

Fiscal Policy Impacts with Adaptive Expectations

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Purpose

1/ 19

- Estimate the impact of predicted versus unexpected fiscal policy.
- Contribute to an unsettled fiscal multiplier literature using SVARs.
 - Size of the multiplier, statistical significance, impacts 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

2/ 19

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

Baseline Structural VAR

3/ 19

- Use as a comparison when examining impact of expected versus unexpected fiscal policy on macroeconomic outcomes.
- Baseline model:

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

- Endogenous vector:

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

- A_0 captures contemporaneous causal relationships, only identified with additional restrictions.

Identification Strategy

4/ 19

- Implementation lag for government spending: g_t does not contemporaneously respond to anything.
- Taxes do contemporaneously respond to real GDP, unemployment, government spending decisions.
- Taxes do not contemporaneously respond to consumption or investment.
- Taxes directly affect consumption and investment decisions.
- Taxes do not directly affect real GDP, only indirectly through its components.
- 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

5/ 19

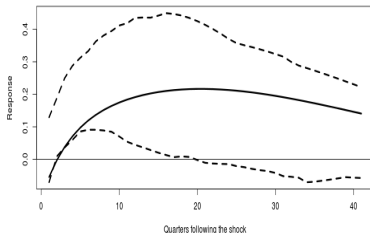
These restrictions leads to the following structure:

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

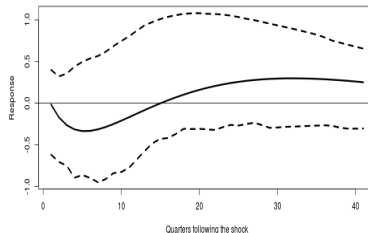
- $A(L)$: first-order distributed lag.
- $z_{k,t}$: independently and identically distributed shocks.
- Measure fiscal policy impacts: impulse responses functions of macro outcomes to innovations to taxes ($z_{t,t}$) and government spending ($z_{g,t}$).

Impulse Response: Shock to Government Spending 6/19

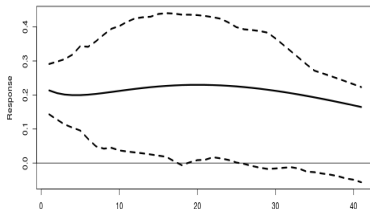
Impulse Response of Consumption
to a Shock to GovSpending



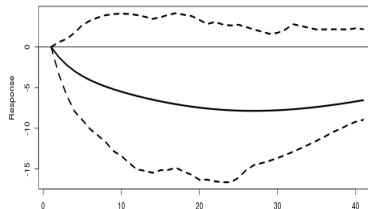
Impulse Response of Investment
to a Shock to GovSpending



Impulse Response of GDP
to a Shock to GovSpending



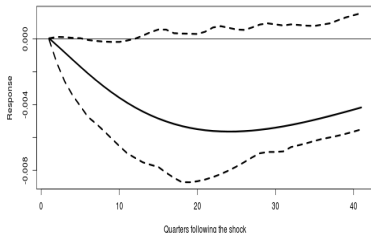
Impulse Response of Unemployment
to a Shock to GovSpending



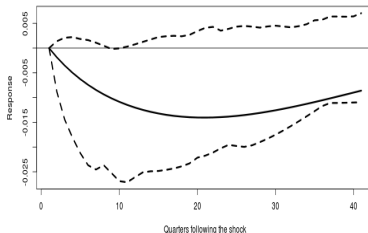
Impulse Response: Shock to Taxes

7/ 19

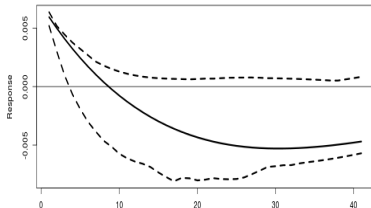
Impulse Response of Consumption
to a Shock to Taxes



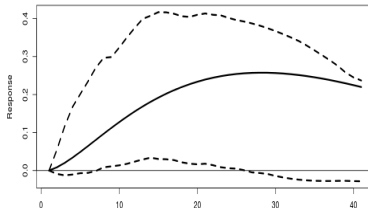
Impulse Response of Investment
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Impulse Response of GDP
to a Shock to Taxes



Impulse Response of Unemployment
to a Shock to Taxes



Fiscal Policy Uncertainty

8/ 19

- 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 Learning

9/ 19

- 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

10/ 19

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

11/ 19

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 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: $\hat{e}_{f,t} = f_t - X_t' \hat{\phi}_{t-1}$

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

12/ 19

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

13/ 19

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 : $\omega_\tau = (1 - \gamma)\gamma^\tau$.

Extended Structural VAR

14/ 19

- 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

15/ 19

- 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 anything.

Identification Strategy

16/ 19

Structural VAR with identification restrictions:

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

Impulse response function to measure impacts of fiscal policy:

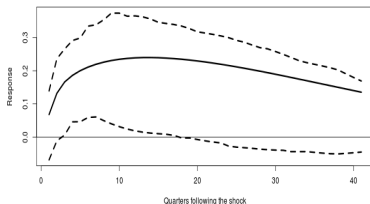
- Expected fiscal policy: innovations to $z_{\hat{t},t}$ and $z_{\hat{g},t}$.
- Unexpected fiscal policy: innovations to $z_{t,t}^e$ and $z_{g,t}^e$.

Impulse Response: Government Spending

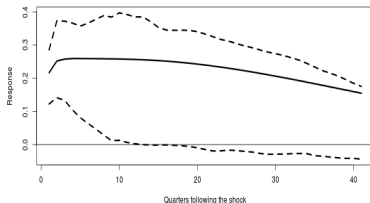
17/ 19

Expected Gov Spending

Impulse Response of Consumption
to a Shock to Predicted Government Spending

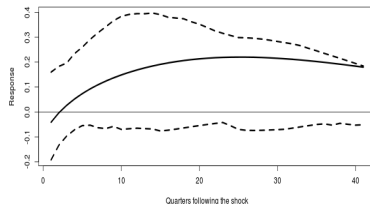


Impulse Response of GDP
to a Shock to Predicted Government Spending

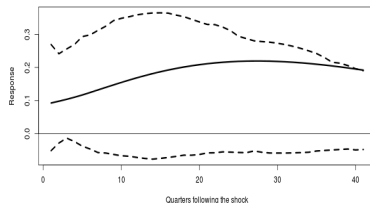


Unexpected Gov Spending

Impulse Response of Consumption
to a Shock to Unexpected Government Spending



Impulse Response of GDP
to a Shock to Unexpected Government Spending

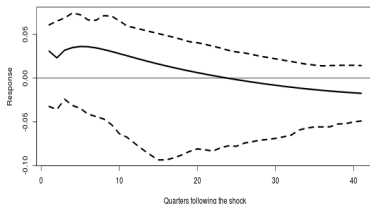


Impulse Response: Net Taxes

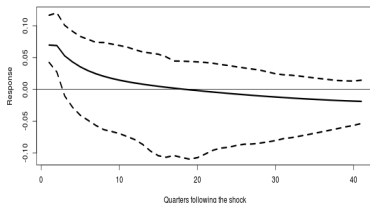
18/ 19

Expected Net Taxes

Impulse Response of Consumption
to a Shock to Predicted Taxes

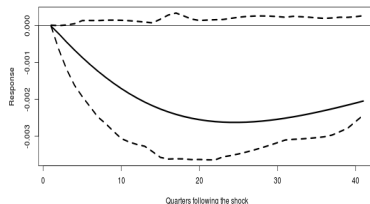


Impulse Response of GDP
to a Shock to Predicted Taxes

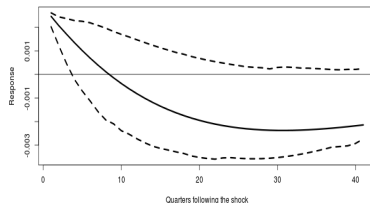


Unexpected Net Taxes

Impulse Response of Consumption
to a Shock to Unexpected Taxes



Impulse Response of GDP
to a Shock to Unexpected Taxes



Conclusions for Fiscal Policy

19/ 19

- Government spending:
 - Timing of the response different for shocks to expected versus unexpected policy.
 - Consumption decisions react more quickly to expected fiscal policy.
 - Unexpected policy: Consumption and real GDP responses are insignificant.
- Taxes:
 - Responses to unexpected shocks similar to baseline model tax shocks.
 - Unexpected tax shocks are muted - net taxes are an automatic stabilizer.
 - Consumption is more likely to fall in response to an unexpected tax increase.