

Chronicle of a War Foretold: The Macroeconomic Effects of Anticipated Defense Spending Shocks

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Chronicle of
a Death Foretold

"In haunting, so lovely
and so true as anything
Gabriel Márquez has
written before"
—THE NEW YORK TIMES

GABRIEL GARCÍA
MÁRQUEZ

What are the effects of fiscal shocks?

Three different schools

- “Dummy Variable” approach [Rotemberg and Woodford (1992), Ramey and Shapiro (1998)]
- Structural Vector Autoregression (SVAR) methodology: [Fatas and Mihov (2001), Blanchard and Perotti (2002)]
- Sign Restrictions approach: [Canova and Pappa (2006), Mountford and Uhlig (2009)]

Shocks in Military spending

- Ramey (2011) large increases in military spending are anticipated
- Ramey news:
 1. narrative evidence (based on information in the Business Week and other newspapers)
 2. Survey of Professional Forecasters, estimated changes in government spending are measured as the difference between actual government spending growth and the forecast of government growth made one quarter earlier.
- This paper:
 - Provide alternative to Ramey's identification of fiscal news - using medium run restrictions - maximum forecast error variance (MFEV)
 - We identify US defense news shocks as shocks that best explain future movements in defense spending over a five-year horizon and are orthogonal to current defense spending.
 - propose a sticky price model with distortionary taxation, variable capital utilization, capital adjustment costs and rule-of-thumb consumers that replicates the empirical findings.
 - Use the model to test our methodology

Related literature

- Anticipation of G shocks is SVAR models
 - Mertens and Ravn (2010), Forni and Gambetti (2010), Gambetti (2013), Leeper, Richter and Walker (2012)
- Theoretically:
 - Tax shocks: Mertens and Ravn (2011, 2012)
 - G shocks: Schmitt-Grohe and Uribe (2012), Mertens and Ravn (2010)

Results

1. Anticipated shocks strongly correlate with Ramey news but explain a much bigger share of the variation in all real variables at business cycle frequencies and estimated to have more significant and positive effects in the economy.
2. Anticipated shocks carry news about fiscal policy that induce a significant and persistent increase in output, consumption, investment, hours and the interest rate.
3. Standard flexible or sticky price models cannot account for empirical responses to unanticipated vs. anticipated shocks.
4. Propose a DSGE model that can match the facts and test the model
5. Our method passes the test

Data

- US economy 1947:Q1-2008:Q4.
- real per capita output, hours, consumption , and investment, real manufacturing wage, the (Barro:2011) average marginal tax rate, the interest rate on 3 month T-bills, and CPI inflation and Ramey's news series.
- For TFP series, use Fernald (2012)'s measure of TFP for the U.S. business sector, adjusted for variations in factor utilization (labor effort and capital's workweek).

Methodology

- $$\varepsilon_t = \kappa \varepsilon_{t-1} + e_{t-1} + \eta_t$$
- Medium run restrictions - (MFEV)
 - Anticipated shock: explains future variation in defense spending over an horizon of 5 years and orthogonal to current defense spending
 - Unanticipated shock: impacts the level of spending contemporaneously, orthogonalized with respect to Ramey news series.

Recovering fiscal news in the data

- VAR reduced form MA representation:

$$y_t = B(L)u_t, \text{ with } u_t = A\varepsilon_t$$

- => structural MA representation: $y_t = C(L)\varepsilon_t$

with $AA'=\Sigma$, for arbitrary orthogonalization \tilde{A} , permissible impact matrices $\tilde{A}D$, with $DD'=I$
 h step ahead forecast error:

$$y_{t+h} - E_t y_{t+h} = \sum_{\tau=0}^h B_{\tau} \tilde{A} D \varepsilon_{t+h-\tau}$$

- contribution to the forecast error variance of variable i attributable to structural shock j at horizon h :

$$\Omega_{i,j} = \sum_{\tau=0}^h B_{i,\tau} \tilde{A} \gamma \gamma' \tilde{A}' B'_{i,\tau}$$

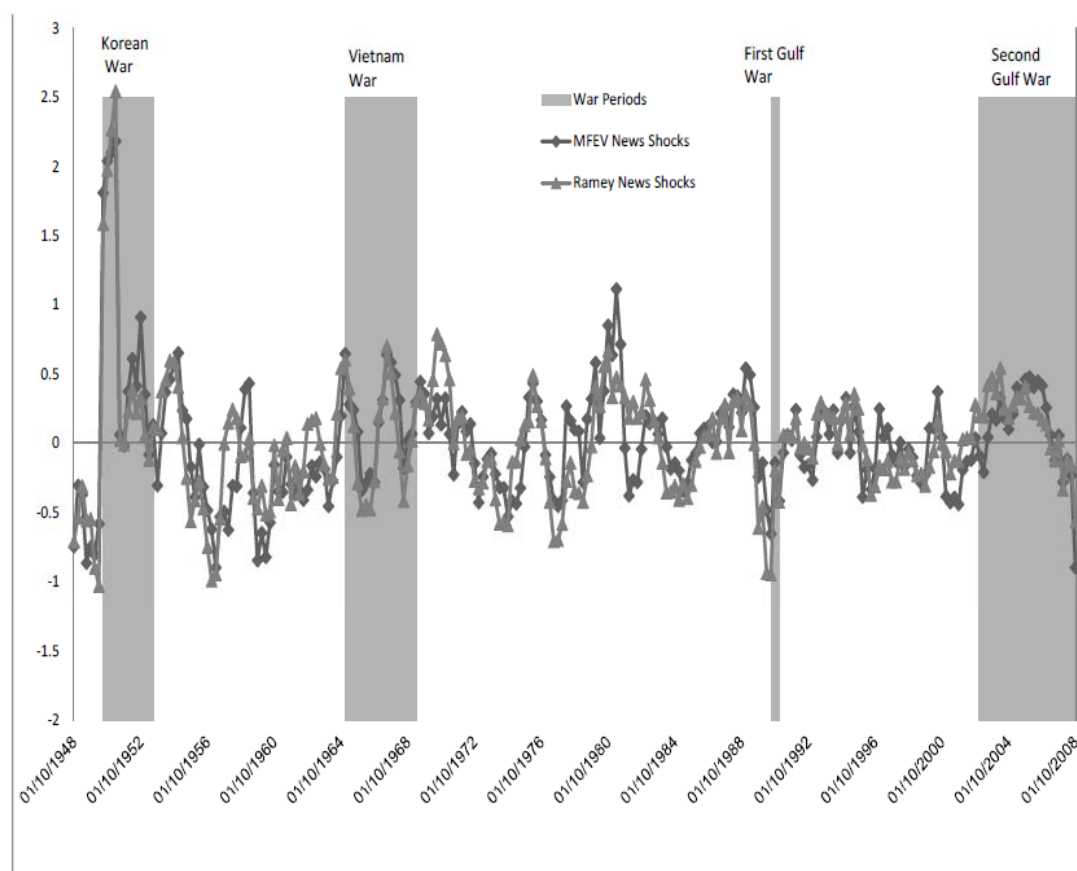
Identification: find γ that max sum of contributions to FEV of defense spending over an horizon of $H=20$ quarters and no contemporaneous effect on defense spending. i.e.,

$$\gamma^* = \underset{\gamma}{\operatorname{argmax}} \sum_{h=0}^H \sum_{i,j} \Omega_{1,2}(h) = \sum_{h=0}^H \sum_{\tau=0}^h B_{2,\tau} \tilde{A} \gamma \gamma' \tilde{A}' B'_{2,\tau}$$

Subject to $A(1,j) = 0 \quad \forall j > 1$
 $\gamma(1,1) = 0$
 $\gamma' \gamma = 1$

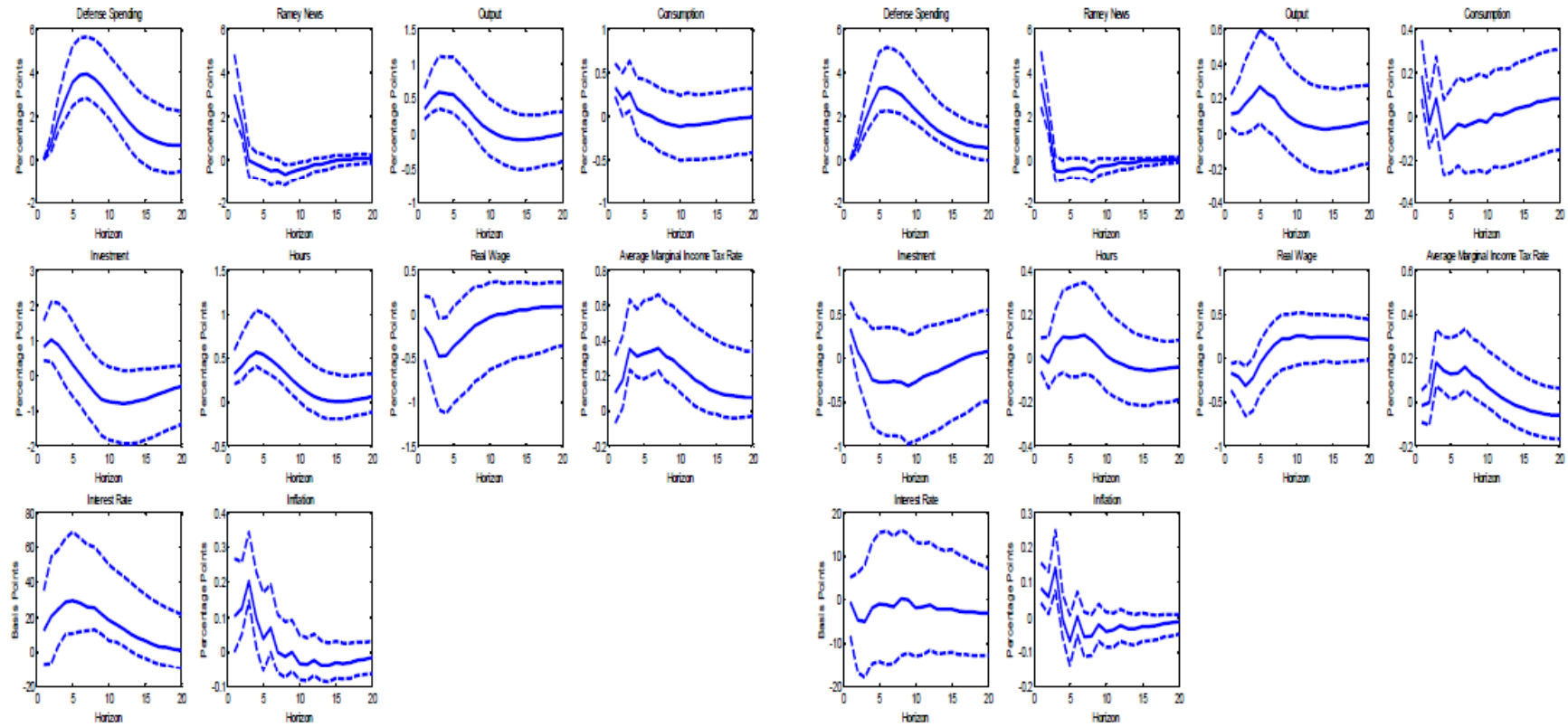
The recovered anticipated shock

Figure 1: MFEV News Shock and Ramey News Shock Time Series.



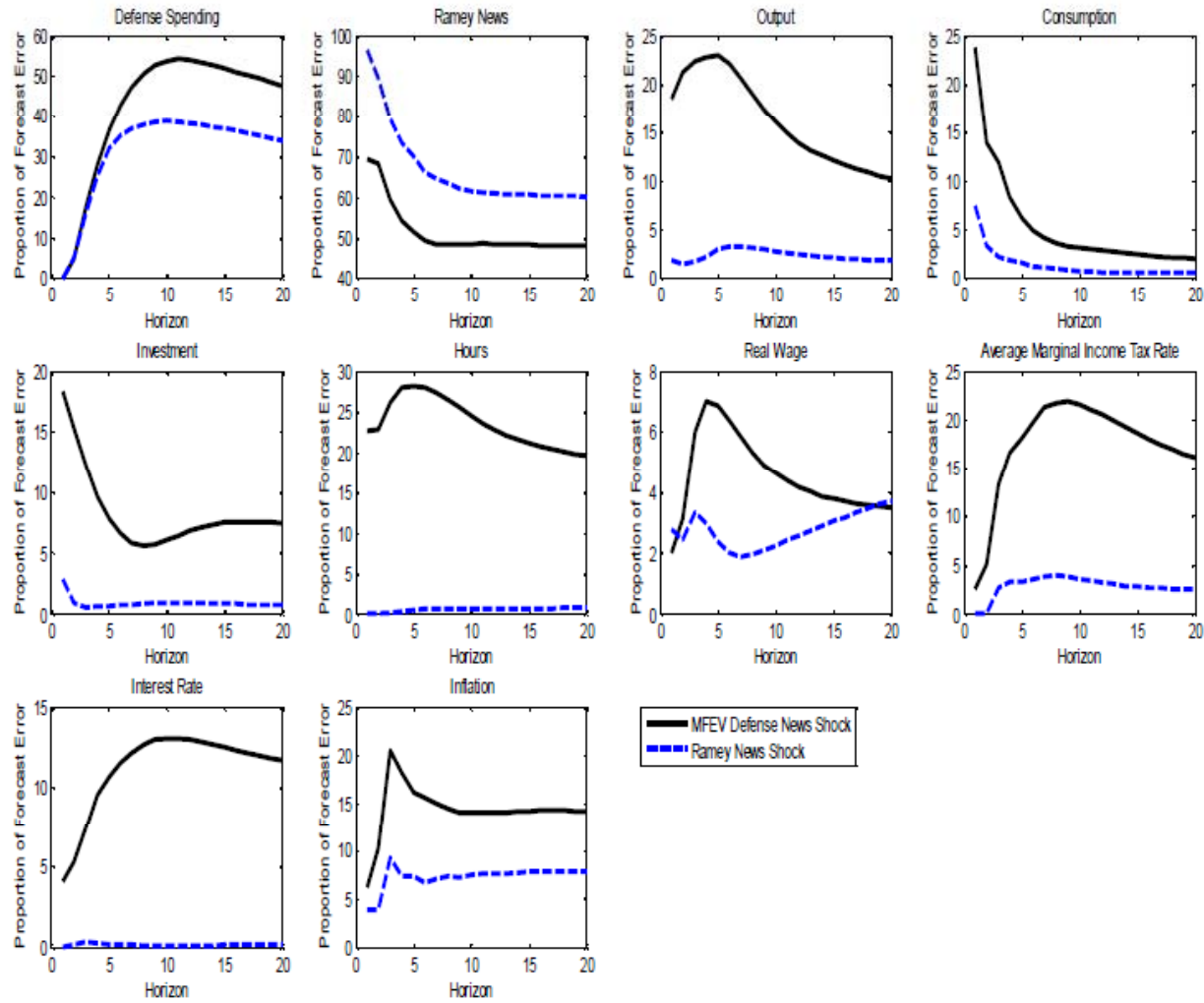
Notes: U.S. war periods are represented by the shaded areas. Plotted is a one year backward looking average of the shock series $\varepsilon_t^s = (\varepsilon_{t-3} + \varepsilon_{t-2} + \varepsilon_{t-1} + \varepsilon_t)/4$. The series begin in 1948:Q4 and ends in 2008:Q4.

Figure 2: Benchmark VAR: (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock



(a) Impulse responses to a one standard deviation MFEV News Shock. (b) Impulse responses to a one standard deviation Ramey News Shock.

Figure 3: The Share of Forecast Error Variance Attributable to MFEV News Shocks and Ramey's News Shocks.



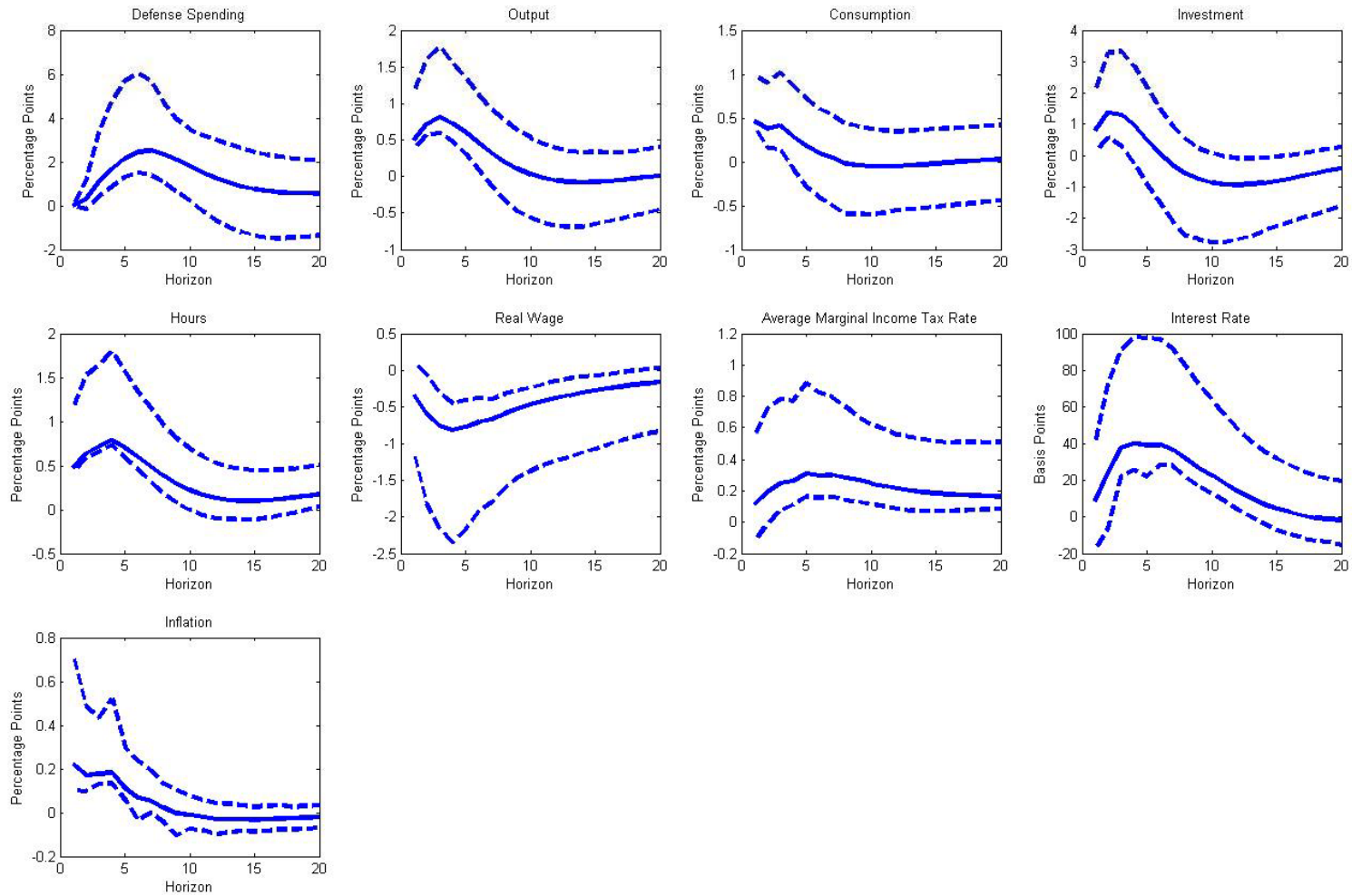
Notes: The MFEV news shock corresponds to that from figure 2a whereas the Ramey news shock corresponds to that from figure 2b.

Table 2: The Difference Between the Forecast Error Variance Contributions of MFEV and Ramey News Shocks: Statistical Significance

Variable	Contribution Difference (%)	Horizon	P-Value (%)
Defense Spending	16	12	0
Output	21	3	2.2
Consumption	16	1	12.5
Investment	15	1	6.1
Real Wage	5	5	24.6
Tax Rate	17	9	3.2
Hours	28	5	1.1
Interest Rate	13	10	15.4
Inflation	11	3	10.6

Notes: This table presents the p-values for the null hypothesis that the difference between the contribution of the MFEV news shock and the Ramey news shock to the corresponding variable's variation is not positive. The horizon for which the p-value is computed is the one at which the point estimate of the contribution difference is maximal. The second column depicts the maximal point estimate difference between the two shocks' contributions to the corresponding variable's variation, and the third column gives the corresponding horizon. Each estimated p-value was obtained as the proportion of bootstrap values of the contribution difference of the two shocks not exceeding zero.

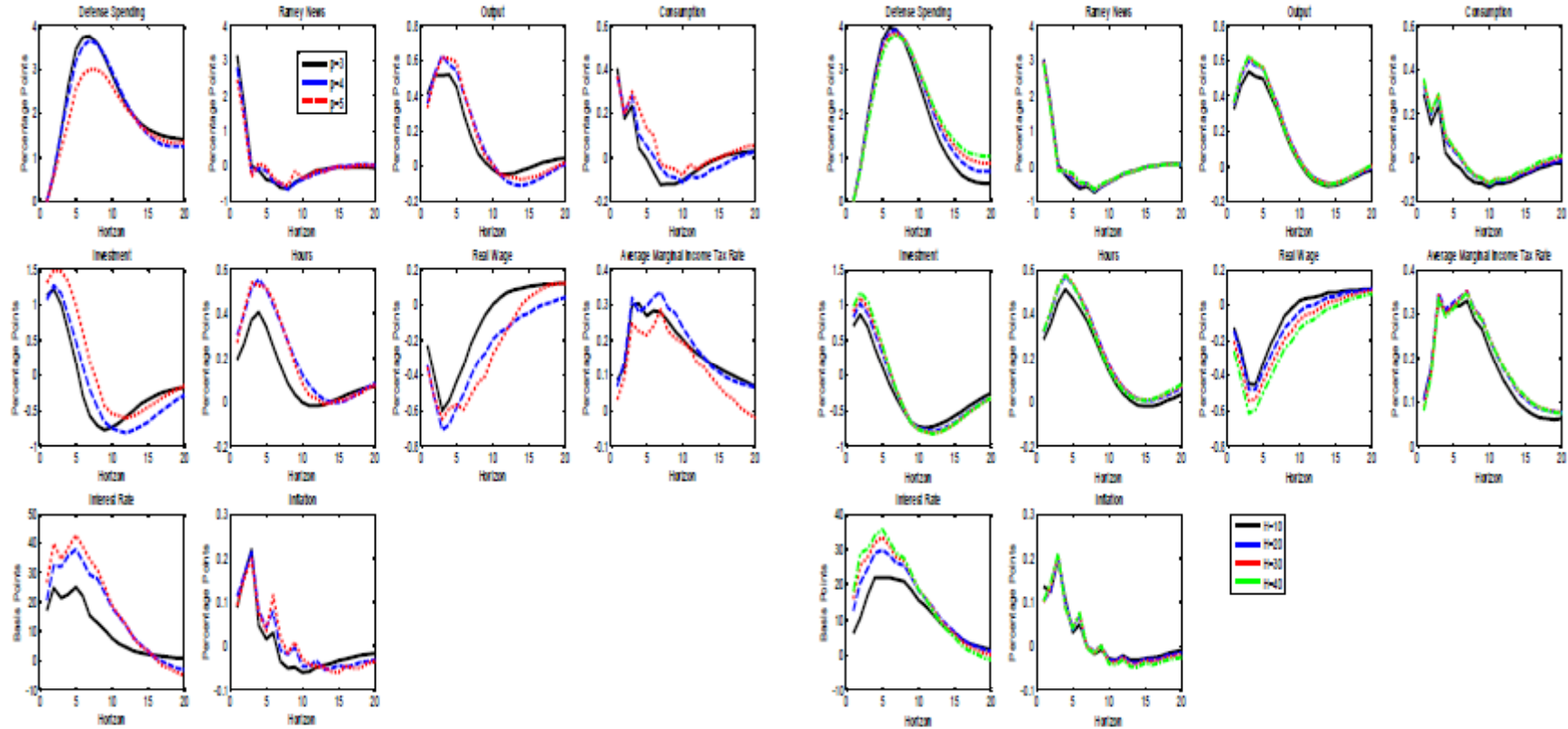
Identifying the anticipated shock without including the Ramey series



Sensitivity analysis

- Truncation horizon and VAR lags

Figure 4: Robustness: (a) VAR lags; (b) Truncation horizon

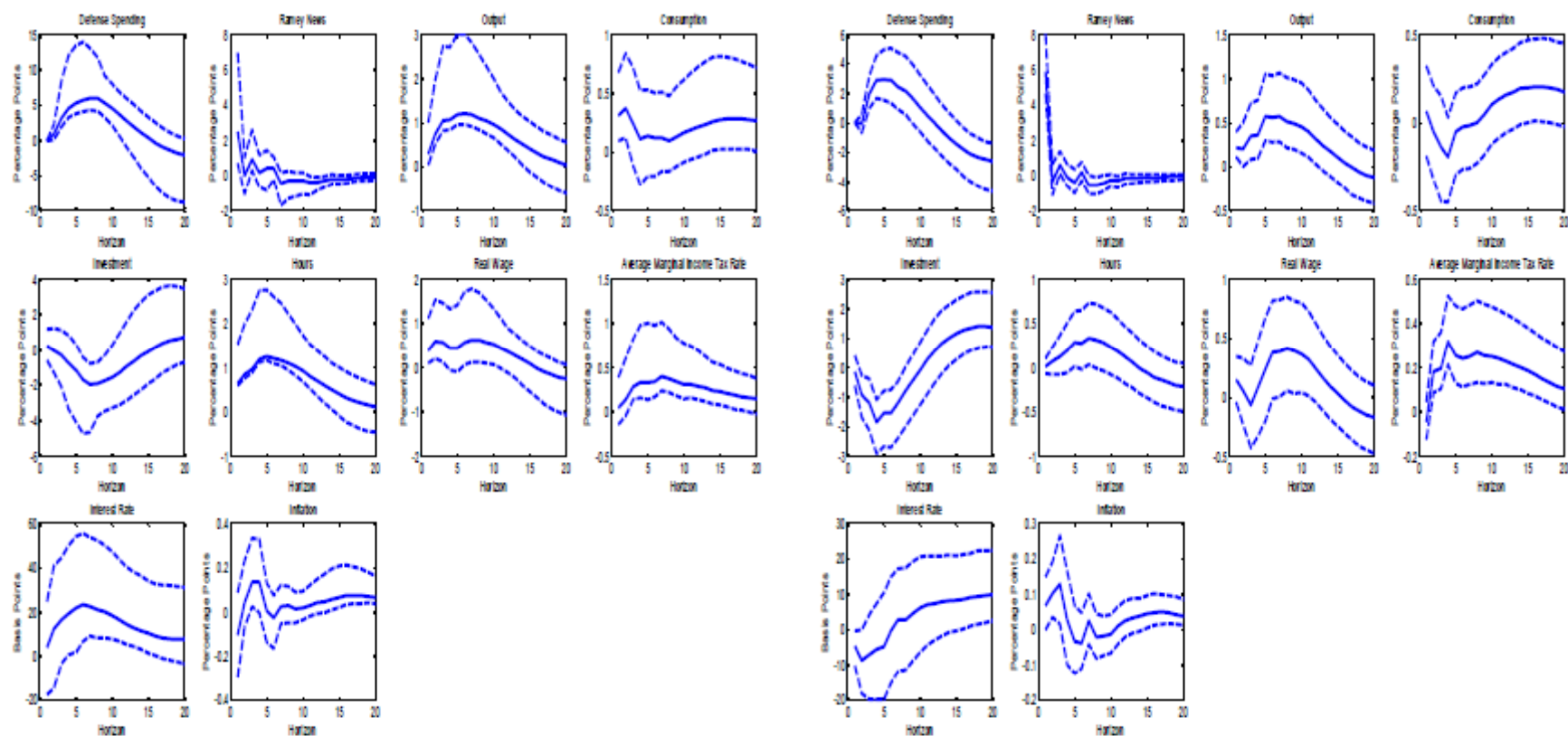


(a) Impulse responses to a one standard deviation Defense News Shock: robustness to different lag structures. (b) Impulse responses to a one standard deviation Defense news shock: robustness to different truncation horizons.

Sensitivity analysis

- Truncation horizon and VAR lags
- Larger sample

Figure 5: Larger Sample (1939-2008): (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock

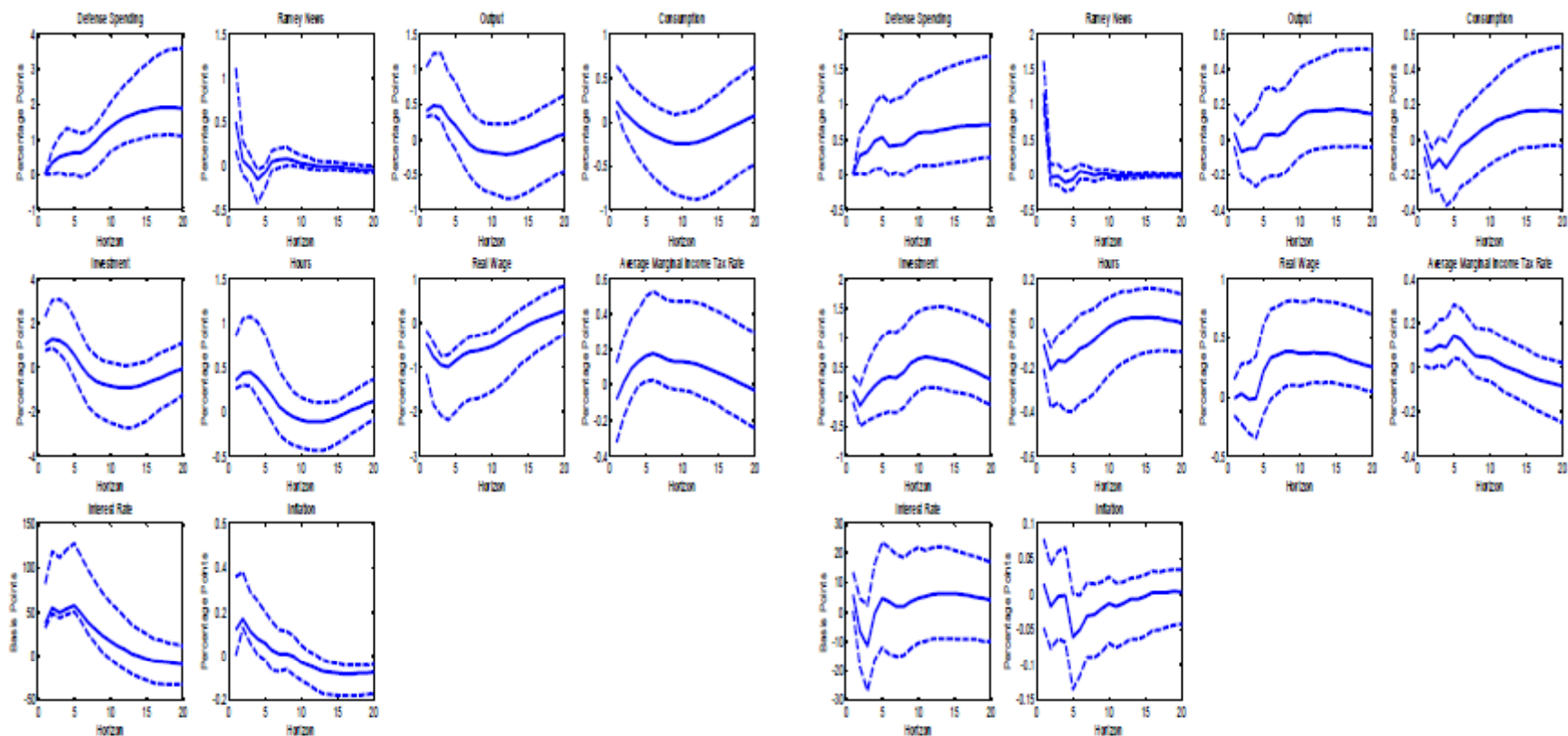


(a) Impulse responses to a one standard deviation MFEV News Shock. (b) Impulse responses to a one standard deviation Ramey News Shock.

Sensitivity analysis

- Truncation horizon and VAR lags
- Larger sample
- Excluding Korea

Figure 6: Post-Korean War Sample (1955-2008): (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock

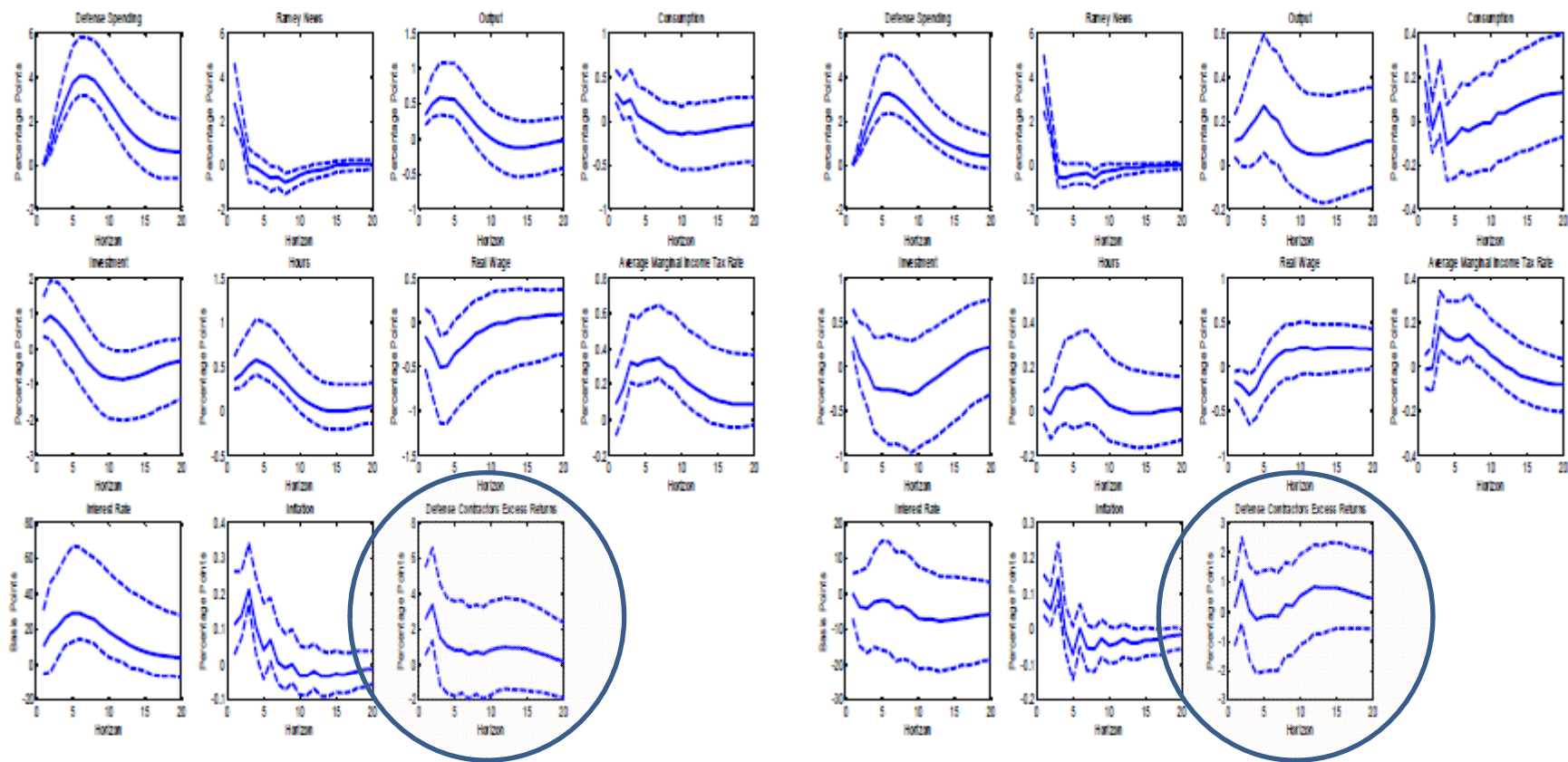


(a) Impulse responses to a one standard deviation MFEV News Shock. (b) Impulse responses to a one standard deviation Ramey News Shock.

Sensitivity analysis

- Truncation horizon and VAR lags
- Larger sample
- Excluding Korea
- Including series of innovations to the accumulated excess returns of large US military contractors, Fisher and Peters (2011)

Figure 7: VAR with the Fisher and Peters (2011) Defense Shock Series: (a) Impulse Responses to MFEV News Shock; (b) Impulse Responses to Ramey News Shock

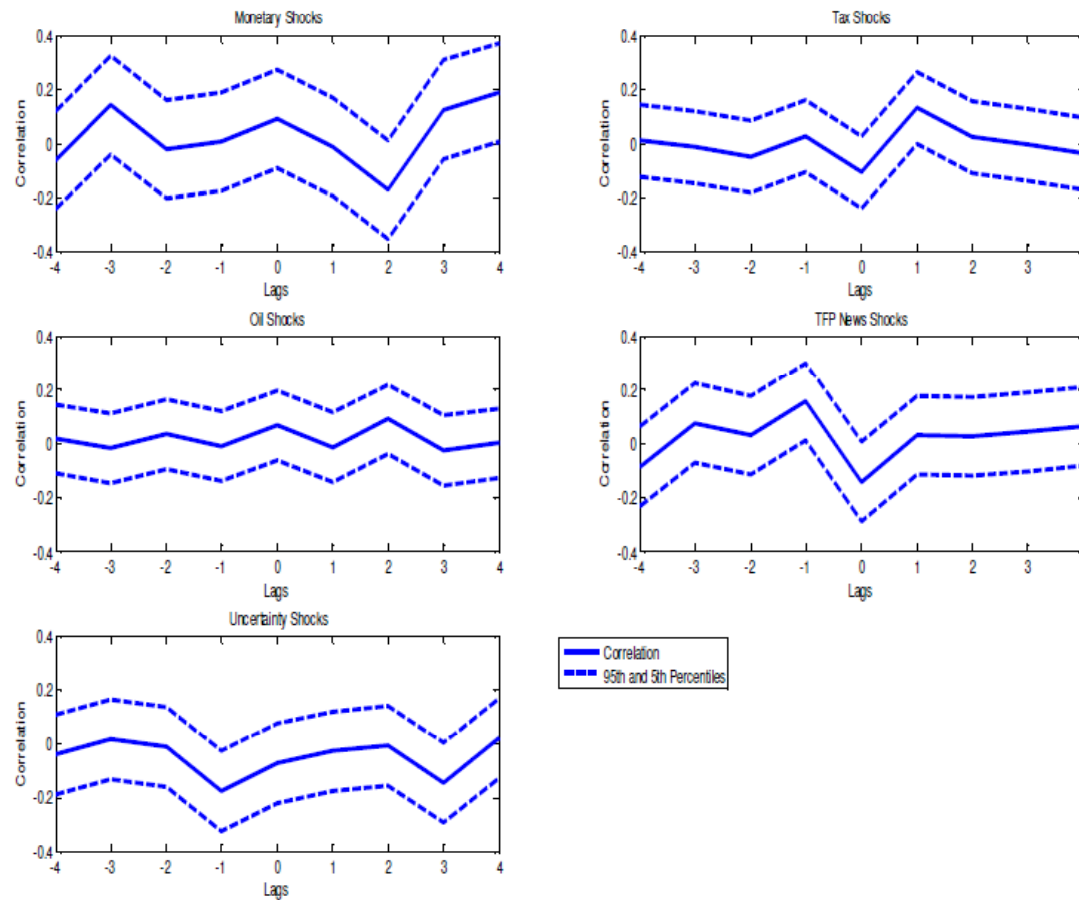


(a) Impulse responses to a one standard deviation MFEV News Shock. (b) Impulse responses to a one standard deviation Ramey News Shock.

Sensitivity analysis

- Truncation horizon and VAR lags
- Larger sample
- Excluding Korea
- Including series of innovations to the accumulated excess returns of large US military contractors, Fisher and Peters (2011)
- Correlation with other structural shocks

Figure 8: The Cross-Correlation between the MFEV News Shock and Lags/Leads of Other Structural Shocks.



Notes: The solid line is the cross-correlation and the dashed lines represent the 95% asymptotic confidence interval. The other shocks are the [Romer and Romer \(2004\)](#) monetary policy shock measure, [Romer and Romer \(2010\)](#) tax shock measure, shock to the real price of oil, the TFP news shock from [Barsky and Sims \(2011\)](#), and the shock to the uncertainty measure used in [Bloom \(2009\)](#) which is based on stock market volatility and corresponds to Figure 1 in his paper. Apart from the [Barsky and Sims \(2011\)](#) TFP news shock series which was used in its raw form, all other shocks were constructed as the residuals of univariate regressions of each of the four variables on four lags.

Summing up

- Anticipated increases in military spending have significant and persistent output effects and increase significantly investment consumption, hours, the interest rate and inflation.

A standard model: Households

Derive utility from consumption and disutility from working. They max lifetime utility :

$$E_0 \sum_{t=0}^{\infty} \frac{(C_t + \omega G_t)^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\phi}}{1+\phi}$$

subject to a series of budget constraints:

$$P_t(C_t + I_t) + \{Q_{t+1,t} D_{t+1}\} + R_t^{-1} B_{t+1} \leq (1 - \tau^l) P_t w_t N_t + [r_t - \tau^k (r_t - \delta^p)] P_t K_t + D_t + B_t - T_t P_t + \Xi_t$$

and evolution of capital:

$$K_{t+1} = I_t + (1 - \delta) K_t - v \left(\frac{K_{t+1}}{K_t} \right) K_t$$

where:

$$v \left(\frac{K_{t+1}}{K_t} \right) = \frac{b}{2} \left(\frac{K_{t+1} - (1 - \delta) K_t}{K_t} - \delta \right)^2$$

A standard model: Firms

- Perfect competition in labour and capital markets
- Imperfect competition in good markets
- Partial Adjustment Price Setting for NK: $(1-\gamma)$ probability of price change. For RBC $\gamma=0$.

- Production for firm j :

$$Y_t(j) = (A_{z_t} N_t(j))^{1-\alpha} K_t(j)^\alpha$$

- where A_{z_t} exogenous productivity common to all firms

Cost minimization:

$$\frac{K_t}{N_t} = \frac{\alpha}{1-\alpha} \left(\frac{w_t}{r_t} \right)$$

$$mc_t = \frac{1}{\alpha^\alpha (1-\alpha)^{1-\alpha}} r_t^\alpha w_t^{1-\alpha}$$

Optimal price:

$$\tilde{P}_t^i = \frac{\varepsilon}{\varepsilon - 1} \frac{1}{1 - \tau^\varepsilon} \frac{E_t \sum_{j=0}^{\infty} Q_{t,t+j} \gamma^j [mc_{t+j}^i Y_{t+j}^i]}{E_t \sum_{j=0}^{\infty} Q_{t,t+j} \gamma^j Y_{t+j}^i}, \quad \tilde{P}_t^i = mc_t$$

$$P_t = \left[\gamma P_{t-1}^{1-\varepsilon} + (1-\gamma) \tilde{P}_t^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}$$

Government

- The governments budget constraint is given by:

$$R_t^{-1} B_{t+1} = P_t G_t + B_t - T_t P_t - \tau^\varepsilon P_t Y_t - \tau^l P_t w_t N_t - \tau^k P_t [r_t - \delta^p] K_t^p$$

$$\text{for } g_t = \frac{G_t}{G}, \quad \ln g_t = \rho \ln g_{t-1} + e_t, \quad \varepsilon_t^g = \rho^g \varepsilon_{t-1}^g + g_{t-j} + \varepsilon_t^{g,0}$$

- To avoid indeterminacy of equilibria (Leeper (1991)):

$$T_t = \bar{T} \exp(\zeta_b (b_t - \bar{b}))$$

- Monetary Policy:

$$R_t = R + \zeta_{\pi} \pi_t + q_t^R$$

where q_t^R monetary policy shock

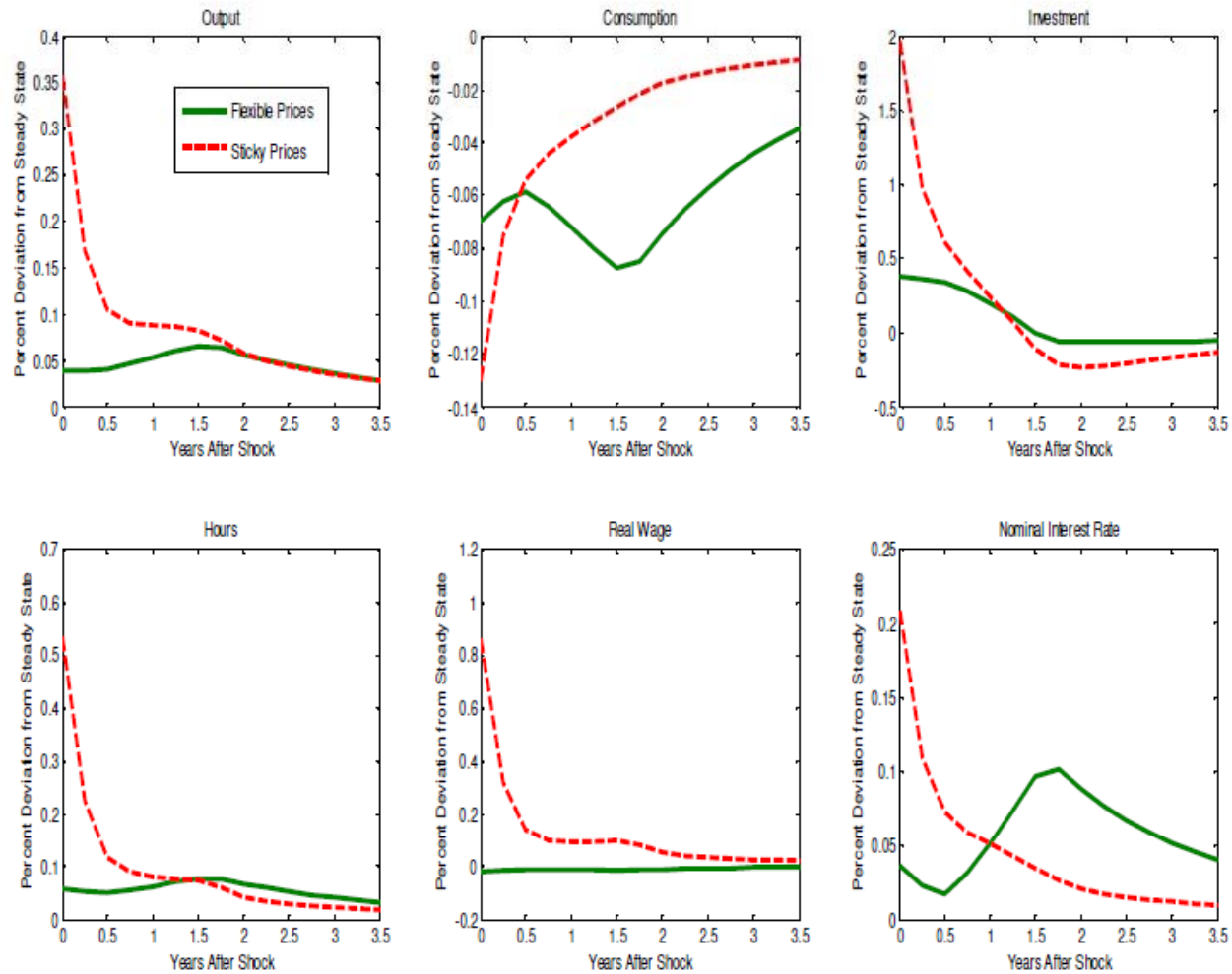
- Resource constraint:

$$Y_t = C_t^P + I_t^P + G_t$$

Table 1: Parameter values

β	discount factor	0.99
B/Y	steady state debt to output ratio	0.55
σ	risk aversion coefficient	2
ϕ	preference parameter	0.7
b	adjustment cost parameter	15
δ	capital depreciation rate	0.025
α	capital share	0.36
τ^l	average labor tax rate	0.3
τ^k	average capital tax rate	0.3
G/Y	steady state G/Y ratio	0.07
ζ_π	Taylor's coefficient	1.1
ζ_b	coefficient on debt rule	2
γ	degree of price stickiness	0.75
$\frac{\varepsilon}{\varepsilon-1}$	steady state markup	7.88
λ	rule of thumb consumers	0.3
ϕ_u	elasticity of depreciation to changes in utilization	1.40

Figure 9: Benchmark DSGE Model: Responses to an Anticipated Shock.



Notes: The Responses were obtained from the model of Section 5.1, where the solid lines correspond to the sticky price model and the dashed lines correspond to the flexible price version of the model.

- A flexible price model can fit better qualitatively (but not quantitatively) the data.
- Responses of consumption to anticipated shocks have the opposite sign
- Next: work with models that can propagate fiscal news and reverse consumption response to news

Positive responses of consumption after a G shock

- a) the consumption and hours' complementarities in the utility function (see Monacelli and Perotti (2008), Hall (2009), Christiano et al. (2011) and Nakamura and Steinsson (2011));
- b) a lax monetary policy (see Canova and Pappa (2011), Christiano et al. (2011) and Erceg and Linde (2010));
- c) rule-of-thumb consumers (see Gali et. al. (2007));
- d) deep habits (see Ravn et.al. (2012));
- e) spending reversals (see Corsetti et al. (2009)) and
- f) home production (see Gnocchi et al. (2013)
- g) Complementarities between private and public consumption

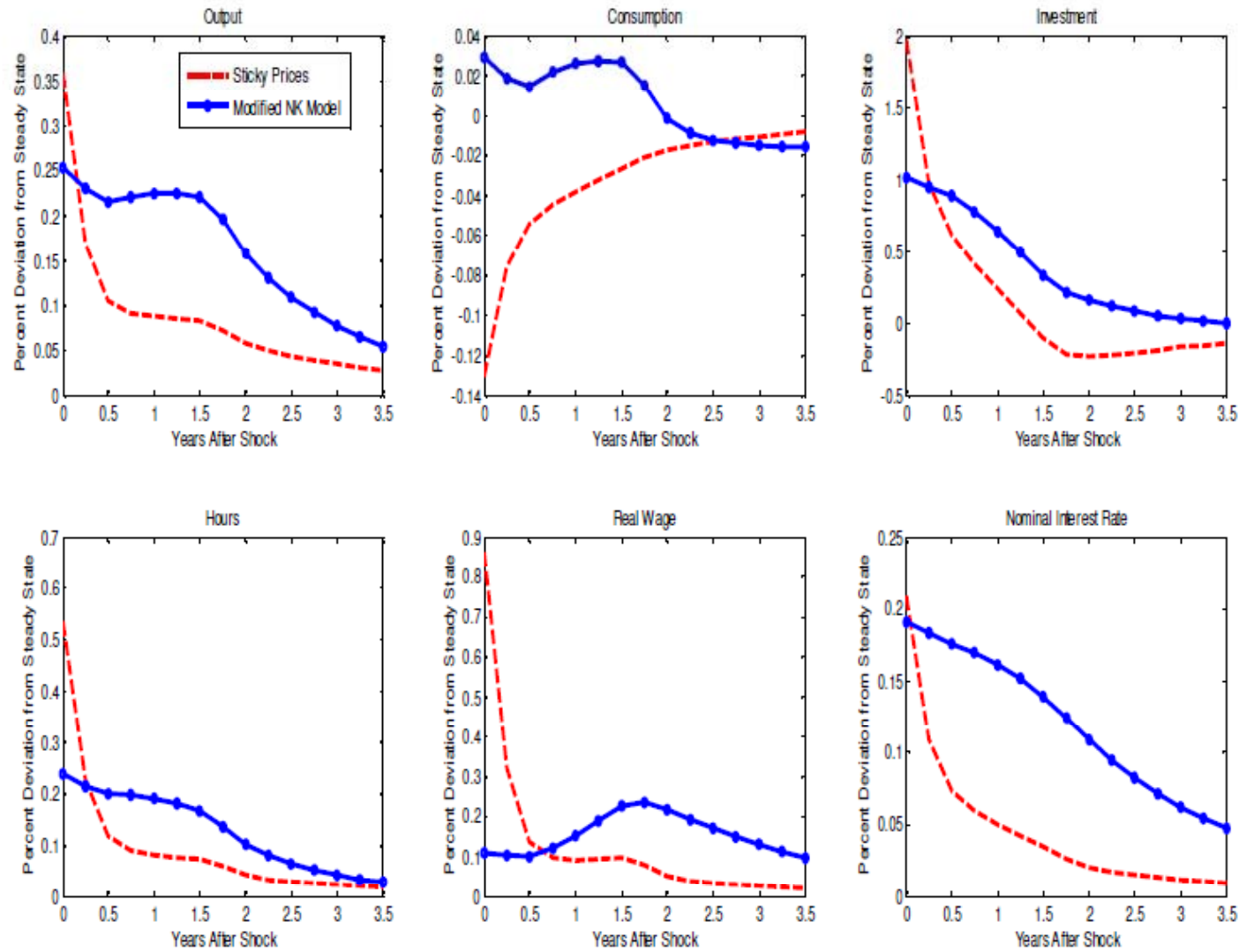
'News Driven Business Cycles'

- a) making consumption or leisure an inferior good (see, Eusepi and Preston (2009) and (2011));
- b) wealth in the utility function (Karnizova (2010));
- c) allowing for sticky prices and accommodative monetary policy (see Christiano et. al. (2010), Khan and Tsoukalas (2012), Lorenzoni (2009) among others)
- d) adopting a multi-sector structure (see, Beaudry and Portier (2007))
- e) investment adjustment costs and variable capital utilization (see Jaimovich and Rebelo (2009))
- f) introducing search and matching frictions (see, Den Haan and G. Kaltenbrunner (2009)).

A model that can replicate empirical findings

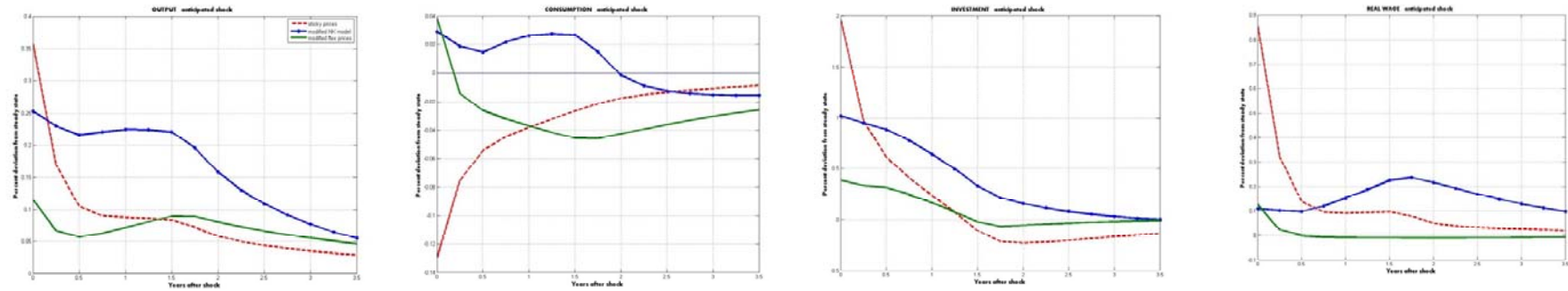
- Additional features to the standard model:
 - Rule of thumb consumers (increase in private consumption)
 - Variable capacity utilization (propagates the effects of shocks)
 - Distortionary income taxation (higher reaction to anticipated shocks)
 - Complementarity between private consumption and defense spending

Figure 10: Modified DSGE Model: Responses to an Anticipated Shock.

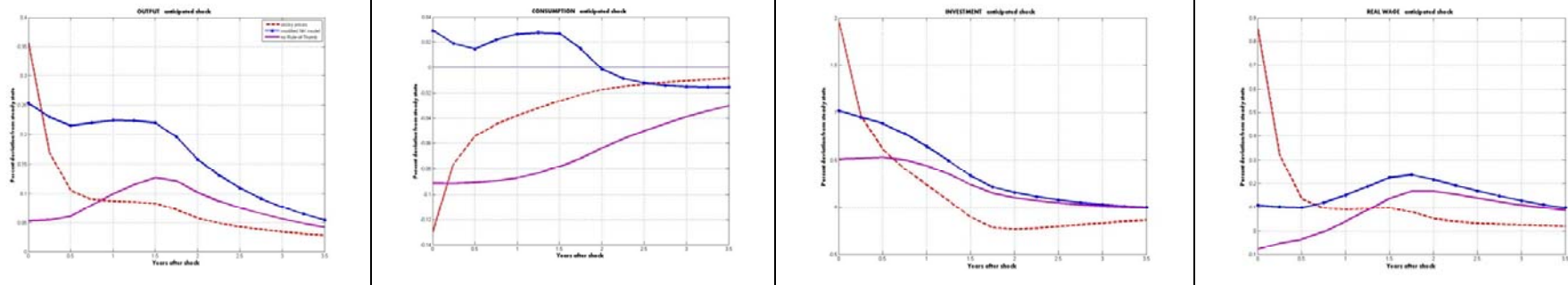


Qualification of the Propagation Mechanisms

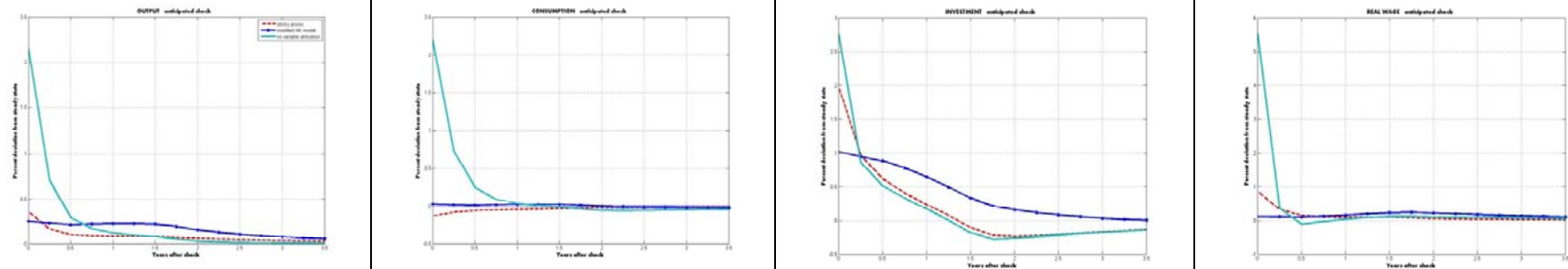
Flexible prices



No Rule of Thumb

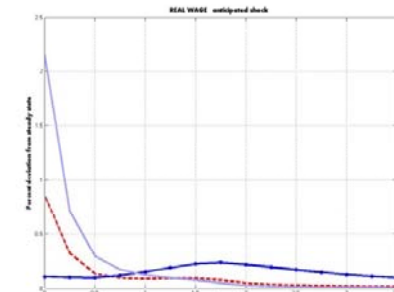
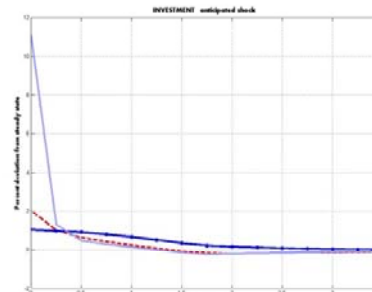
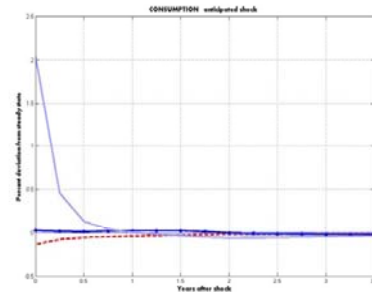
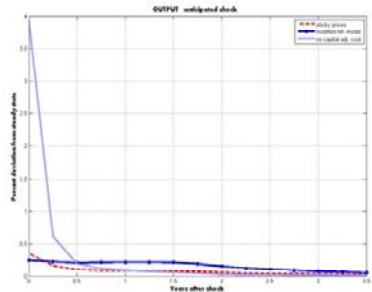


No variable utilization

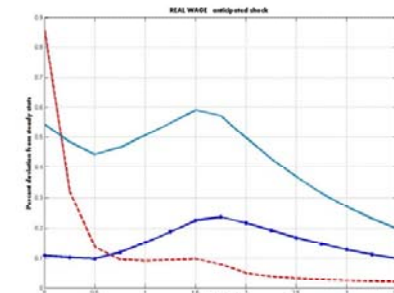
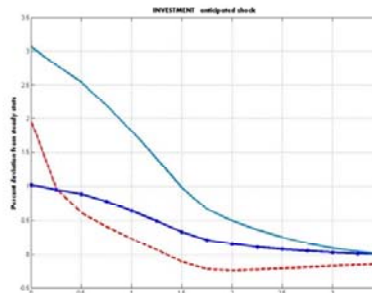
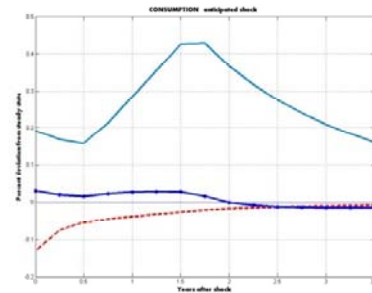
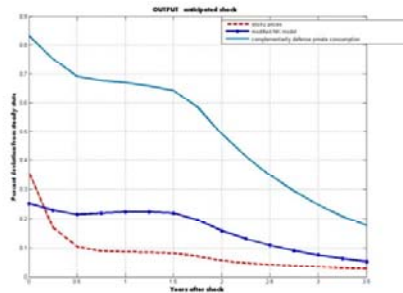


Qualification of the Propagation Mechanisms

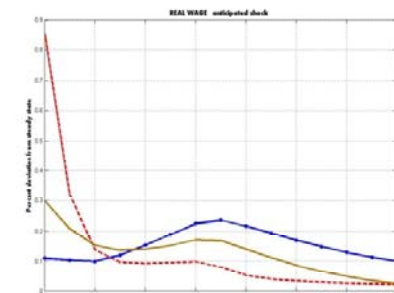
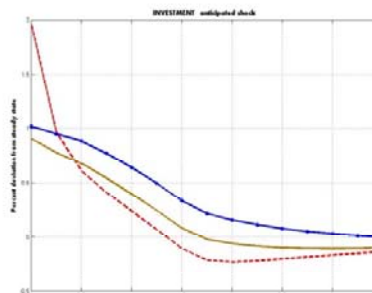
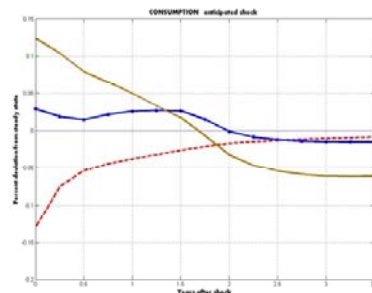
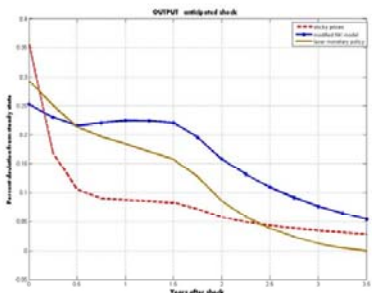
No capital adjustment costs



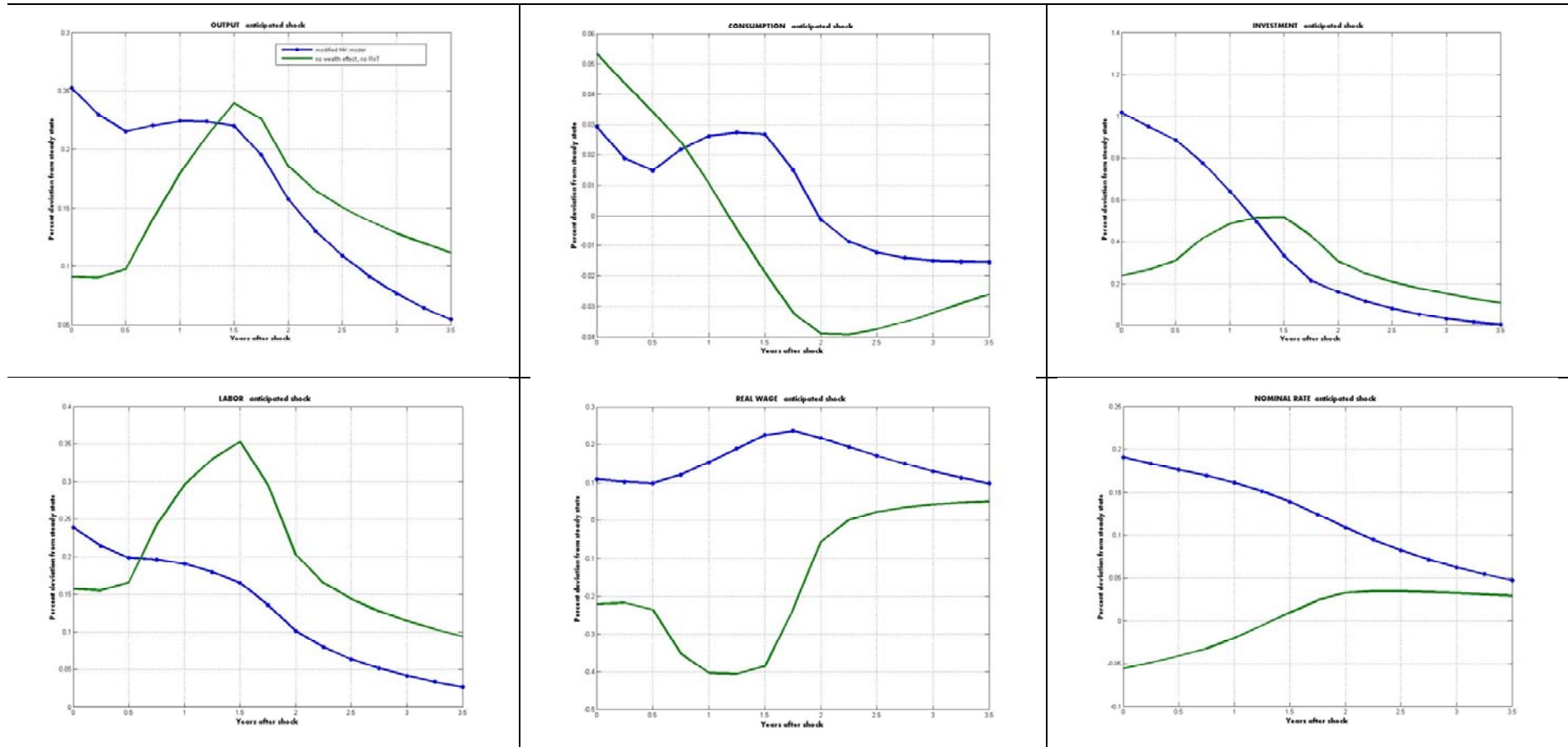
Complementary of military and private spending



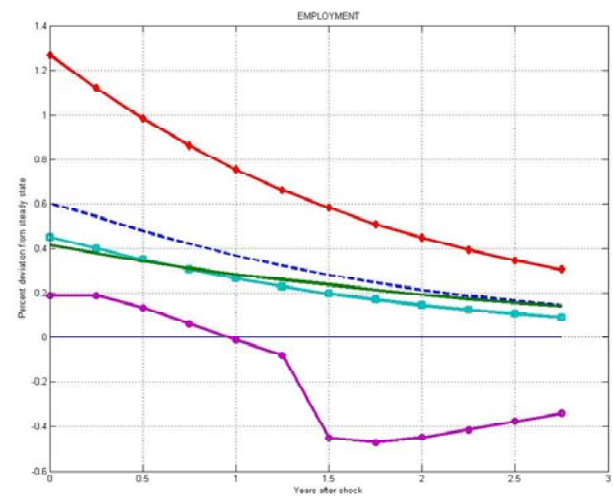
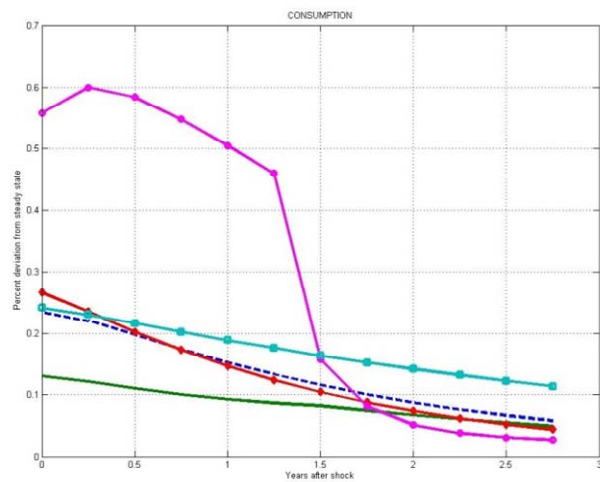
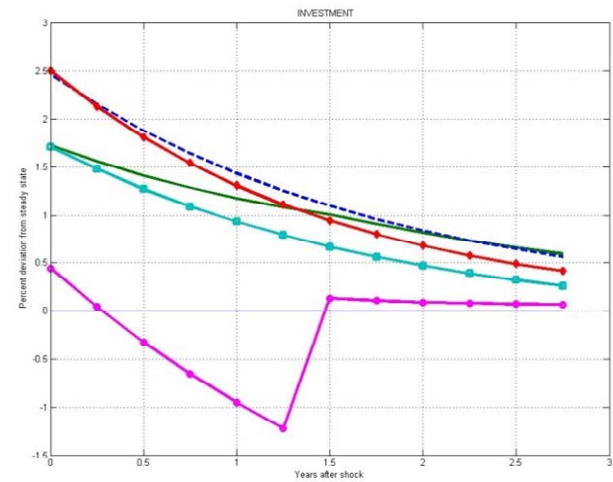
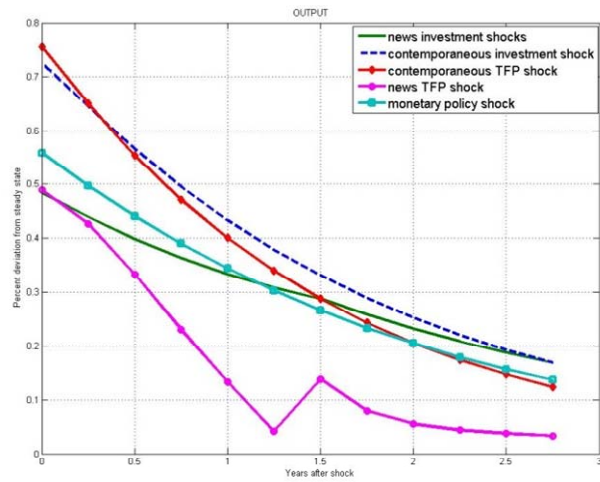
Laxer monetary policy



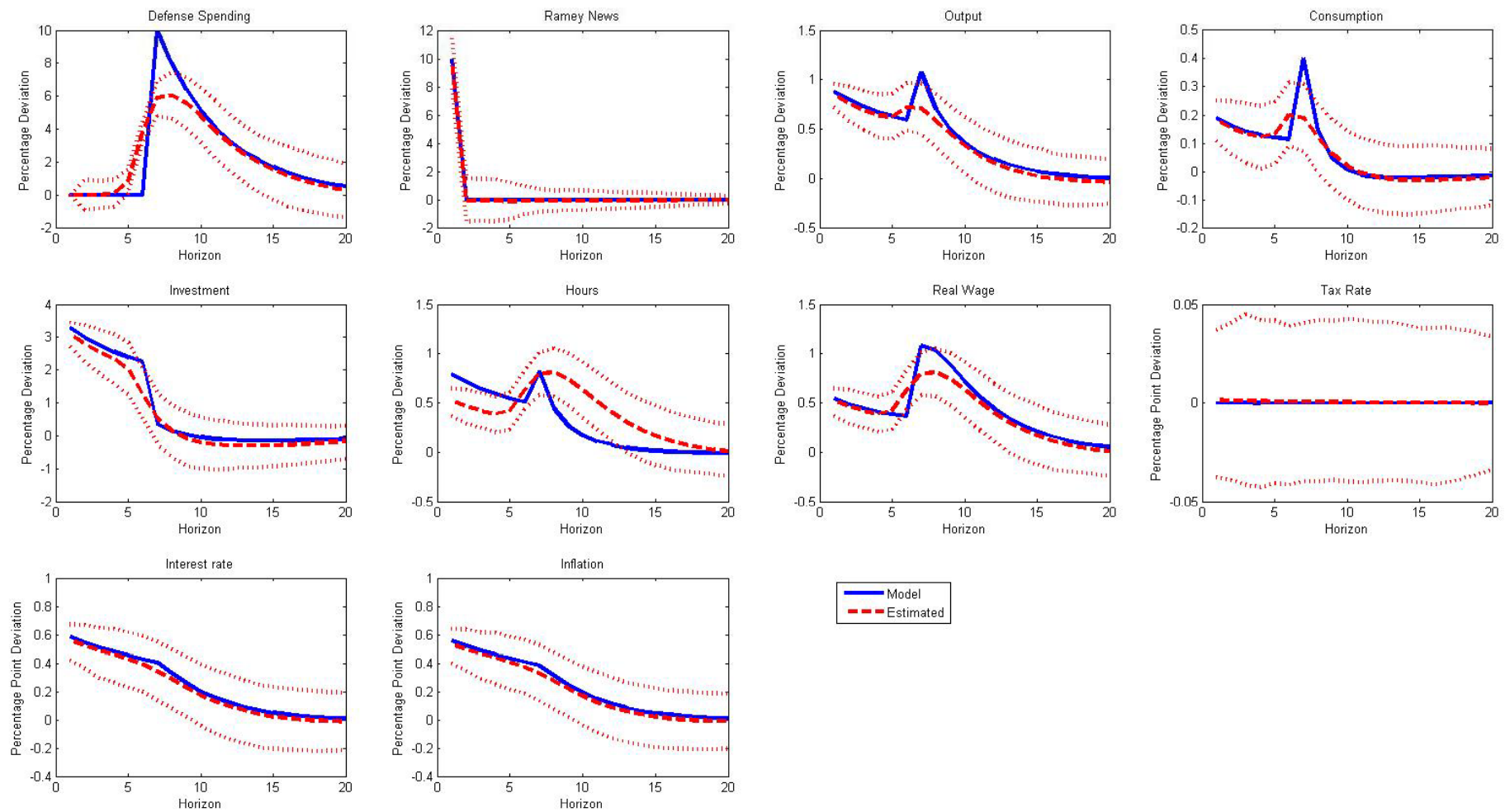
Alternative model: no wealth effects, adj.costs and variable utilization



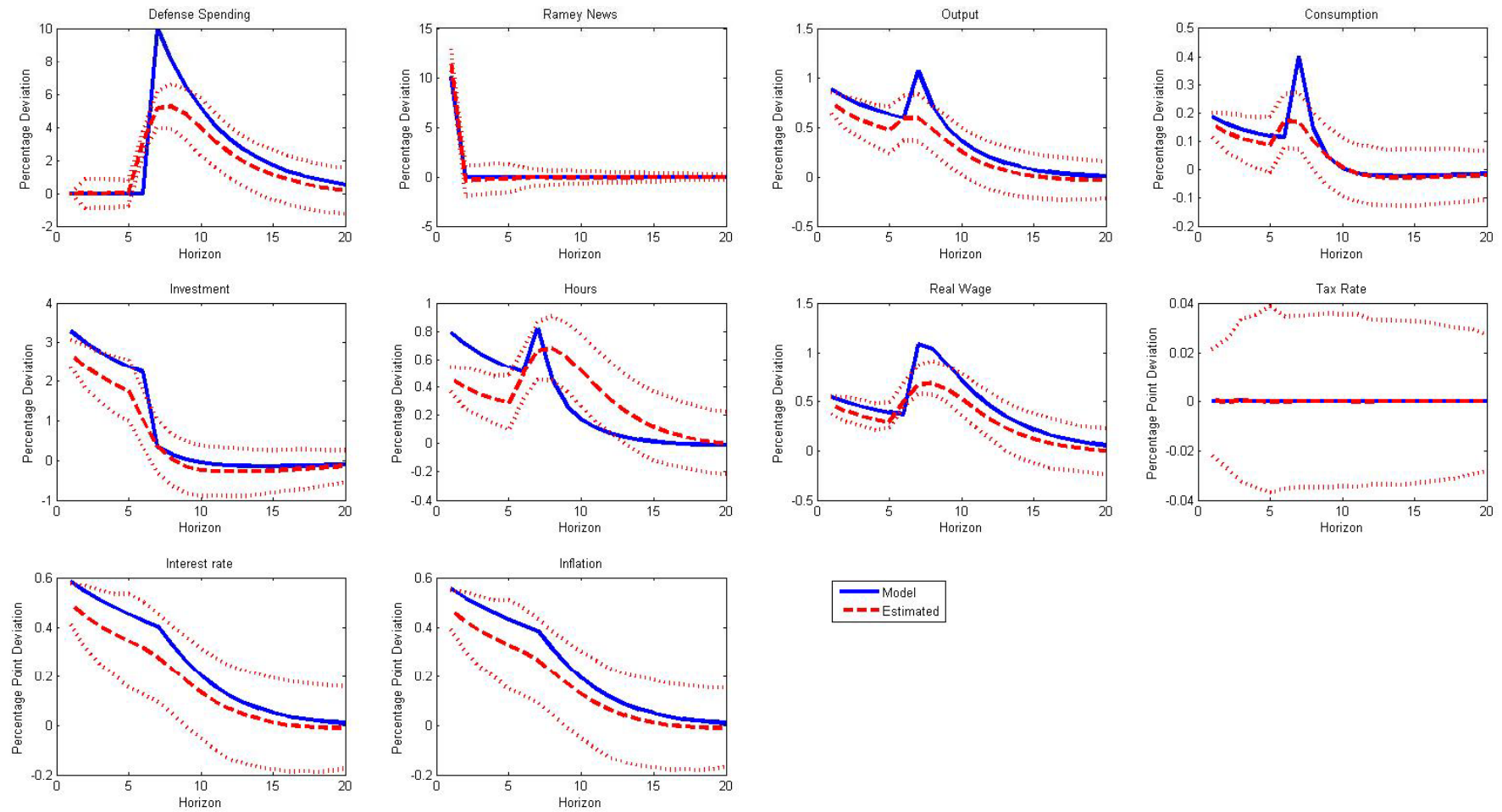
Other shocks

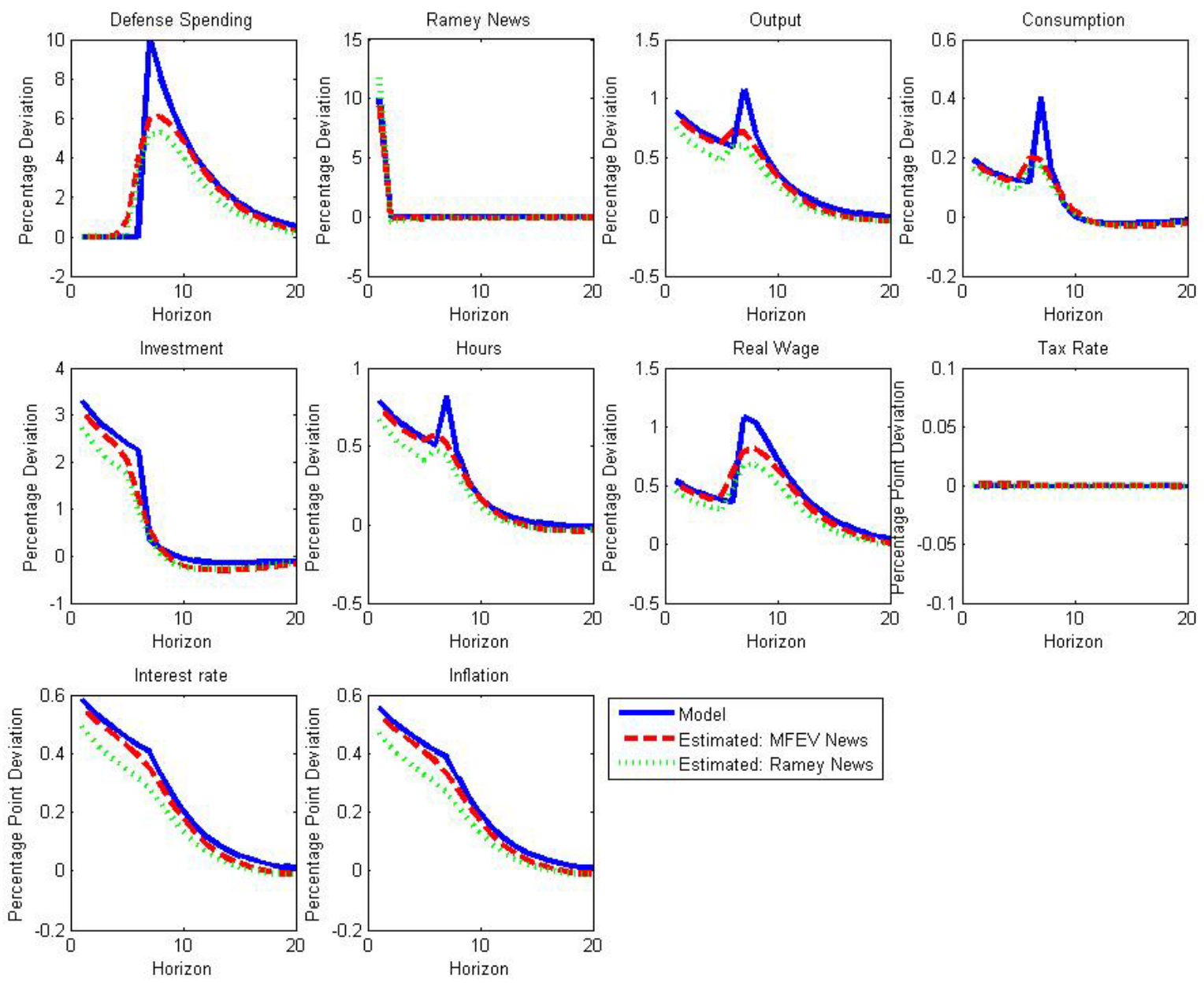


Our methodology in simulated data

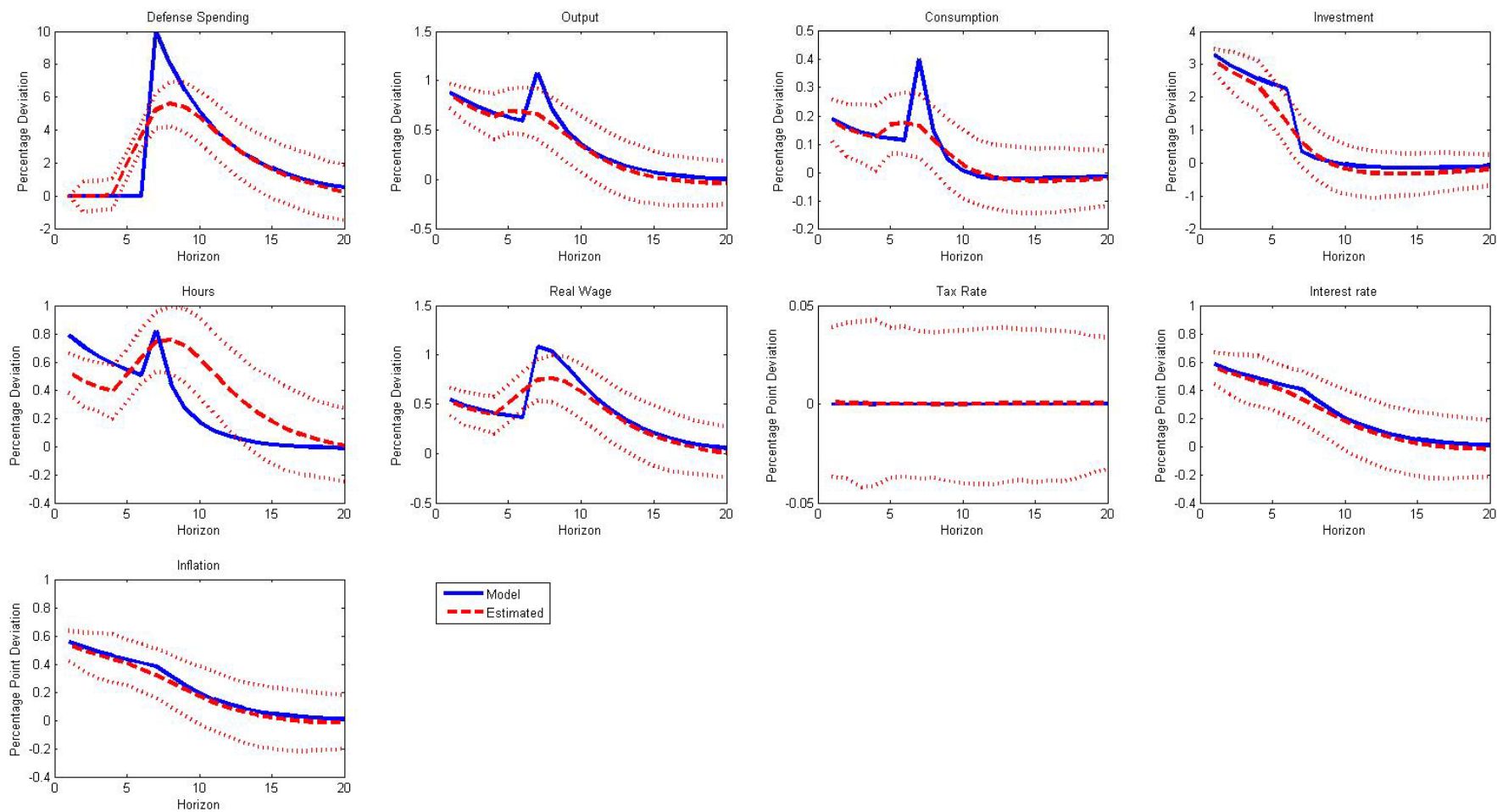


Ramey's identification





Excluding Ramey series from the VAR



conclusions

- According to our proposed methodology: Anticipated shocks to military spending induce a significant and persistent increase in output, consumption, investment, hours and the interest rate and a fall in the real wage.
- Standard models miss a mechanism cannot replicate empirical results.
- Propose a sticky price model with variable capacity utilization, capital adjustment costs, distortionary taxation, rule of thumb consumers and utility from defense spending that matches the empirical findings
- Use our methodology in simulated data and we pass the test.