Fiscal Volatility Shocks and Economic Activity

Jesús Fernández-Villaverde, Pablo Guerrón Quintana,

Keith Kuester, Juan Rubio Ramírez

University of Pennsylvania

October 4, 2013

Motivation

Ben Bernanke [July 18, 2012]:

“The recovery in the United States continues to be held back by a number of other headwinds, including still-tight borrowing conditions for some businesses and households, and – as I will discuss in more detail shortly – the restraining effects of fiscal policy and fiscal uncertainty.”

New York Times [September 30, 2013]:

“The Senate, which returns Monday afternoon, is expected to overwhelmingly reject a bill passed by the Republican-controlled House this weekend that would delay the full effect of President Obama’s health care law as a condition for continuing to finance the government past Monday. But no one -not even House Republicans themselves- seemed to know what would happen next.”

Objective

- *Quantify* the effects of fiscal volatility shocks on economic activity.
- We estimate tax and spending processes for the U.S. with time-variant volatility using a Particle filter and an McMc.
- We feed the estimated rules into an equilibrium business cycle model estimated to the U.S. economy using a SMM.
- We simulate the equilibrium using a third-order perturbation.

Main Results I

1. We find a considerable amount of time-varying volatility in all four fiscal instruments.

2. After a fiscal volatility shock, output, consumption, hours, and investment drop on impact and stay low for several quarters.

   Main transmission mechanism: an endogenous increase in mark-ups.

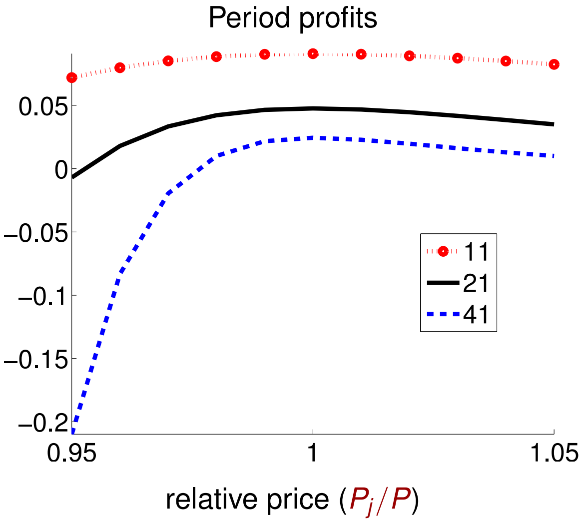
   Upward pricing bias due to the shape of the profit function.

3. Fiscal volatility shocks are “stagflationary": inflation goes up while output falls.

4. We estimate a CEE-style VAR and an ACEL-style VAR to document that, after a fiscal volatility shock, markups significantly increase.

Why the “Stagflation”?

- Steady-state profits: $(P_j/P)^{1-\epsilon}\, y - mc\,(P_j/P)^{-\epsilon}\, y$



Main Results II

5. A two-standard deviations fiscal volatility shock has an effect similar to a 30 b.p. innovation in the FFR as estimated by a SVAR.

6. At the ZLB, the effects are much bigger: 1.7 percent fall of output if we are at the ZLB for 8 quarters.

7. Most important channel: larger uncertainty about the future tax rate on capital income.

8. An accommodative monetary policy increases the effect of fiscal volatility shocks.

How Do We Quantify Fiscal Volatility Shocks?

- Volatility is not directly observed.
- No data (surveys, asset prices...) or very limited (SPF for g, but short horizon (5qtrs)).
- Instead, we estimate a stochastic volatility process as in Fernández-Villaverde et al. (2011).

Empirical Model

- Fiscal instruments follow:

$$x_t = \rho_x x_{t-1} + \phi_{x,y} \tilde{y}_{t-1} + \phi_{x,b} \left(\frac{b_{t-1}}{y_{t-1}} \right) + \exp(\sigma_{x,t}) \varepsilon_{x,t}$$

$$\sigma_{x,t} = (1 - \rho_{\sigma_x}) \sigma_x + \rho_{\sigma_x} \sigma_{x,t-1} + \left(1 - \rho_{\sigma_x}^2 \right)^{(1/2)} \eta_x u_{x,t}$$

- $x \in \{g, \tau_c, \tau_l, \tau_k\}$.
- Fiscal shocks: $\varepsilon_{x,t}$.
- Volatility shock: $u_{x,t}$.
- No direct effect on taxes.

Data

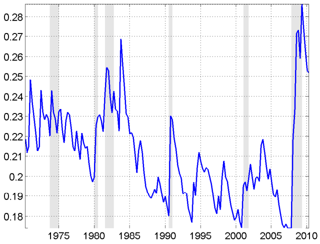
- Construct aggregate (average) effective tax rates from NIPA (Mendoza et al., 1994; Leeper et al., 2010): consumption, labor and capital income taxes.
- *General government* ($=$ federal + state + local).
- Spending rule: ratio of government expenditures to GDP.
- Federal debt (held by the public) from St. Louis Fed.
- Data sample: 1970Q1 - 2010Q2.

Estimation of Fiscal Rules

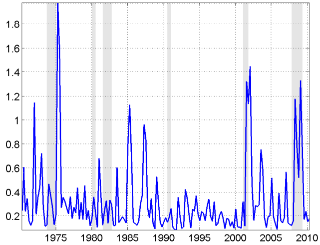
- Instrument by instrument (easily extended).
- No correlation of shocks (easily extended).
- Particle filter+Bayesian methods.
- Flat priors.
- 20,000 draws from posterior (5,000 additional burn-in draws) using McMc.
- 10,000 particles to perform the evaluation of the likelihood.

Smoothed Volatility

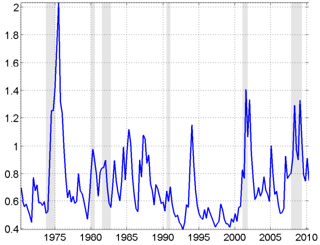
Government spending



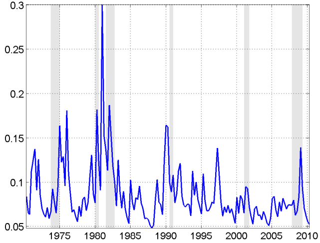
Labor Tax



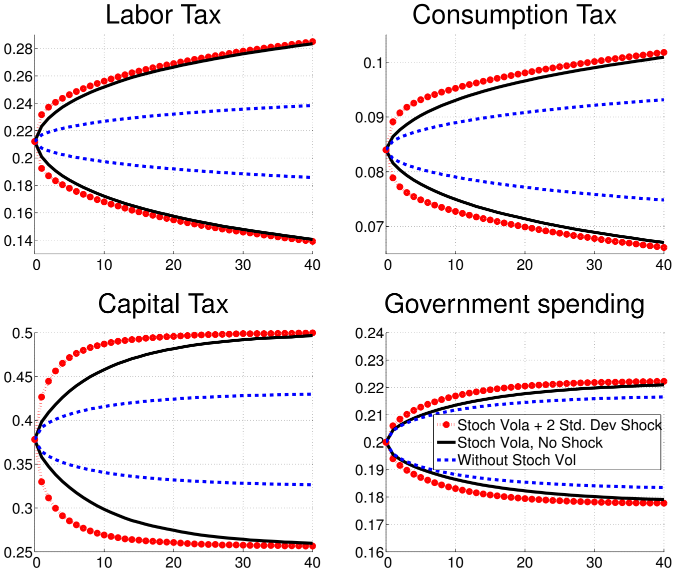
Capital Tax



Consumption Tax



Forecast Dispersion



Key Ingredients

- Representative household.
- Labor supply flexible, but wages with quadratic adjustment cost.
- Investment adjustment costs, but flexible utilization margin of capital.
- Prices with quadratic adjustment cost.
- Fiscal rules as discussed above+Taylor rule for monetary policy.

Details of the Model

Estimation

- General point: problems for calibration in non-linear models.
- The Pruned State-Space System for Non-Linear DSGE Models: Theory and Empirical Applications.
- We use a SMM to estimate most parameters.
- Parameters for fiscal instruments laws of motion: median of our posteriors.
- Third-order perturbation solution. Why?

Details of the Estimation

Experiment to Understand Fiscal Volatility Shocks

$$x_t = \rho_x x_{t-1} + \phi_{x,y}\tilde{y}_{t-1} + \phi_{x,b}\left(\frac{b_{t-1}}{y_{t-1}}\right) + \exp(\sigma_{x,t})\varepsilon_{x,t}$$

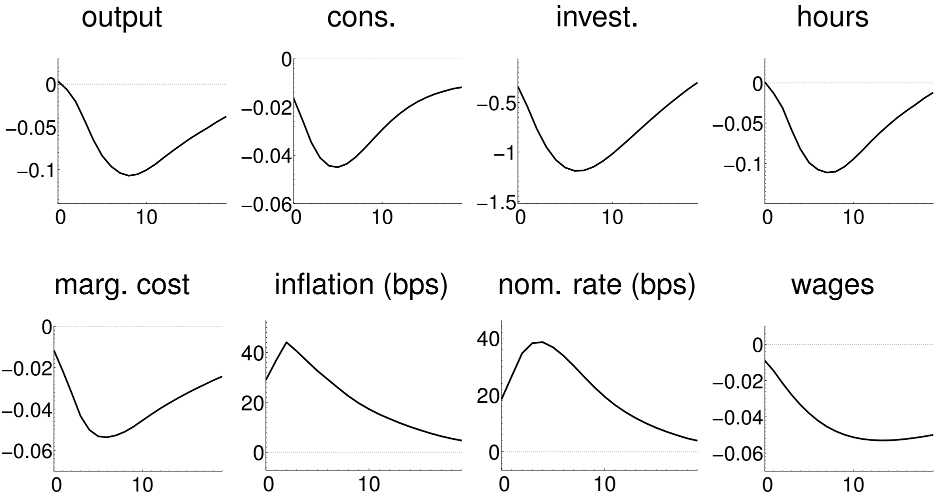
$$\sigma_{x,t} = (1-\rho_{\sigma_x})\,\sigma_x + \rho_{\sigma_x}\sigma_{x,t-1} + \left(1-\rho_{\sigma_x}^2\right)^{(1/2)}\eta_x u_{x,t}$$

- At time 0, the economy is hit by a fiscal volatility shock to capital income tax.
- Taxes are constant today.
- Two-standard deviation shocks to $u_{x,t}$'s.

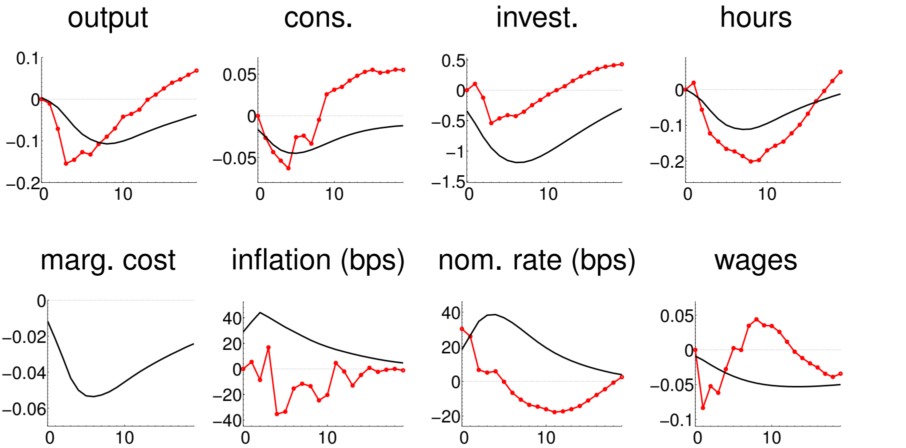
  Meant to capture current fiscal outlook.

  Perotti (2007), Bloom (2009).

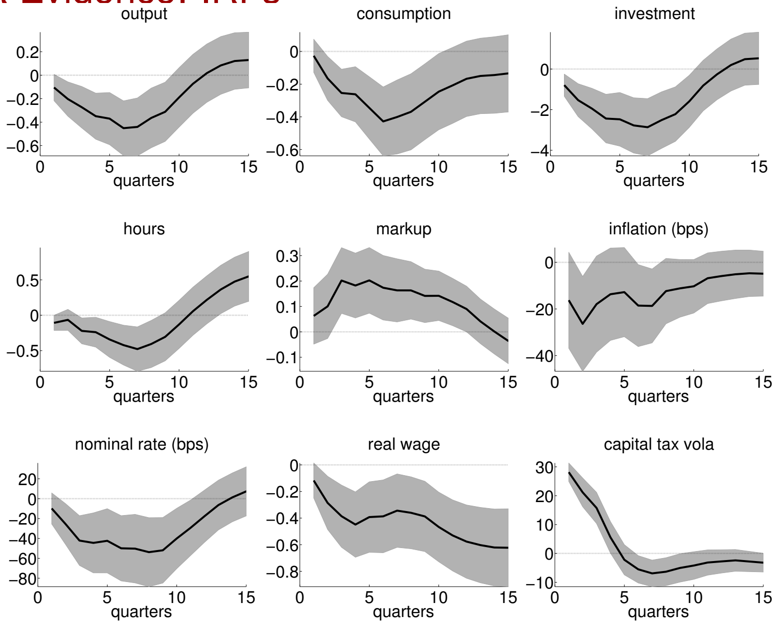
Fiscal Volatility Shocks



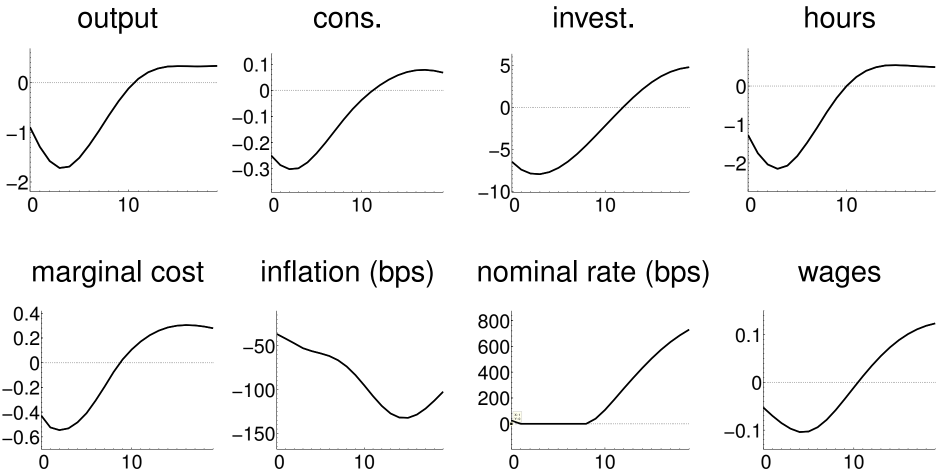
Fiscal Volatility Shocks (black solid) vs. 30bps Monetary Shock (red dots)



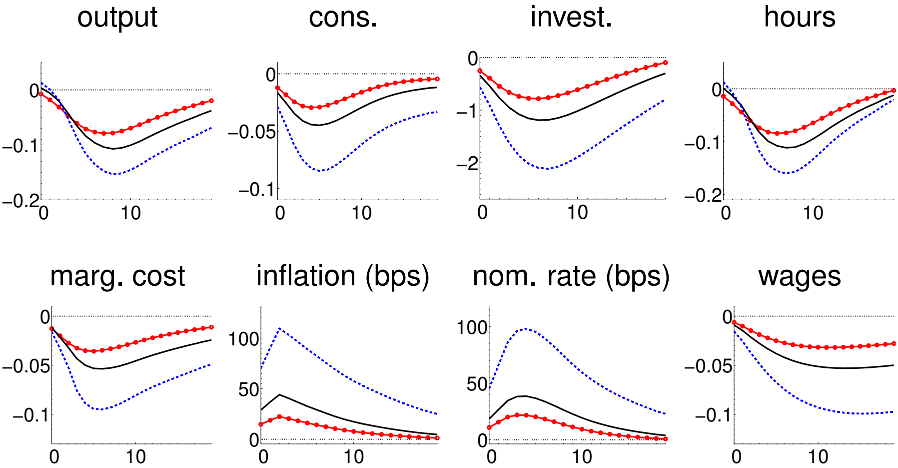
VAR Evidence: IRFs



The Effect of the ZLB

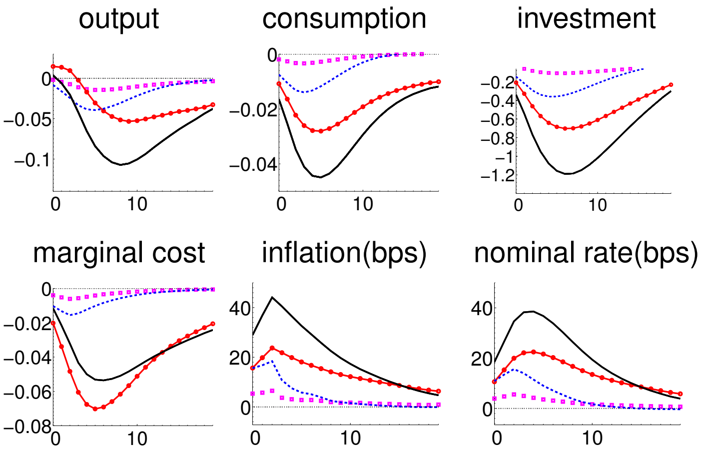


Role for Monetary Policy



- $\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{1-\phi_R} \left(\frac{\Pi_t}{\Pi}\right)^{(1-\phi_R)\gamma_\Pi \uparrow = 1.5} \left(\frac{y_t}{y}\right)^{(1-\phi_R)\gamma_y \uparrow = 0.5} e^{\sigma_m \xi_t}$

Degree of Nominal Rigidities



- blue: (Calvo) $\phi_p = 0.1$
- red: (Calvo) $\phi_w = 0.1$
- magenta: (Calvo) $\phi_p = 0.1$ and $\phi_w = 0.1$

Agenda

- Additional ingredients?
  - Financial frictions.
  - Non-convexities.
  - “Investment” into labor relationships.
  - Human capital.
- Feedback from higher levels of debt to tax volatility?

Conclusion

- High fiscal volatility is a concern for policymakers.
- But, how big are the effects of fiscal volatility shocks?
- Our simulations indicate that the effect can be important.
- Key role for monetary policy in propagation.
- Modeling of political-economic equilibrium that leads to these shocks remains an open issue.

Estimated Parameters

	Tax rate on			Government
	Labor	Consumption	Capital	Spending
ρ_x	0.99 [0.975,0.999]	0.99 [0.981,0.999]	0.97 [0.93,0.996]	0.97 [0.948,0.992]
σ_x	-6.01 [-6.27,-5.75]	-7.09 [-7.34,-6.78]	-4.96 [-5.29,-4.66]	-6.13 [-6.49,-5.39]
$\phi_{x,y}$	0.031 [0.011,0.055]	0.001 [0.000,0.005]	0.044 [0.004,0.109]	-0.004 [-0.02,0.00]
$\phi_{x,b}$	0.003 [0.00,0.007]	0.0006 [0.00,0.002]	0.004 [0.00,0.016]	-0.008 [-0.012,-0.003]
ρ_{σ_x}	0.31 [0.06,0.57]	0.65 [0.08,0.91]	0.76 [0.47,0.92]	0.93 [0.43,0.99]
η_x	0.94 [0.73,1.18]	0.60 [0.31,0.93]	0.57 [0.33,0.88]	0.43 [0.13,1.15]

Notes: The posterior median and a 95% probability interval.

- Persistent mean-dynamics.
- Stochastic volatility is significant and moderately persistent.

Relation with Other Measures of Uncertainty

- How much do we believe our empirical results?

- Bloom et al. (2011) measure uncertainty using news media coverage, tax provisions set to expire, and disagreement among forecasters.

- Surprisingly high correlation of their uncertainty measure with our smoothed volatilities.

- For instance, correlation of uncertainty with volatility of capital taxes: 0.56.

Households I

- Household maximizes:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t d_t \left\{ \frac{(c_t - b_h c_{t-1})^{1-\omega}}{1-\omega} - \psi \int_0^1 \frac{l_{j,t}^{1+\vartheta}}{1+\vartheta} dj \right\}$$

- Intertemporal shock d_t:

$$\log d_t = \rho_d \log d_{t-1} + \sigma_d \varepsilon_{dt}, \varepsilon_{dt} \sim \mathcal{N}(0,1)$$

- Savings:

  1. Invest, i_t.

  2. Hold government bonds, B_t, with nominal gross interest rate R_t.

Households II

- Budget constraint:

$$(1+\tau_{c,t})c_t + i_t + b_t + \Omega_t + \int_0^1 AC_{j,t}^w dj =$$

$$\left(1-\tau_{l,t}\right)\int_0^1 w_{j,t} l_{j,t} dj + \left(1-\tau_{k,t}\right) r_{k,t} u_t k_{t-1} + \tau_{k,t} \delta k_{t-1}^b +$$

$$+ b_{t-1}\frac{R_{t-1}}{\Pi_t} + F_t.$$

- Real wage adjustment costs for labor type j:

$$AC_{j,t}^w = \frac{\phi_w}{2}\left(\frac{w_{j,t}}{w_{j,t-1}} - 1\right)^2 y_t$$

- Quadratic cost $\neq$ Calvo. Remember: non-linear solution!
- We also computed the model with Calvo pricing.

Households III

- Labor packer:

$$l_t = \left(\int_0^1 l_{j,t}^{\frac{\epsilon_w - 1}{\epsilon_w}} dj \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}$$

- Demand for each type of type of labor:

$$l_{j,t} = \left(\frac{w_{j,t}}{w_t} \right)^{-\epsilon_w} l_t$$

- By a zero-profit condition:

$$w_t = \left(\int_0^1 w_{j,t}^{1-\epsilon_w} \right)^{\frac{1}{1-\epsilon_w}}$$

Households IV

- Capital accumulation:

$$k_t = (1 - \delta(u_t))\, k_{t-1} + \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right) i_t$$

where: $$\delta(u_t) = \delta + \Phi_1(u_t - 1) + \frac{1}{2}\Phi_2(u_t - 1)^2$$

- Quadratic adjustment cost:

$$S\left[\frac{i_t}{i_{t-1}}\right] = \frac{\kappa}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2$$

which implies $S(1) = S'(1) = 0$ and $S''(1) = \kappa$.

- Book value of capital:

$$k_t^b = (1 - \delta)k_{t-1}^b + i_t$$

Firms I

- Competitive producer of a final good:

$$y_t = \left(\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

- Buys intermediate goods at price $P_{i,t}$ and charges P_t.
- Demand:

$$y_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\varepsilon} y_t$$

- Price index:

$$P_t = \left(\int_0^1 P_{it}^{1-\varepsilon} di \right)^{\frac{1}{1-\varepsilon}}$$

Firms II

- Intermediate good producer with market power:

$$y_{it} = A_t k_{it}^{\alpha} l_{it}^{1-\alpha} - \phi$$

- A_t is neutral productivity:

$$\log A_t = \rho_A \log A_{t-1} + \sigma_A \varepsilon_{At}, \varepsilon_{At} \sim \mathcal{N}(0,1) \text{ and } \rho_A \in [0,1)$$

- Intermediate producer sets prices at cost:

$$AC_{i,t}^{p} = \frac{\phi_p}{2}\left(\frac{P_{i,t}}{P_{i,t-1}} - \Pi\right)^2 y_{i,t}$$

Government

- Monetary authority follows Taylor rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{1-\phi_R} \left(\frac{\Pi_t}{\Pi}\right)^{(1-\phi_R)\gamma_\Pi} \left(\frac{y_t}{y}\right)^{(1-\phi_R)\gamma_y} e^{\sigma_m \xi_t}$$

- Fiscal authority's budget constraint:

$$\begin{aligned} b_t = \quad & b_{t-1}\frac{R_{t-1}}{\Pi_t} \\ & + g_t - \left(c_t \tau_{c,t} + w_t l_t \tau_{l,t} + r_{k,t} u_t k_{t-1} \tau_{k,t} - \delta k^b_{t-1} \tau_{k,t} + \Omega_t\right) \end{aligned}$$

- Transfers:

$$\Omega_t = \Omega + \phi_{\Omega,b}\left(b_{t-1} - b\right)$$

where $\phi_{\Omega,b} > 0$.

Aggregation and Solution

- Aggregate demand:

$$y_t = c_t + i_t + g_t + \frac{\phi_p}{2} (\Pi_t - \Pi)^2 y_t + \frac{\phi_w}{2} \left(\frac{w_t}{w_{t-1}} - 1 \right)^2 y_t$$

- Aggregate supply:

$$y_t = A_t (u_t k_{t-1})^\alpha l_t^{1-\alpha} - \phi$$

- Market clearing.

- Definition of equilibrium is standard.

Return

Estimation I

Preferences and consumer		
β	0.9945	Estimated.
ω	2	Standard choice.
ϑ	2	Chetty (2011).
ψ	75.66	Estimated.
b_h	0.75	CEE (JPE, 2005).
ϕ_w	4889	ACEL (RED, 2011).
ϵ	21	ACEL (RED, 2011).
Cost of utilization and investment		
Φ_1	0.0165	From utilization FOC.
Φ_2	0.0001	Estimated.
κ	3	Estimated.

Estimation II

Firms		
A	1	Normalization
α	0.36	Standard choice.
δ	0.011	Estimated.
ϕ_p	236.10	Gali and Gertler (JME, 1999).
ϵ_w	21	ACEL (RED, 2011).
Monetary policy and lump-sum taxes		
Π	1.0045	Estimated.
ϕ_R	0.6	Estimated.
γ_Π	1.25	FGR (2010).
γ_y	1/4	FGR (2010).
Ω	-4.3e-2	Follows from gov. budget constraint.
$\phi_{\Omega,b}$	0.0005	Small number to stabilize debt.
b	2.64	Estimated.

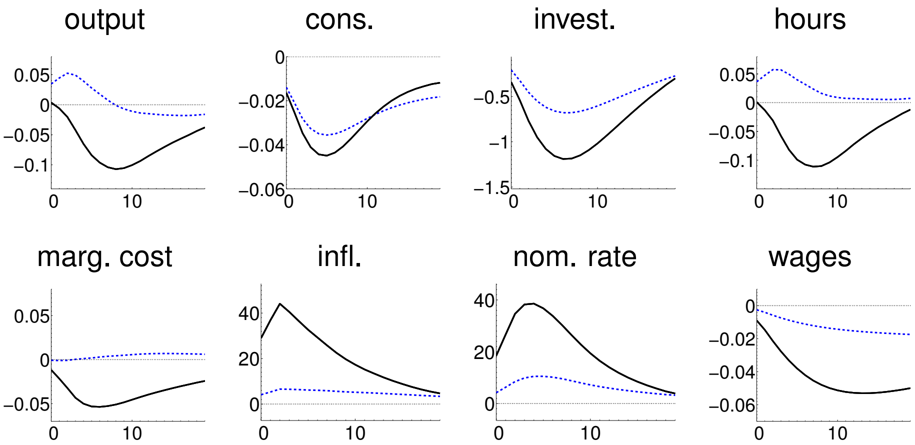
Estimated III

Shocks		
ρ_A	0.95	King and Rebelo (1999).
σ_A	0.001	Estimated.
ρ_d	0.18	Smets and Wouters (AER, 2007).
σ_d	0.078	Estimated.
σ_m	0.0001	Estimated.

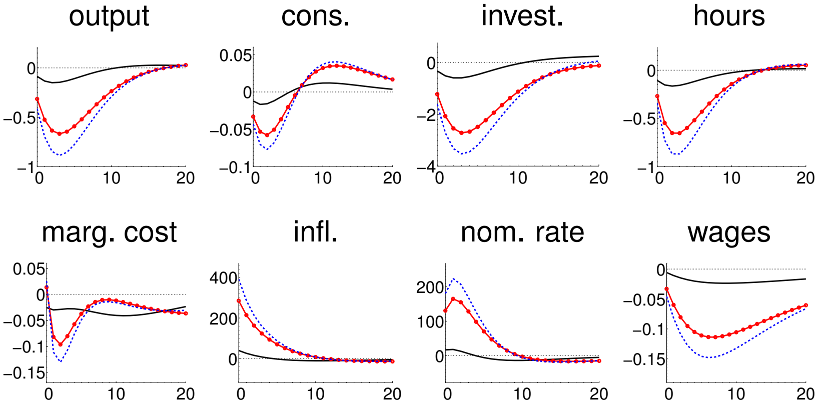
- Parameters for fiscal instruments laws of motion: median of our posteriors.

Return

The Role of Precautionary Price Setting



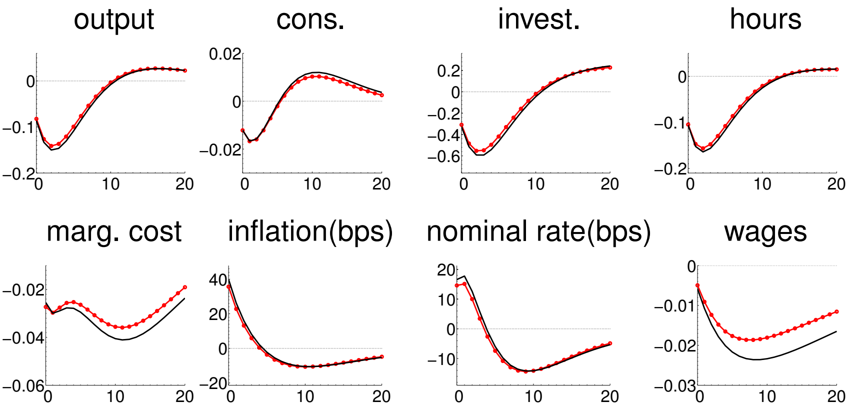
Without Automatic Responses



$$x_t = \rho_x x_{t-1} + \phi_{x,y} \tilde{y}_{t-1} + \phi_{x,b} \left(\frac{b_{t-1}}{y_{t-1}} \right) + \exp(\sigma_{x,t}) \varepsilon_{x,t}$$

- black: benchmark.
- red: no response to output.
- blue: no response to output or debt.

Decomposing Fiscal Volatility Shocks



- black: benchmark.
- red: volatility shock only on capital income taxes.