Expected Versus Unexpected Fiscal Policy Multipliers

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Purpose

- Estimate the impact of predicted versus unexpected fiscal policy.
- Contribute to an unsettled fiscal multiplier literature using SVARs.
  - Size of the multiplier, statistical significance, impact on spending components
  - Identification strategy
  - Hebous (*Journal of Economic Surveys*, 2007)
- Least-squares adaptive expectations.
  - Surveys: Evans and Honkapohja (2008, 2010)
  - Fiscal multipliers with adaptive expectations: Mitra, Evans and Honkapohja (2012).

Outline

1. Baseline model (SVAR): estimate the impact of fiscal policy on macro outcomes.
2. Fiscal policy uncertainty
   - Expectations framework
   - Decompose actual fiscal policy into expected and unexpected components.
3. Extended model (SVAR): estimate the impact on macro outcomes for
   - Expectations for fiscal policy (predicted value)
   - Unexpected fiscal policy (residual)

Baseline Structural VAR

- Baseline model:

$$A_0 x_t = \alpha_0 + \alpha_1 t + A(L)x_t + z_t,$$

- Includes a constant and a linear trend.
- Endogenous vector:

$$x_t = \begin{bmatrix} y_t \\ c_t \\ i_t \\ u_t \\ t_t \\ g_t \end{bmatrix} = \begin{bmatrix} \text{Real GDP per capita} \\ \text{Consumption per capita} \\ \text{Investment per capita} \\ \text{Unemployment Rate} \\ \text{Taxes net of transfers per capita} \\ \text{Government consumption per capita} \end{bmatrix}$$

- A_0 captures contemporaneous causal relationships
  - Identified with zero-restrictions on contemporaneous relationships.

Identification Strategy

- Implementation lag for government spending: g_t does not contemporaneously respond to anything.
- Taxes contemporaneously respond to everything: real GDP, consumption, investment, unemployment, government expenditures.
- Consumption contemporaneously responds to taxes, government expenditures, real GDP, and unemployment.
- Investment contemporaneously responds to taxes, government expenditures, and real GDP.
- Real GDP contemporaneously determined by its components: c_t, i_t, and g_t.
- Labor market frictions prevent unemployment from contemporaneously responding to anything.

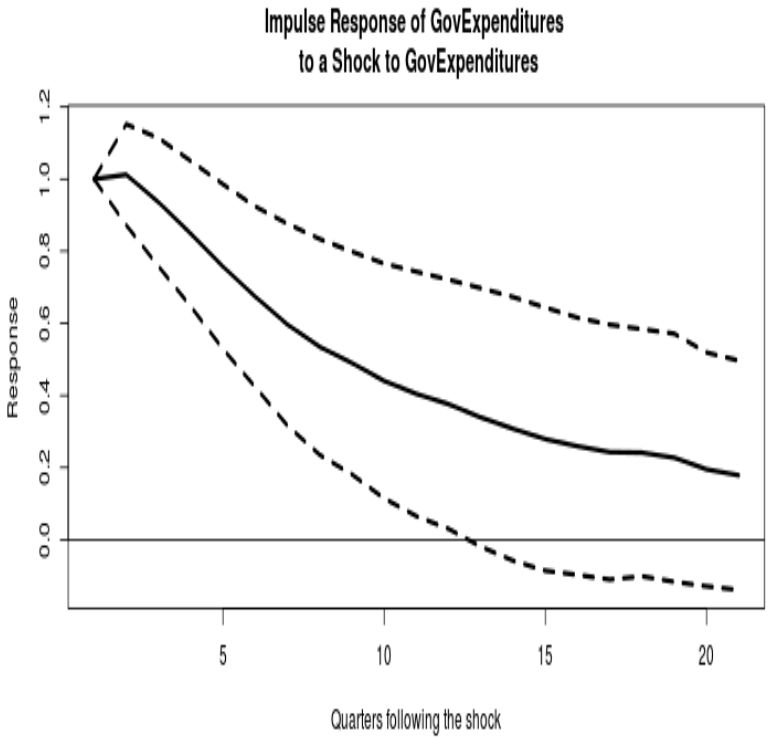
Identification Strategy

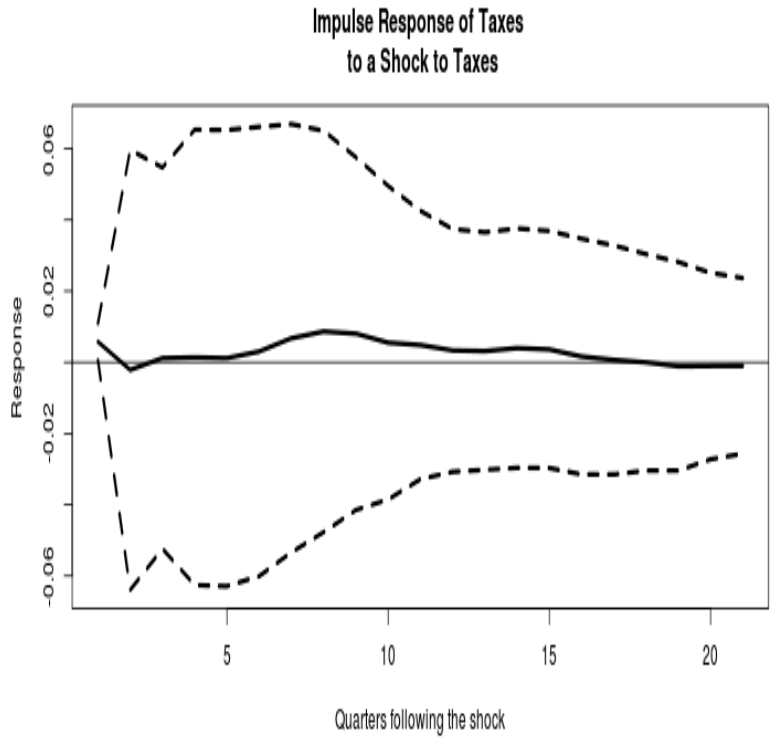
These restrictions leads to the following structure:

$$\begin{bmatrix} 1 & a_{y,c} & a_{y,i} & 0 & 0 & a_{y,g} \\ a_{c,y} & 1 & 0 & a_{c,u} & a_{c,t} & a_{c,g} \\ a_{i,y} & 0 & 1 & 0 & a_{i,t} & a_{i,g} \\ 0 & 0 & 0 & 1 & 0 & 0 \\ a_{t,y} & a_{t,c} & a_{t,i} & a_{t,u} & 1 & a_{t,g} \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} y_t \\ c_t \\ i_t \\ u_t \\ t_t \\ g_t \end{bmatrix} = A(L) \begin{bmatrix} y_{t-1} \\ c_{t-1} \\ i_{t-1} \\ u_{t-1} \\ t_{t-1} \\ g_{t-1} \end{bmatrix} + \begin{bmatrix} z_{y,t} \\ z_{c,t} \\ z_{i,t} \\ z_{u,t} \\ z_{t,t} \\ z_{g,t} \end{bmatrix},$$

- $A(L)$: first-order distributed lag.
- $z_{k,t}$: independently and identically distributed shocks to endogenous variables.
- Fiscal policy responses: IRFs of macro outcomes to taxes $(z_{t,t})$ and government expenditures $(z_{g,t})$.

Fiscal Policy Responses to Own Shocks

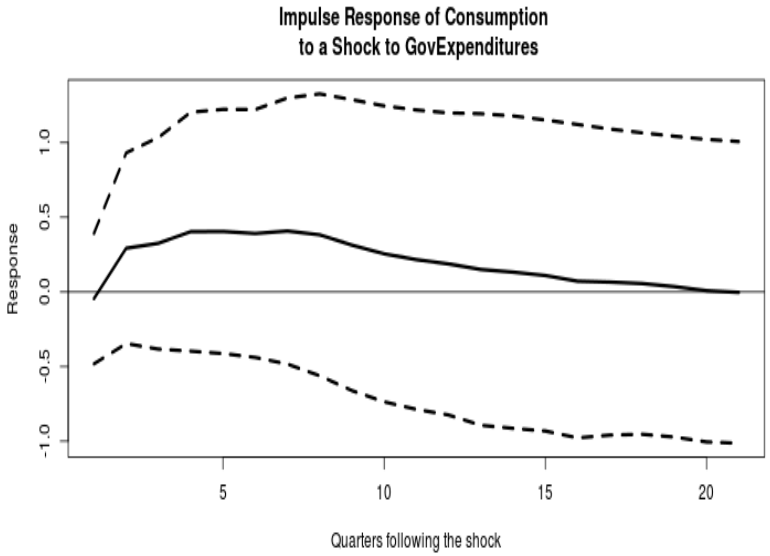


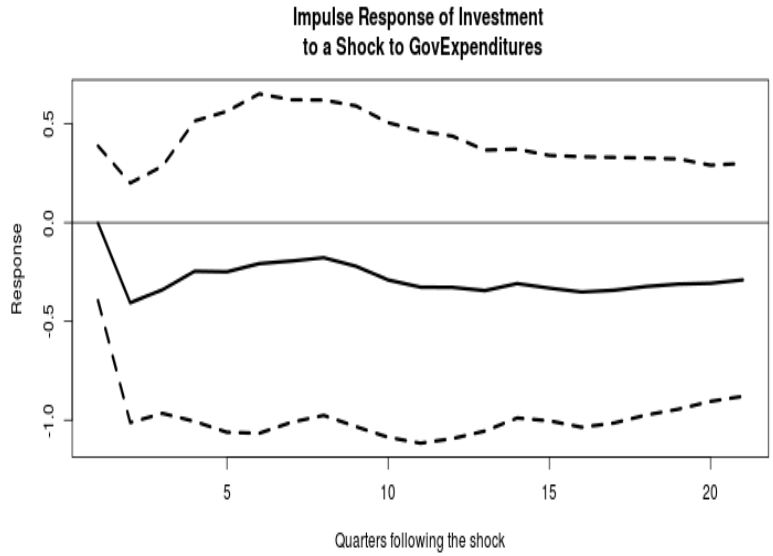


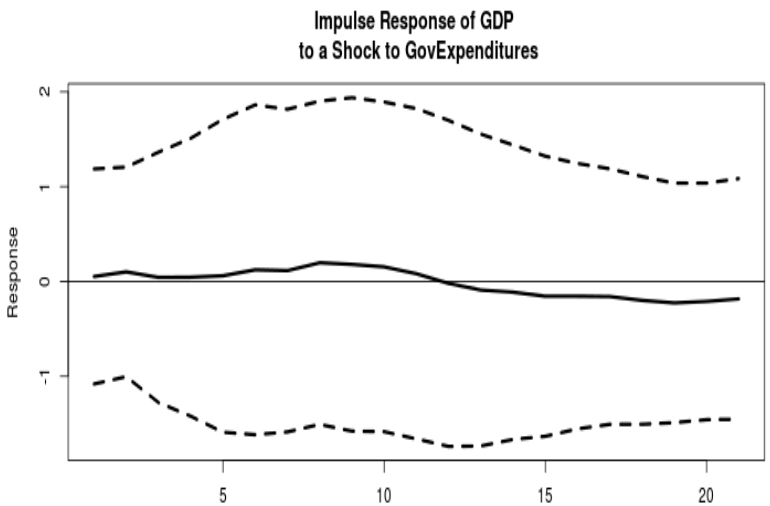
Government expenditures shock is very persistent

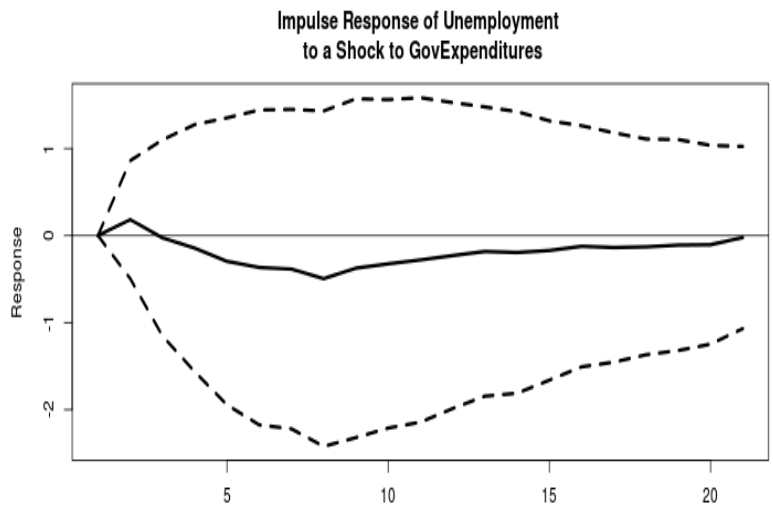
Taxes? Problem with Identification Scheme?

Impulse Response: Shock to Government Spending

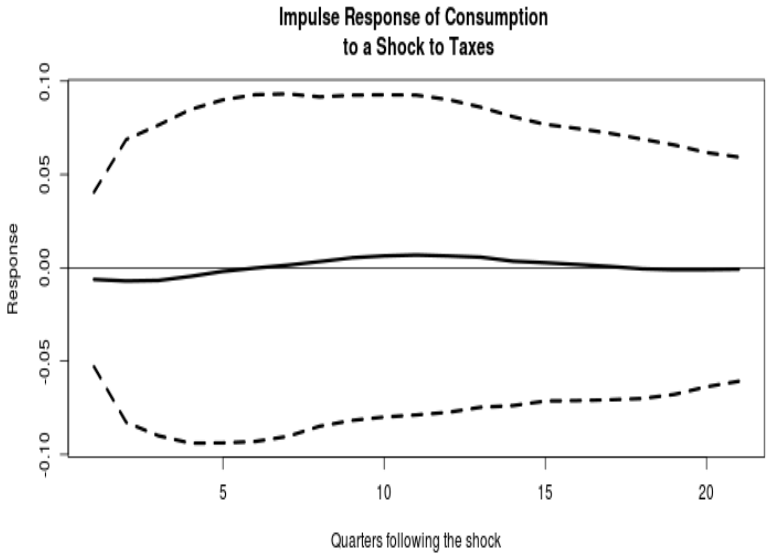


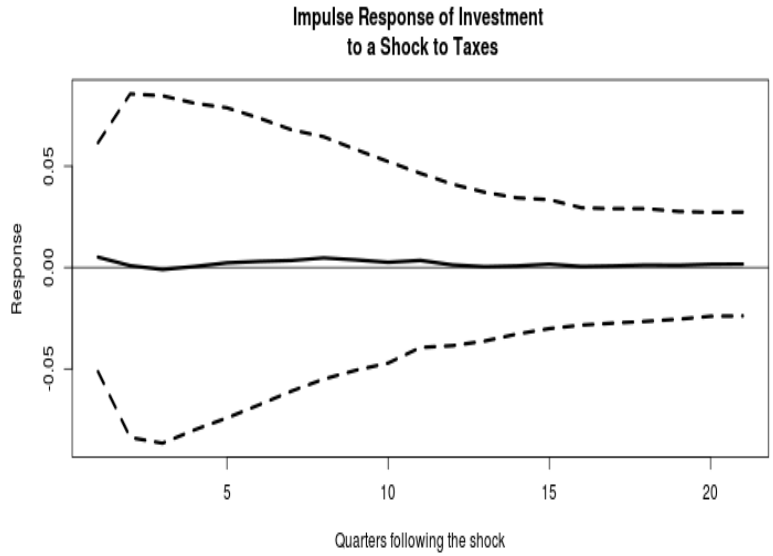


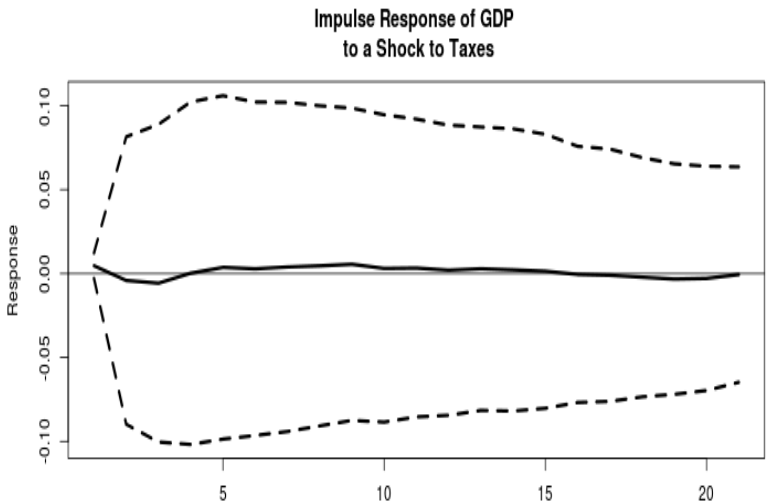




Impulse Response: Shock to Taxes







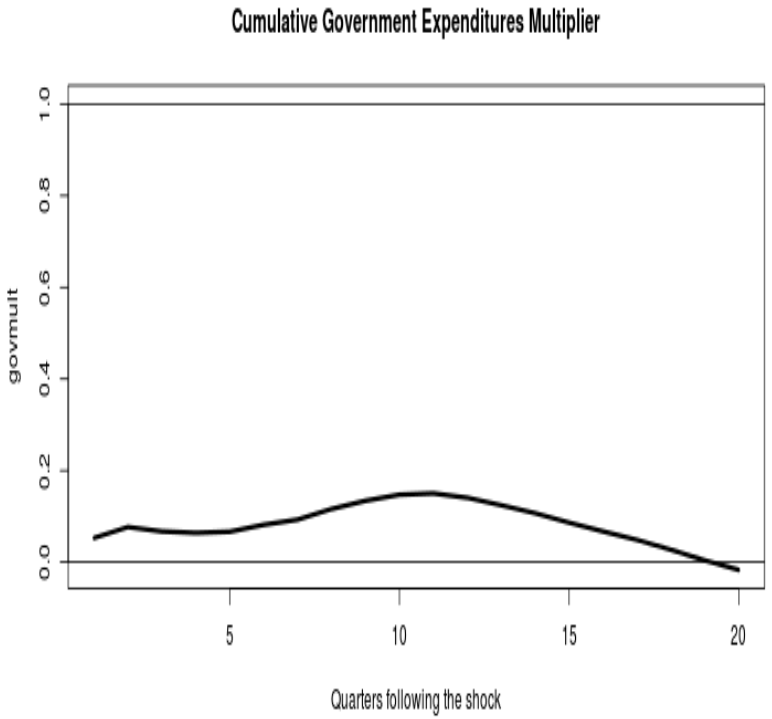
Fiscal Policy Multiplier

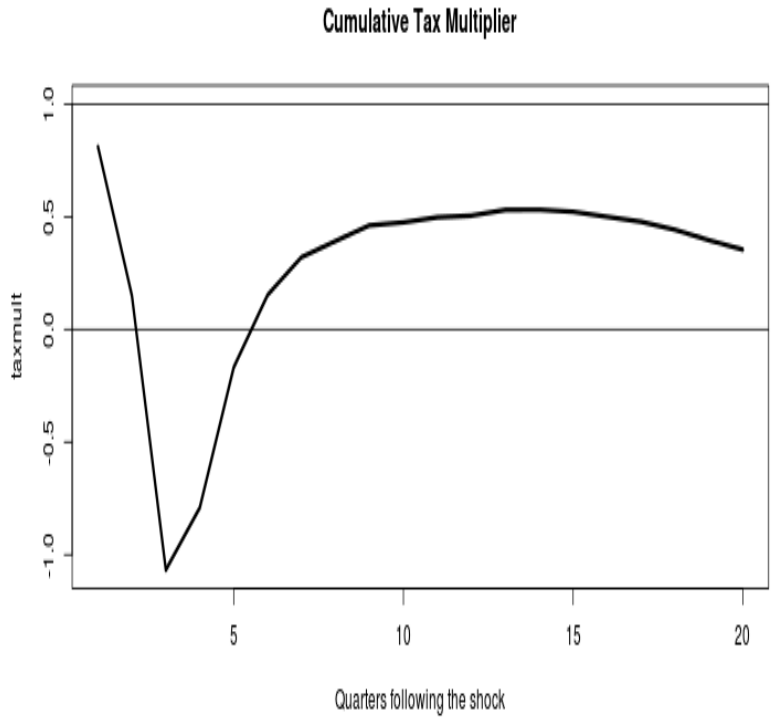
Cumulative multiplier for each period after the shock.

$$\text{Multiplier}_T \equiv m_T = \frac{\sum_{\tau=0}^{T} y_\tau^{resp}}{\sum_{\tau=0}^{T} f_\tau^{resp}}$$

- y_T^{resp} is the response of real GDP, T periods after the initial shock.
- f_T^{resp} is the response of the fiscal policy variable, g_T and t_T in turn.

Fiscal Policy Multipliers





Government consumption multiplier is very close to zero

Tax multiplier has the opposite sign than expected.

Knowledge of Fiscal Policy

- Market participants' set of knowledge at any point in the sample period, is not equal to my estimated SVAR from June 2013.
- Market participants are less informed:
  - Knowledge of the nature of fiscal policy at time t depends on data *prior* to t.
- Might be more informed:
  - Structural change not captured by my SVAR, agents at time t have a better perception of their structure, using data near t.
  - Announcements or news of economic events (not in this paper though).
- Might have misconceptions:
  - Past data may be a poor guide to upcoming policy.

Fiscal Policy Uncertainty

- Exact conduct of fiscal policy decisions is unknown.
- Boundedly rational: agents expect tax and government spending decisions respond to:
  - Macroeconomic variables: Unemployment, real GDP.
  - Fiscal variables: own lag, debt.
- Agents use least-squares regression models to forecast fiscal variables.
- Expectations are adaptive:
  - Agents re-estimate a regression model every quarter, updating their information set with new observation from the previous quarter.
  - Agents put more weight on more recent observations: Constant gain, weighted least-squares forecast.

Motivation for Least-Squares Learning

- Taxes and transfers: respond contemporaneously to economic conditions.
- Government spending:
  - Even announcements could be subject to legislative adjustments or reversals.
  - Stimulus policies are complicated mixtures of taxes, transfers, and spending.
  - Stimulus policies involve complicated implementation lags.
  - Forecast is for the national entire portfolio of federal, state, and local spending.
- Cognitive consistency principle (Evans and Honkapohja, 2010)

Fiscal Policy Rules

Fiscal policy forecasting models

$$g_t = \alpha_0 + \rho_g g_{t-1} + \alpha_y(L) y_t + \alpha_u(L) u_t + \alpha_d d_{t-1} + \epsilon_{g,t}$$

$$t_t = \beta_0 + \rho_t t_{t-1} + \beta_u(L) y_t + \beta_u(L) u_t + \beta_d d_{t-1} + \epsilon_{t,t},$$

Notation

- g_t: Gov spending
- t_t: Net taxes
- y_t: Real GDP
- u_t: Unemployment
- d_t: Government debt
- α_0, β_0: constant terms
- ρ_g, ρ_t: persistence
- α_d, β_d: response to debt
- $\alpha_y(L)$, $\alpha_u(L)$: 2nd order distributed lag polynomials.

Least-Squares Learning

OLS Regression

Time t estimates of the regression coefficients:

$$\hat{\Phi}_t = \left(\sum_{\tau=0}^{t} X_\tau X_\tau' \right)^{-1} \left(\sum_{\tau=0}^{t} X_\tau' f_\tau \right)$$

- $f_\tau \in \{g_\tau, t_\tau\}$ is fiscal policy policy variable.
- X_τ is the vector of explanatory variables in the regression equation (per-determined at τ).
- Predicted fiscal policy: $\hat{f}_t = X_t' \hat{\Phi}_{t-1}$
- Unexpected policy: $\hat{\epsilon}_{f,t} = f_t - X_t' \hat{\Phi}_{t-1}$

Recursive Formulation

The OLS regression coefficients can be rewritten as:

$$R_t = R_{t-1} + \gamma_t (X_t X_t' - R_{t-1}),$$

$$\hat{\Phi}_t = \Phi_{t-1} + \gamma_t R_t^{-1} X_t (f_t - X_t' \hat{\Phi}_{t-1})$$

where $\gamma_t = 1/t$ is the **learning gain**.

Constant Gain Learning

Constant gain framework

- Replace γ_t with a constant, $\gamma \in (0, 1)$.
- Weighted least squares - more recent observations have more weight.

Ideal situations for constant gain learning

- Precedence of structural changes.
- No a-priori knowledge on menu of structural changes and probability distributions.
- Reasonable that learning dynamics should not disappear with time.

Constant-Gain Learning

Constant Gain Recursive Formulation

$$R_t = R_{t-1} + \gamma(X_t X_t' - R_{t-1}),$$

$$\hat{\Phi}_t = \Phi_{t-1} + \gamma R_t^{-1} X_t (f_t - X_t' \hat{\Phi}_{t-1})$$

- Learning gain, $\gamma \in (0, 1)$, is constant, related to the weight assigned to most recent observation.
- Typical estimates for $\gamma \sim 0.02$ (Milani (2008), Slobodyan and Wouters (2008)).

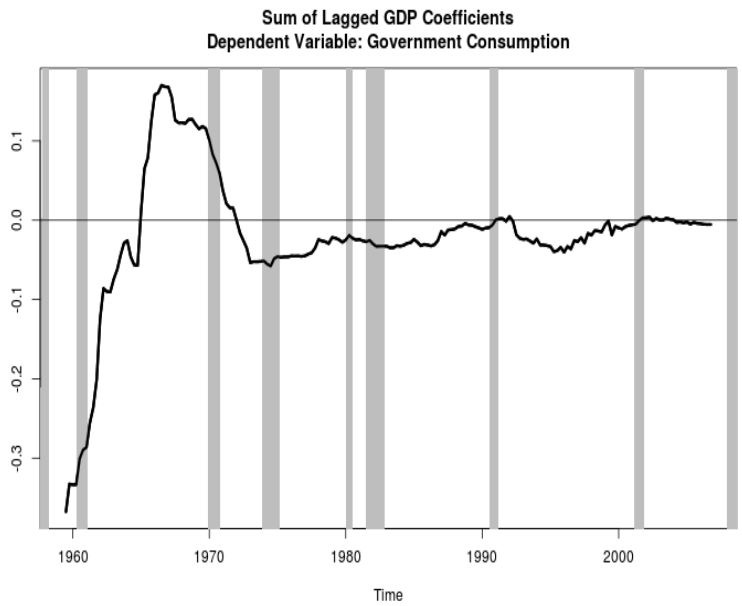
Standard Formulation

$$\hat{\Phi}_t = \left((1-\gamma) \sum_{\tau=1}^{t} \gamma^\tau X_{t-\tau} X_{t-\tau}' \right)^{-1} \left((1-\gamma) \sum_{\tau=1}^{t} \gamma^\tau X_{t-\tau} f_{t-\tau} \right).$$

Weight on $t-\tau$ observation declines geometrically with τ: $\omega_\tau = (1-\gamma)\gamma^\tau$.

Dependent variable: Government Consumption

Evolution of Coefficients



Real GDP

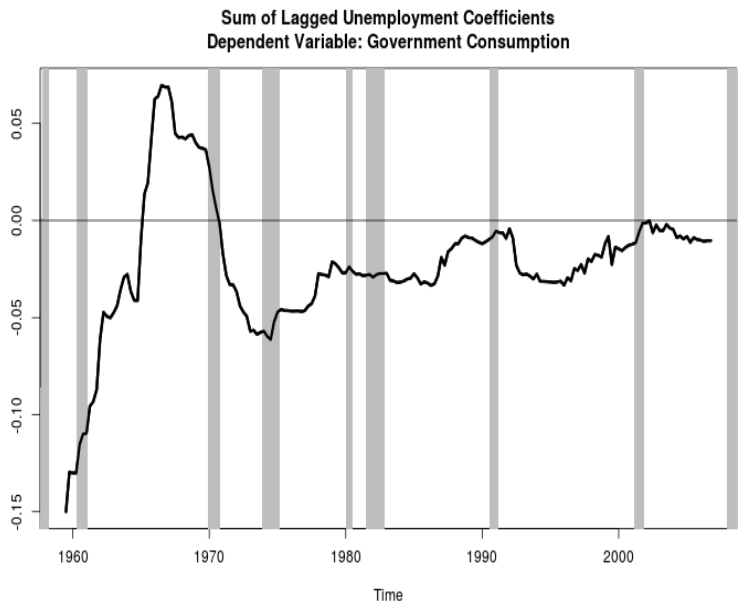
(Expect: Negative)

Government Debt

(Expect: Negative)

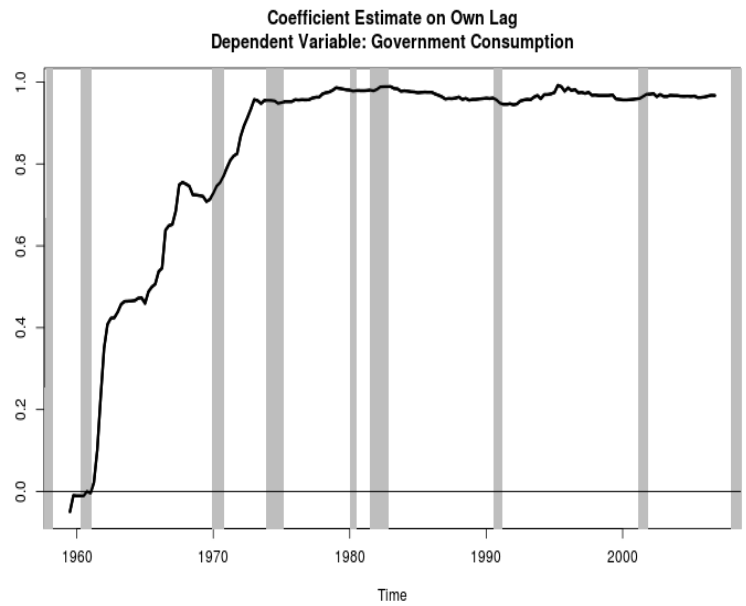
Dependent variable: Government Consumption

Evolution of Coefficients



Unemployment

(Expect: Positive)

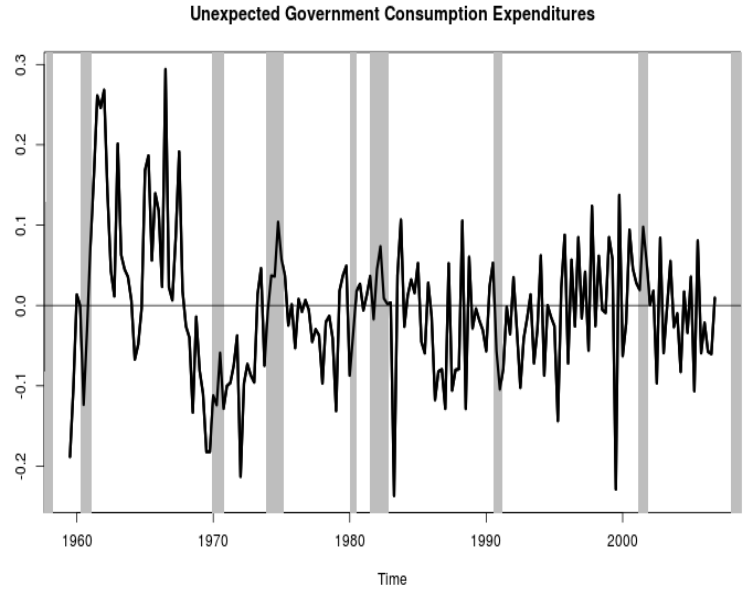


Own Lag

(Expect: Between 0 and 1)

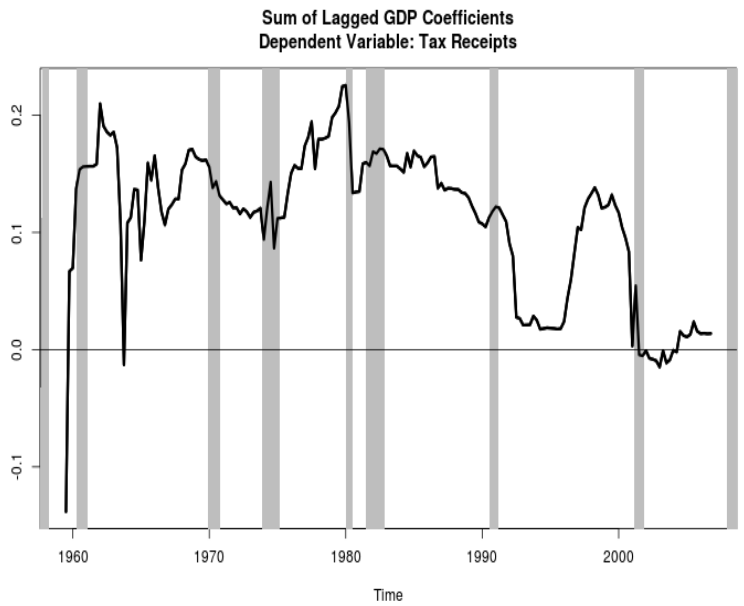
Dependent variable: Government Consumption

Predicted and Unexpected Government Consumption



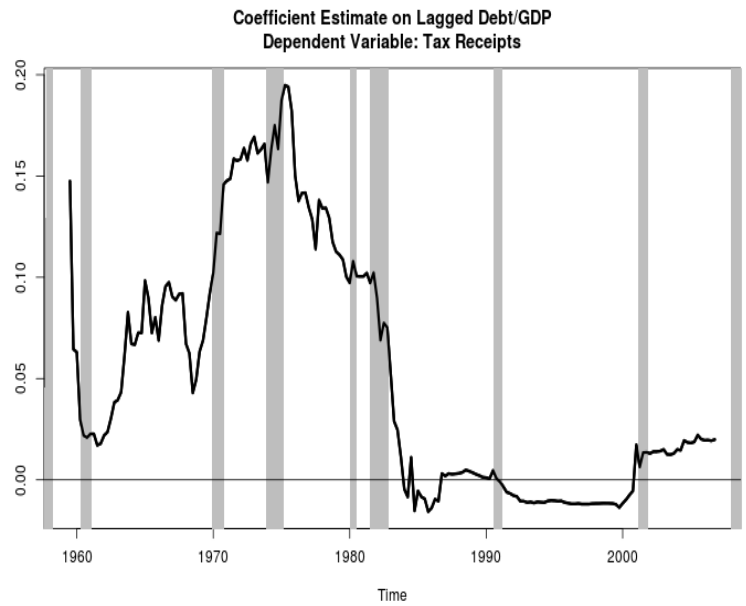
Dependent variable: Taxes

Evolution of Coefficients



Real GDP

(Expect: Positive)

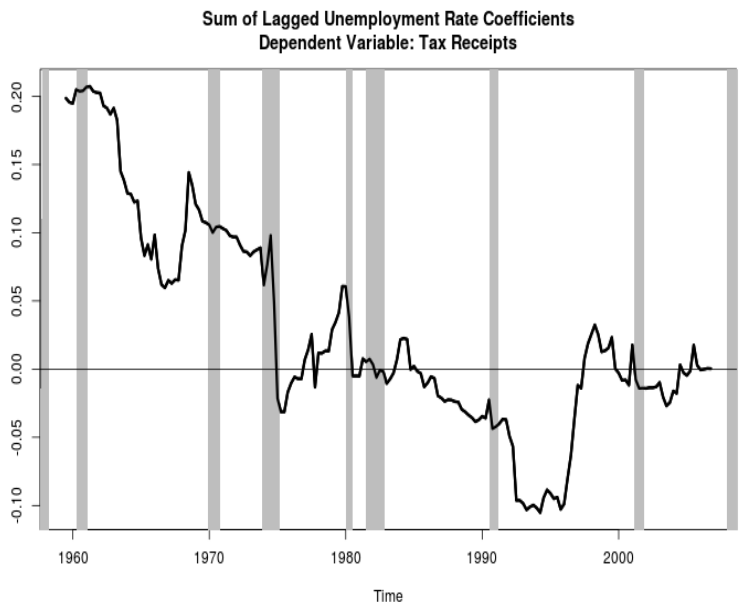


Government Debt

(Expect: Positive)

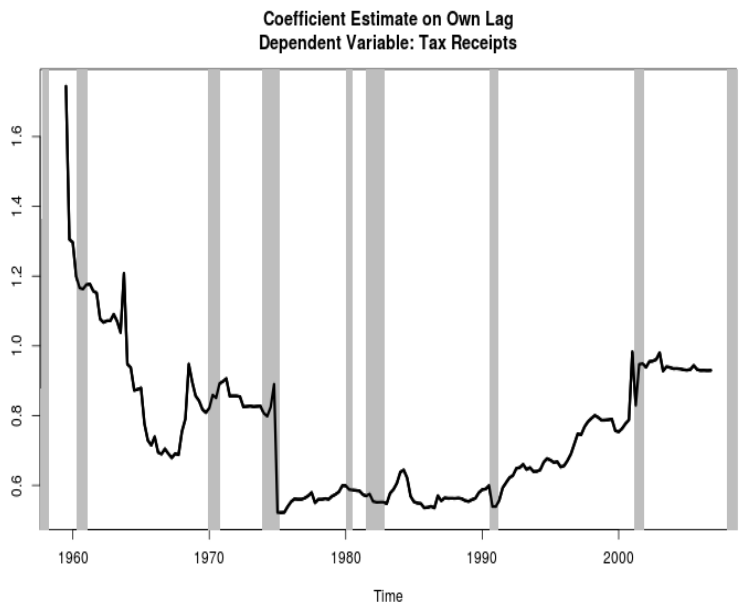
Dependent variable: Taxes

Evolution of Coefficients



Unemployment

(Expect: Negative)

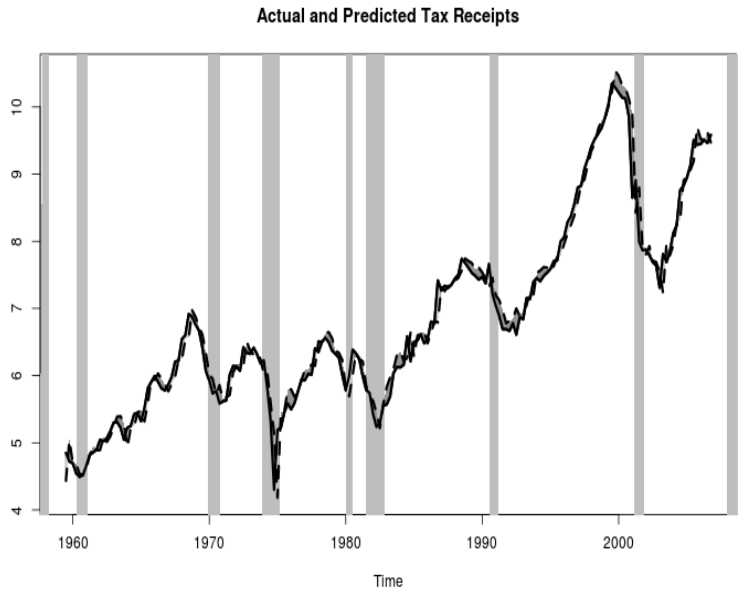


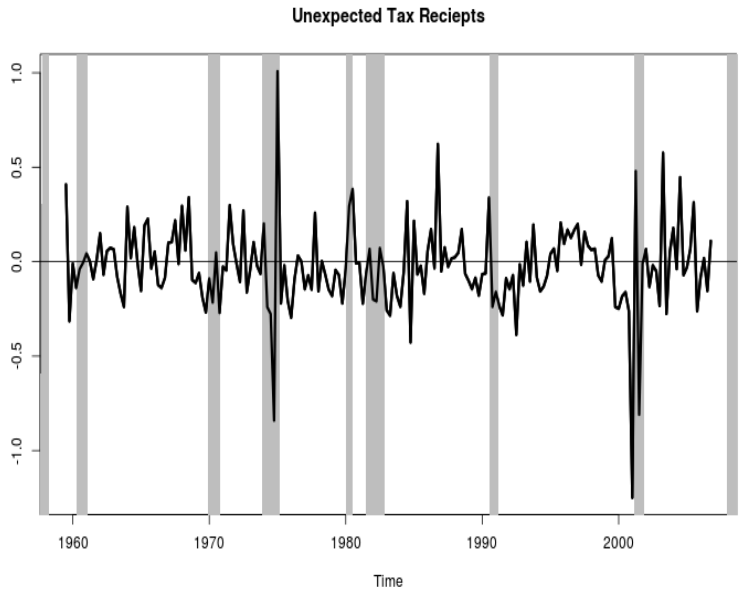
Own Lag

(Expect: Between 0 and 1)

Dependent variable: Taxes

Predicted and Unexpected Taxes Net of Transfers





Extended Structural VAR

- Model:

$$A_0 x_t = A(L)x_t + z_t,$$

- Endogenous vector:

$$x_t = \begin{bmatrix} y_t \\ c_t \\ i_t \\ u_t \\ \hat{\epsilon}_{t,t} \\ \hat{\epsilon}_{g,t} \\ \hat{t}_t \\ \hat{g}_t \end{bmatrix} = \begin{bmatrix} \text{Real GDP} \\ \text{Consumption} \\ \text{Investment} \\ \text{Unemployment Rate} \\ \text{Unexpected Net Taxes} \\ \text{Unexpected Government Spending} \\ \text{Expected Net Taxes} \\ \text{Expected Government Spending} \end{bmatrix}$$

Identification Restrictions

- Similar to above: treat unexpected fiscal policies in the same manner as fiscal policy in the baseline.
- Expectations of fiscal policy in the current period are predetermined.
  - Nothing contemporaneously affects expected fiscal policy.
  - Expected fiscal policy may contemporaneously affect consumption, investment, unemployment, unexpected fiscal policy.

Identification Strategy

Structural VAR with identification restrictions:

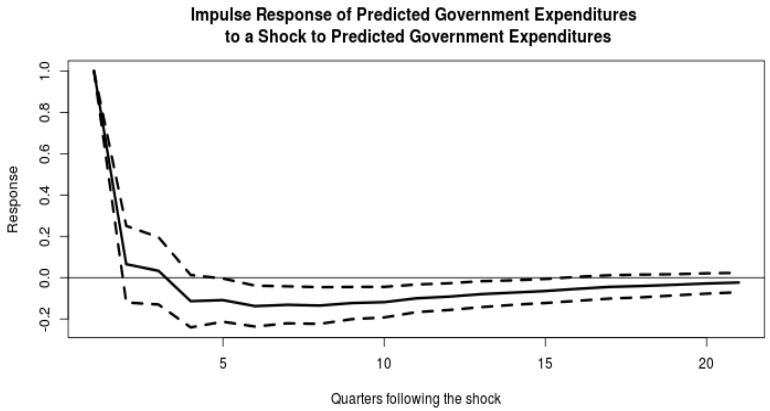
$$\begin{bmatrix} 1 & a_{y,c} & a_{y,i} & 0 & 0 & a_{y,g} & 0 & a^e_{y,g} \\ 0 & 1 & 0 & a_{c,u} & a_{c,t} & a_{c,g} & a^e_{c,t} & a^e_{c,g} \\ a_{i,y} & 0 & 1 & 0 & a_{i,t} & a_{i,g} & a^e_{i,t} & a^e_{i,g} \\ 0 & 0 & 0 & 1 & 0 & 0 & a^e_{u,t} & a^e_{u,g} \\ a_{t,y} & a_{t,c} & a_{t,i} & a_{t,u} & 1 & a_{t,g} & a^e_{t,t} & a^e_{t,g} \\ 0 & 0 & 0 & 0 & 0 & 1 & a^e_{g,t} & a^e_{g,g} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} y_t \\ c_t \\ i_t \\ u_t \\ \hat{\epsilon}_{t,t} \\ \hat{\epsilon}_{g,t} \\ \hat{t}_t \\ \hat{g}_t \end{bmatrix} = A(L) \begin{bmatrix} y_{t-1} \\ c_{t-1} \\ i_{t-1} \\ u_{t-1} \\ \hat{\epsilon}_{t,t-1} \\ \hat{\epsilon}_{g,t-1} \\ \hat{t}_{t-1} \\ \hat{g}_t \end{bmatrix} + \begin{bmatrix} z_{y,t} \\ z_{c,t} \\ z_{i,t} \\ z_{u,t} \\ z^{\epsilon}_{t,t} \\ z^{\epsilon}_{g,t} \\ z_{\hat{t},t} \\ z_{\hat{g},t} \end{bmatrix}$$

Impulse response functions to measure the impact of fiscal policy:

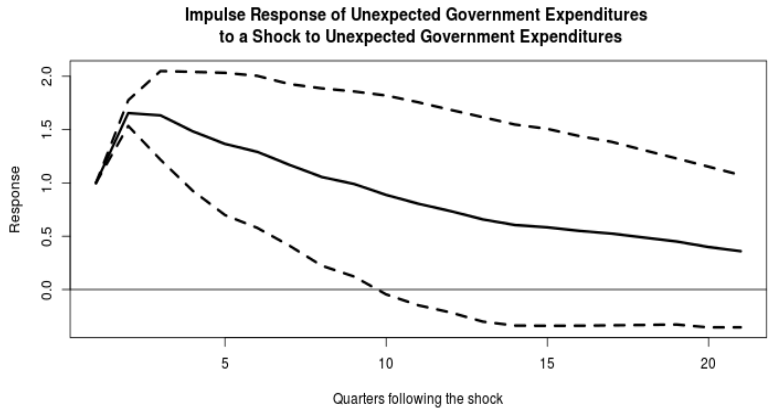
- Expected fiscal policy: innovations to $z_{\hat{t},t}$ and $z_{\hat{g},t}$.
- Unexpected fiscal policy: innovations to $z^{\epsilon}_{t,t}$ and $z^{\epsilon}_{g,t}$

Fiscal Policy Responses to Own Shocks

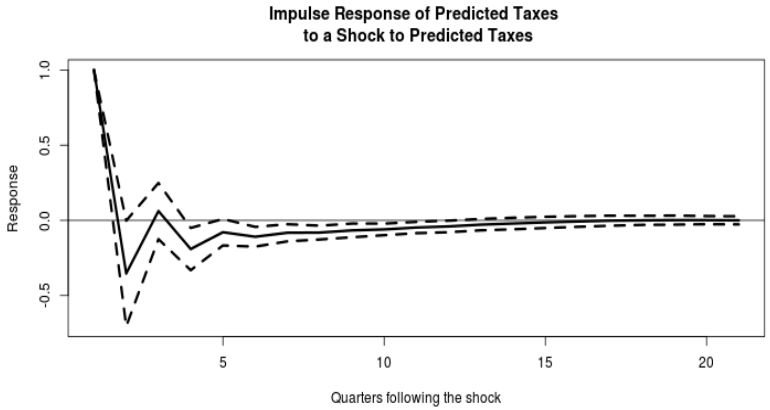
Expected Gov Expenditures



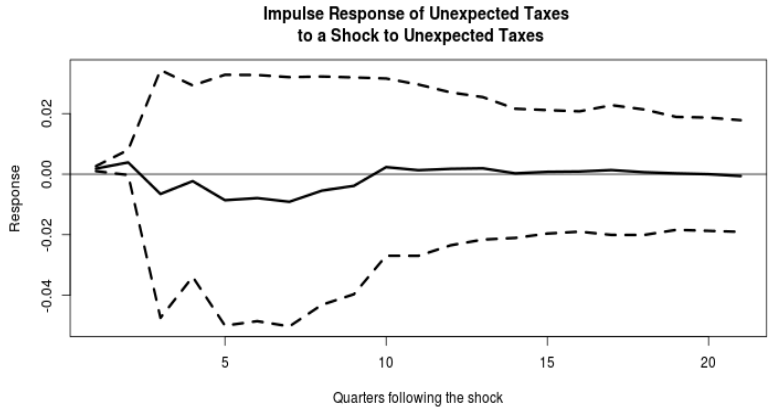
Unexpected Gov Expenditures



Expected Taxes

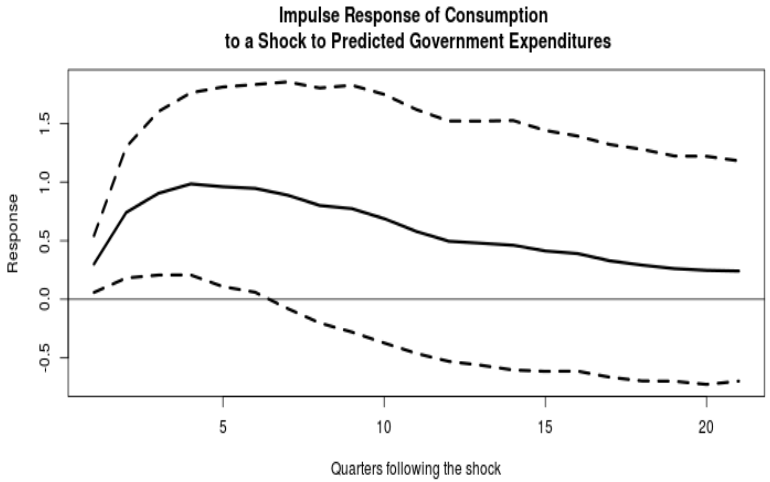


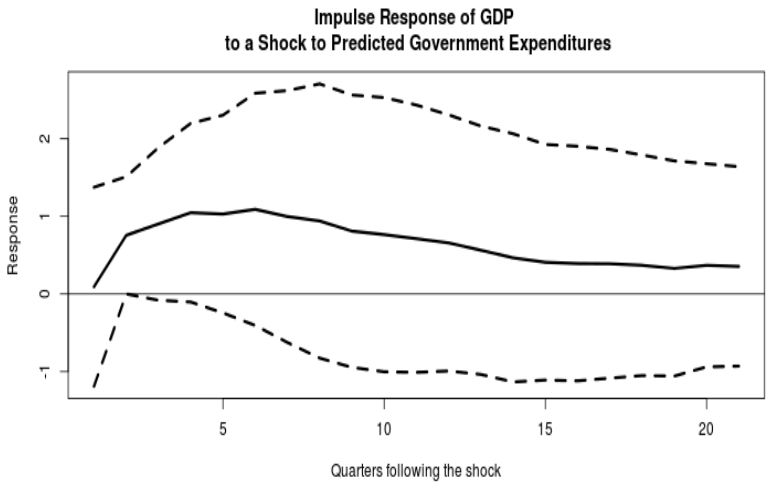
Unexpected Taxes



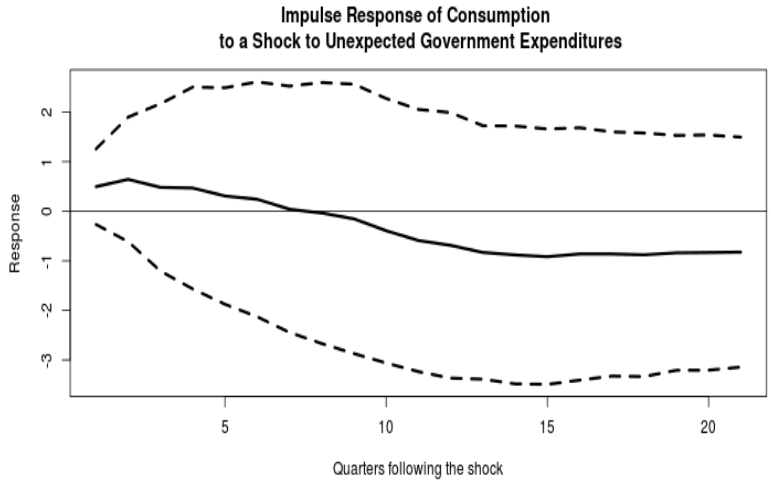
Impulse Response: Government Expenditures

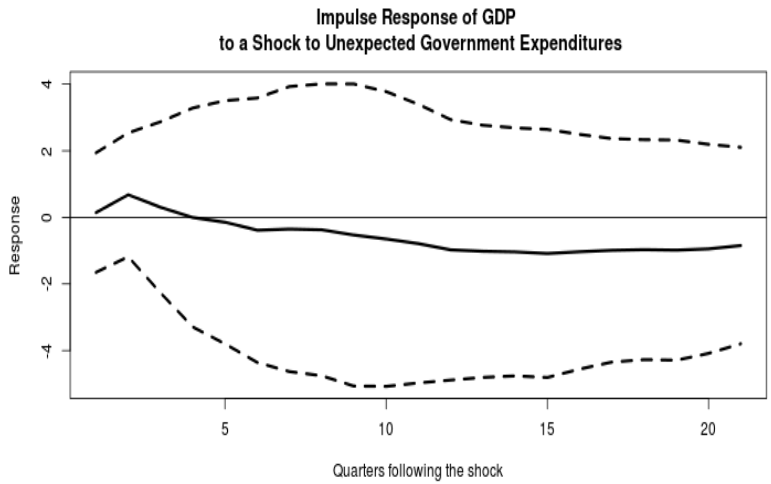
Expected Gov Expenditures





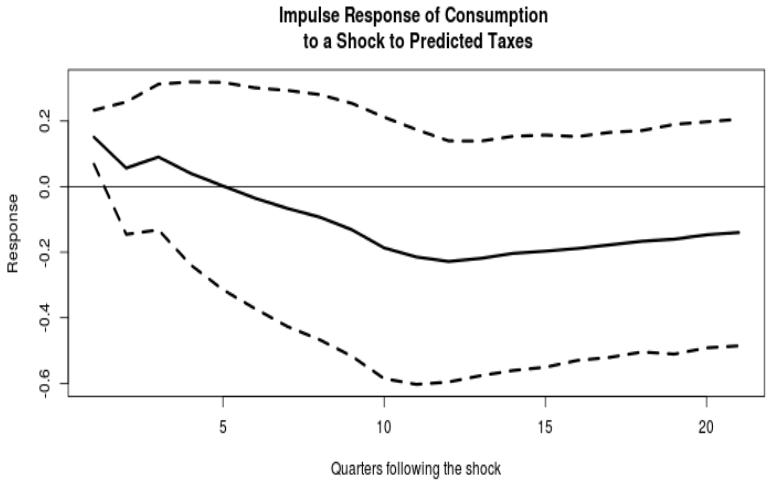
Unexpected Gov Expenditures

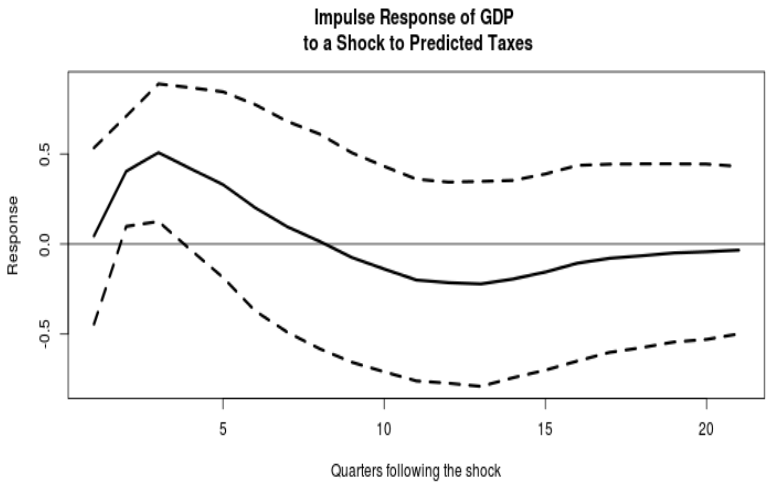




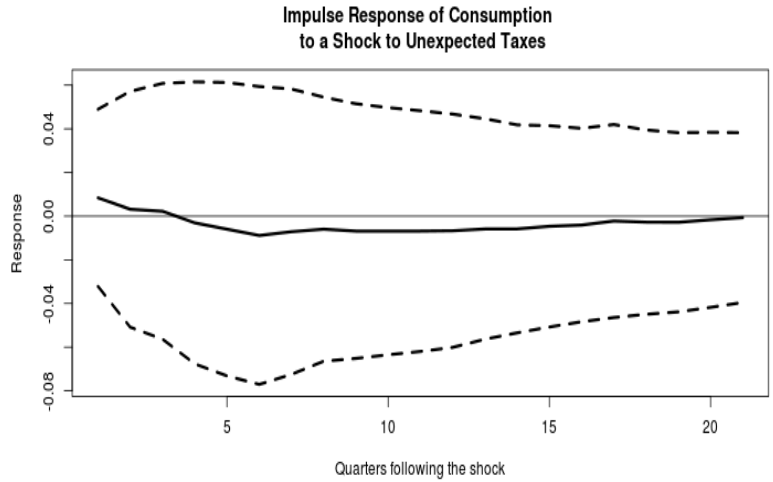
Impulse Response: Net Taxes

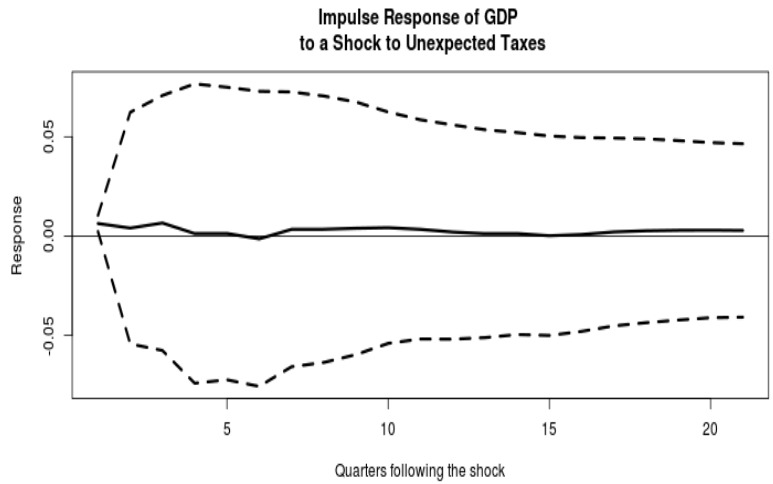
Expected Net Taxes





Unexpected Net Taxes



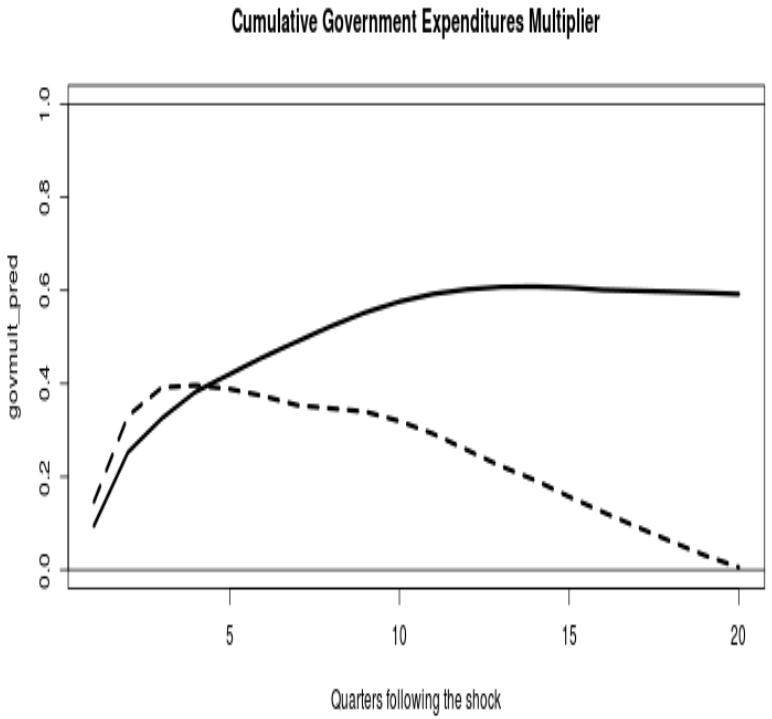


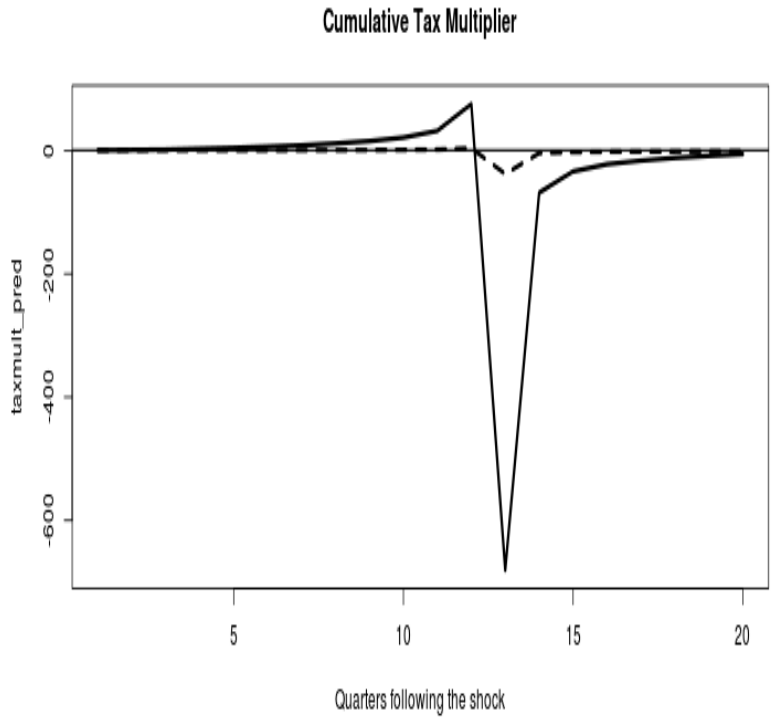
Fiscal Policy Multipliers

$$\text{Multiplier}_T = \frac{\sum_{\tau=0}^{T} y_\tau^{resp}}{\sum_{\tau=0}^{T} \hat{f}_\tau^{resp} + \hat{\epsilon}_{f,\tau}^{resp}}$$

- y_T^{resp} is the response of real GDP, T periods after the initial shock.
- $\hat{f}_T^{resp}$ is the response of the predicted fiscal policy variable, $\hat{g}_T$ and $\hat{t}_T$, in turn.
- $\hat{\epsilon}_{f,\tau}^{resp}$ is the response of the unexpected (residual) fiscal policy variable, $\hat{\epsilon}_{g,T}$ and $\hat{\epsilon}_{t,T}$, in turn.

Fiscal Policy Multipliers





Expected fiscal policy multiplier is larger in longer horizons

Something's wrong.

Conclusions for Fiscal Policy

- Government spending:
  - Timing of the response different for shocks to expected versus unexpected policy.
  - Consumption responses to expected fiscal policy are statistically significant.
  - Consumption responses to unexpected fiscal policy are not statistically significant.
  - Expected fiscal policy multiplier is larger in longer horizons.
- Taxes:
  - Responses to unexpected shocks similar to baseline model tax shocks.
  - Unexpected tax shocks are muted - net taxes are an automatic stabilizer.

Moving Forward

- Sign restrictions identification strategy (Mountford and Uhlig, 2009).
- Minimal assumptions to identify minimal shocks:
  - Business cycle or monetary shock: increase output, consumption, and investment; decrease unemployment.
  - Fiscal policy shock: fiscal policy variable increases, shock is orthogonal to shock above.