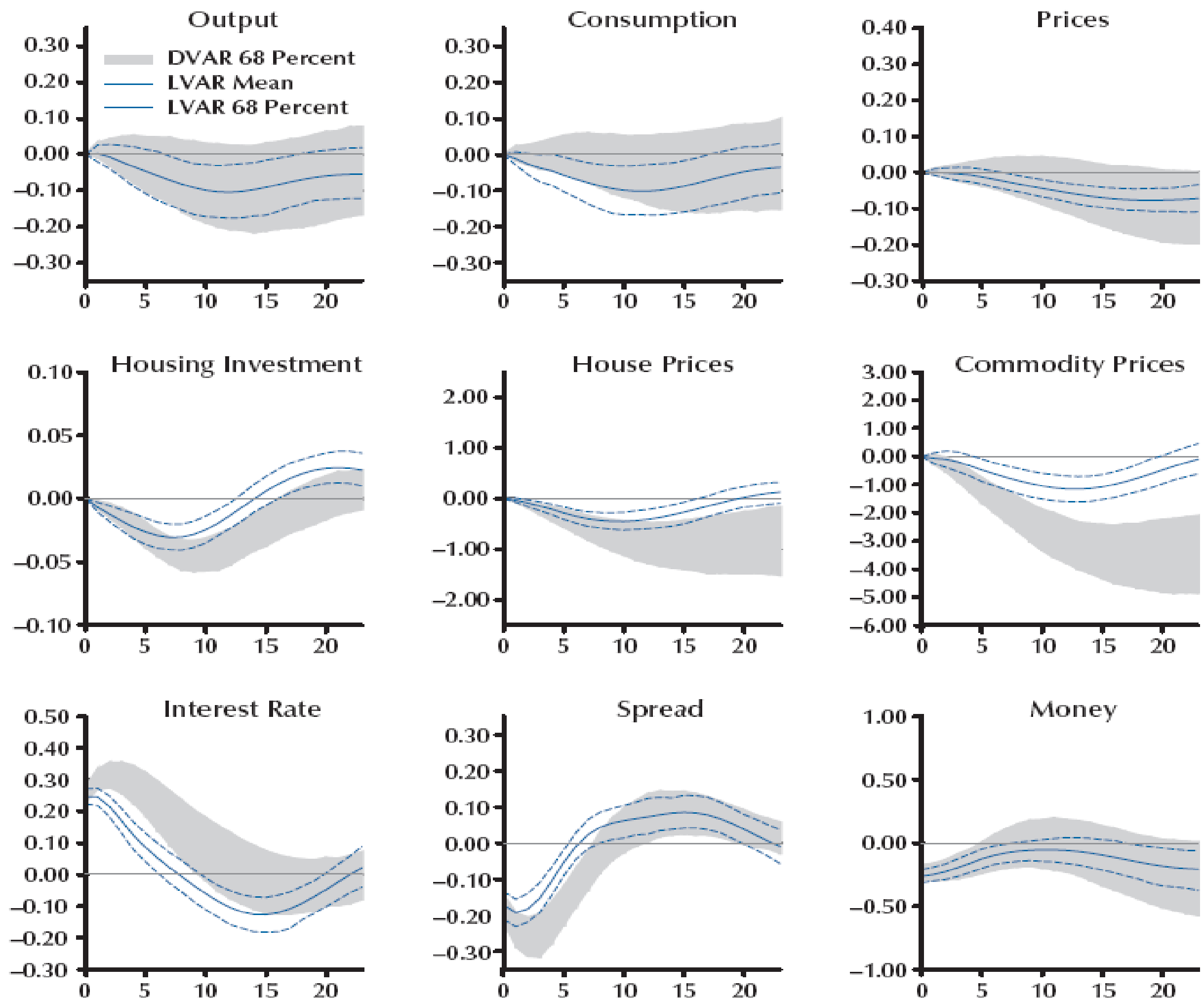
- Jarocinski and Smets (2008) addresses this question.

- Strategy:

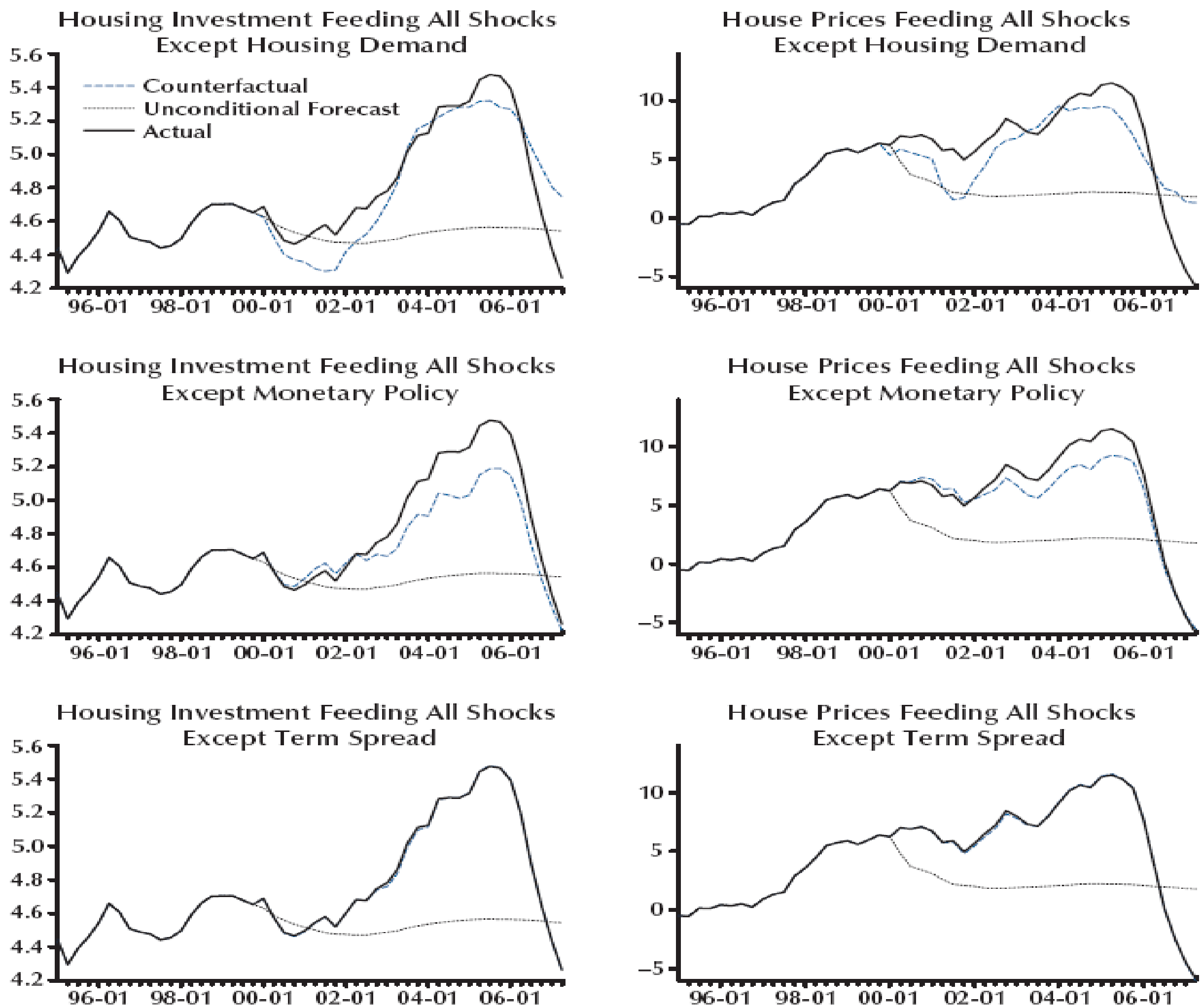
  1. Estimate a VAR nine variables (including: short term interest rate, interest rate spread, housing investment share of GDP, real GDP, real consumption, real hours prices, prices, commodity price index and a money indicator.

  2. Identify the monetary policy shock using the restriction that the shock does not affect prices and output contemporaneously but affect the short term interest rate, the spread and the money stock and analyze the impulse response functions.

  3. Shut down the identified shock and study the counterfactual path of housing prices over time.



Source: Jarocinki and Smets (2008)



Source: Jarocinki and Smets (2008)

Table 2A

Shares of Housing Demand, Monetary Policy, and Term Spread Shocks in Variance Decompositions, DVAR

Variable	Shock	Horizon 0	3	11	23
Output	Housing	0.016	0.034	0.052	0.062
	Monetary policy	0.000	0.004	0.021	0.039
	Term premium	0.000	0.003	0.015	0.028
Consumption	Housing	0.005	0.018	0.033	0.055
	Monetary policy	0.000	0.003	0.015	0.029
	Term premium	0.000	0.005	0.034	0.063
Prices	Housing	0.002	0.013	0.120	0.166
	Monetary policy	0.000	0.003	0.014	0.037
	Term premium	0.000	0.006	0.034	0.046
Housing investment	Housing	0.521	0.579	0.382	0.291
	Monetary policy	0.000	0.015	0.175	0.136
	Term premium	0.000	0.005	0.023	0.062
House prices	Housing	0.535	0.554	0.410	0.242
	Monetary policy	0.000	0.010	0.068	0.083
	Term premium	0.000	0.002	0.021	0.060
Commodity prices	Housing	0.027	0.028	0.041	0.085
	Monetary Policy	0.000	0.012	0.167	0.222
	Term premium	0.000	0.004	0.018	0.055
Interest rate	Housing	0.037	0.061	0.165	0.178
	Monetary policy	0.752	0.496	0.192	0.166
	Term premium	0.000	0.023	0.076	0.088
Spread	Housing	0.090	0.050	0.177	0.186
	Monetary policy	0.223	0.303	0.214	0.206
	Term premium	0.336	0.245	0.146	0.134
Money	Housing	0.060	0.044	0.062	0.099
	Monetary policy	0.204	0.141	0.044	0.045
	Term premium	0.013	0.042	0.129	0.135

NOTE: The reported shares are averages over the posterior distribution and relate to the (log) level variables.

Source: Jarocinki and Smets (2008)