# Identifying Fiscal Policy Uncertainty and Its Macroeconomic Consequences

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## Quantify uncertainty concerning fiscal policy

- Realistic framework for forming expectations
- Isolate five sources:

  Government expenditures          Government debt
  Taxes                            Overall fiscal uncertainty
  Transfers

## Estimate the Macroeconomic Impact

- Autoregressive distributed lag (ARDL) models with fiscal uncertainty explanatory variables.
- Five dependent variables:

  Real GDP        Investment        Inflation
  Consumption     Unemployment

### Time-varying Fiscal Volatility

- Fernández-Villiverde et. al. (2011a): Fiscal policy uncertainty is stagflationary
- Born and Pfeifer (2011):
    - Significant evidence for time-varying volatility in fiscal shocks.
    - Not a significant driver for business cycles.
- Johannsen (2012): Matters more at ZLB.

### Other ways of doing it

- Baker, Bloom, and Davis (2013): Index based on headlines, variance of professional forecasts, expiring tax provisions.
- Orlik and Veldkamp (2013):
    - Not about fiscal policy. Macro uncertainty.
    - Uncertainty is margin of error for forecasts.
    - Forecasts are based on Bayesian learning and model uncertainty.

### Specific Fiscal Challenges

- Bi, Leeper, and Leith (2013): Time and composition of fiscal consolidations
- Davig, Leeper, and Walker (2010): Unsustainable entitlement programs
- Davig and Foerster (2013): Expiring tax provisions - with uncertain extensions.
- Richter and Throckmorton (2013): uncertain debt targets

## Constant gain learning mechanism

- Every period, run a least-squares regression for each fiscal policy variable, using data from previous periods.
- Weighted least squares - more recent observations have more weight.
- Regression forecast serves as expectation.
- Root (weighted) mean squared error serves as *fiscal policy uncertainty*.

## Ideal situations for constant gain learning

- Precedence of structural changes
- No a-priori knowledge on menu or evolution of structural changes and probability distributions
- Forecasting rule, but no knowledge of parameter values, or the structure of the whole economy.

## Empirical Model for Fiscal Policy Behavior

Each fiscal policy variable $(f_{i,t})$ responds to:

- Lag of all fiscal policy variables $(f_{t-1})$.
- Above includes lag of government debt $(b_{t-1})$.
- Macro outcomes: real GDP $(y_t)$, consumption $(c_t)$, investment $(I_t)$, and unemployment $(u_t)$.
- All quantities real, per capita, ratio of past real GDP.

## Four regressions

**Fiscal policy variables:** $f_t = [g_t \ r_t \ n_t \ b_t]$
Govt Spending $(g_t)$, Tax Revenue $(r_t)$,
Net Transfers $(n_t)$, Government Debt / GDP $(b_t)$

**Regression equation:**
$$f_{i,t} = \alpha_{t,0} + \alpha'_{t,f} f_{t-1} + \alpha_{t,y} y_t + \alpha_{t,c} c_t + \alpha_{I,t} I_t + \alpha_{t,u} u_t + \epsilon_t$$

## Recursive Formulation

$$\hat{\alpha}_{i,t} = \hat{\alpha}_{i,t-1} + \gamma R_t^{-1} X_t (f_{i,t} - X_t' \hat{\alpha}_{i,t})$$

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

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

## Standard Formulation

$$\hat{\alpha}_{i,t} = \left( (1-\gamma) \sum_{\tau=1}^{t} \gamma^\tau X_{t-\tau} X_{t-\tau}' \right)^{-1} \left( (1-\gamma) \sum_{\tau=1}^{t} \gamma^\tau X_{t-\tau} f_{i,t-\tau} \right).$$

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

## Endogeneity Problem

- Macro outcomes (real GDP, consumption, investment, and unemployment) are likely endogenous.
- Maybe market participants account for that.
- Use instruments: lags of macro outcomes and fiscal variables

## Instrumental Variables Notation

- Let $W_t = [y_t \ c_t \ I_t \ u_t]'$ denote the possibly endogenous regressors in $X_t$,
- Let $V_t = [1 \ f'_{t-1}]'$ denote the remaining exogenous regressors
- Then, $X_t = [V'_t \ W'_t]'$.
- Let $S_t = [W'_{t-1} \ W'_{t-2} \ f'_{t-2}]$ denote vector of instruments.
- Let $Z_t = [V'_t \ S'_t]'$ denote vector Stage 1 IV regressors.

## Stage 1: Endogenous macro variable on instruments + exogenous

$$W_{i,t} = Z_t'\beta_i + \upsilon_{i,t}.$$

$$\hat{\beta}_{i,t} = \hat{\beta}_{i,t-1} + \gamma \left(R_t^{S1}\right)^{-1} Z_{t-1} \left(W_{i,t-1} - Z_{t-1}'\hat{\beta}_{i,t-1}\right)$$

$$R_t^{S1} = R_{t-1}^{S1} + \gamma \left(Z_{t-1}Z_{t-1}' - R_{t-1}^{S1}\right)$$

## Save Stage 1 Predicted Values

$$\hat{W}_{i,t} = Z_t'\hat{\beta}_{i,t}, \quad \hat{X}_t = [V_t' \ \hat{W}_t']'$$

## Stage 2: Constant Gain Learning with IV

$$\hat{\alpha}_{i,t}^{IV} = \hat{\alpha}_{i,t-1}^{IV} + \gamma \left(R_t^{S2}\right)^{-1} \hat{x}_{t-1} \left(f_{i,t-1} - \hat{X}_{t-1}'\hat{\alpha}_{i,t-1}\right)$$

$$R_t^{S2} = R_{t-1}^{S2} + \gamma \left(\hat{X}_{t-1}\hat{X}_{t-1}' - R_{t-1}^{S2}\right).$$

### Unexplained fiscal policy at time $t$

Model prediction error:

$$\epsilon_{i,t} = f_{i,t} - \hat{\alpha}_{i,t}^{IV'} X_t$$

- $\hat{\alpha}_{i,t}^{IV'}$ captures information in past fiscal policy behavior
- $X_t$ captures *current* macroeconomic conditions.

### Fiscal uncertainty measure

Root (weighted) mean squared error:

$$m_{i,t}^{IV} = \sqrt{(1-\gamma) \sum_{\tau=1}^{t} \gamma^\tau \epsilon_{i,t}^2}$$

## Time-Varying Volatility

- Eg: Fernández-Villiverde et. al. (2011), Born and Pfeifer (2011), Johannsen (2012), etc.
- Can separate causal effects of fiscal shocks from i.i.d. innovations to variance.
- Possibly unrealistic set of knowledge and perceptions.
- Is fiscal policy uncertainty exogenous?

## Model Prediction Uncertainty

- Agents are learning fiscal policy processes.
- Constant gain learning: accounts for structural change possibility.
- Fiscal shocks can move expectations away from true model.
- Time-varying uncertainty need not depend on time-varying volatility.

### Some basis in the literature:

- Herro and Murray (2013): Monetary policy uncertainty.
- Orlik and Veldkamp (2013): Macro uncertainty - forecast uncertainty with Bayesian learning
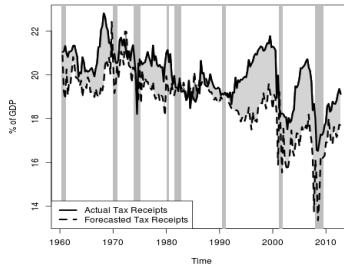
### Shortcomings

- Learning models do not consider government budget constraint
- Backward looking - ignores policy announcements, upcoming policy expiration
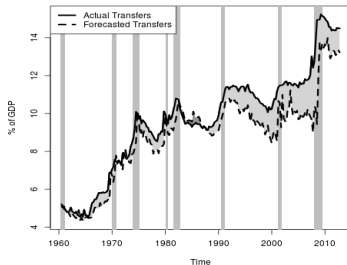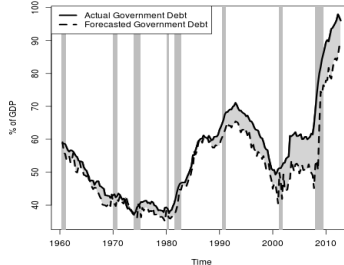- Long-horizon fiscal problems.

Actual and Forecasted Government Expenditures
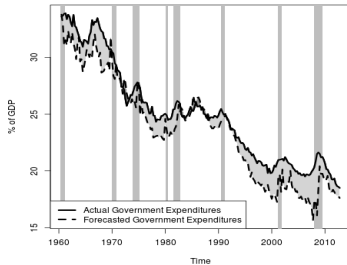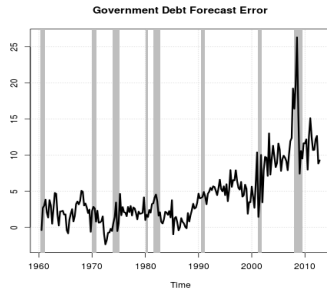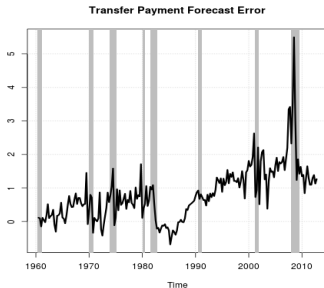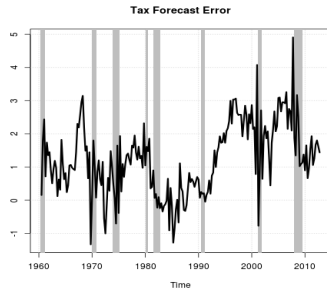


Actual and Forecasted Tax Receipts



Actual and Forecasted Transfer Payments



Actual and Forecasted Government Debt

Government Spending Forecast Error

Tax Forecast Error

Transfer Payment Forecast Error

Government Debt Forecast Error
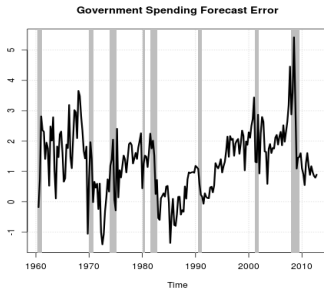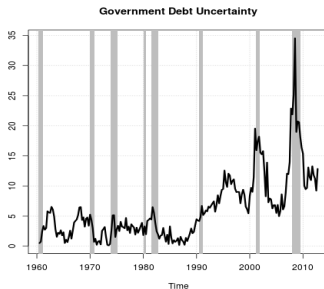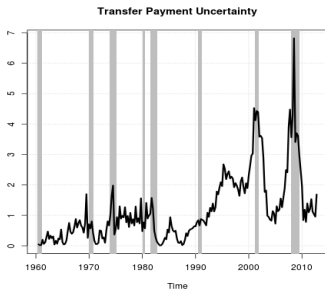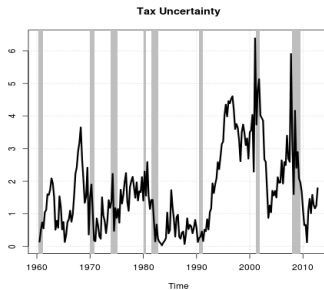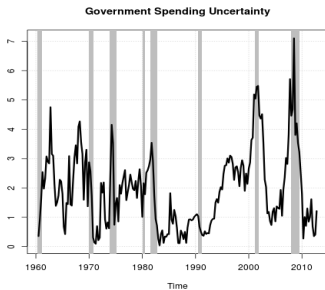
- Uncertainty concerning transfers and debt reached unprecedented levels during Great Recession.
  - Government expenditures uncertainty: Nearly 7% of GDP
  - Tax uncertainty: Nearly 6% of GDP
  - Transfers uncertainty: Nearly 7% of GDP
  - Government debt uncertainty: Nearly 35% of GDP
- Uncertainty seems to run up for several years preceding recessions:
  - Early 1980s, 2001, 2007.
  - Not the rule though (eg: declines prior to 1970s, little volatility prior to 1991)

**Pearson Correlation Coefficient**

|                 | Gov Spending | Tax Revenue | Transfers | Government Debt |
|-----------------|--------------|-------------|-----------|-----------------|
| Gov Spending    | 1.00         | -           | -         | -               |
| Tax Revenue     | 0.75         | 1.00        | -         | -               |
| Transfers       | 0.74         | 0.78        | 1.00      | -               |
| Government Debt | 0.64         | 0.65        | 0.90      | 1.00            |

- All highly correlated.
- Common (latent) factor?

## Objective

- Strip out the common component of fiscal uncertainty
- Construct a general measure of fiscal uncertainty
- Take care of potential multicolinearity problem
- Compare to Baker, Bloom, and Davis (2013) (BBD)

## Stock and Waston (1989) coincident indicator model

- Latent variable: General fiscal uncertainty

$$m_t = m_0 + A\lambda_t + e_t$$
$$\lambda_t = b_1\lambda_{t-1} + b_2\lambda_{t-2} + \upsilon_t$$
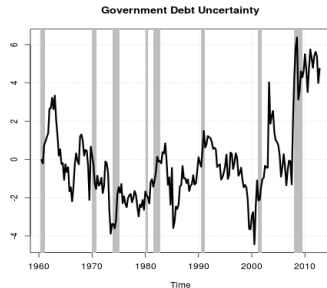$$e_t = Ce_{t-1} + \eta_t$$

  - $m_t$: 4x1 vector of fiscal uncertainty variables
  - $\lambda_t$: general fiscal uncertainty
  - $m_0 + e_t$: "unique" component of fiscal uncertainty.

Government Spending Uncertainty

Tax Uncertainty

Transfer Payment Uncertainty

Government Debt Uncertainty
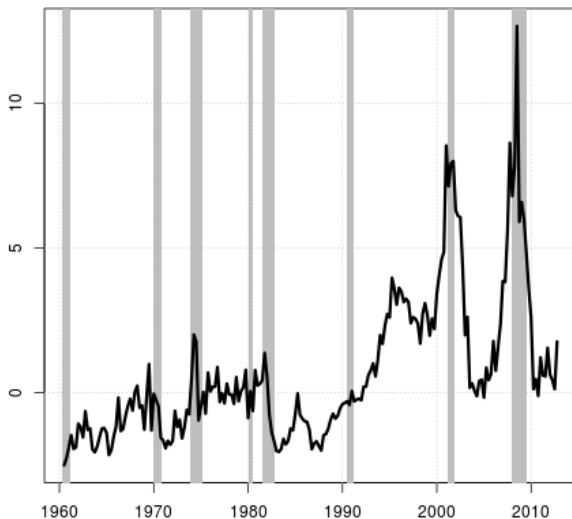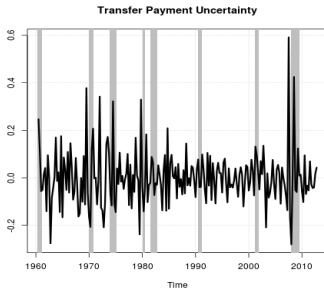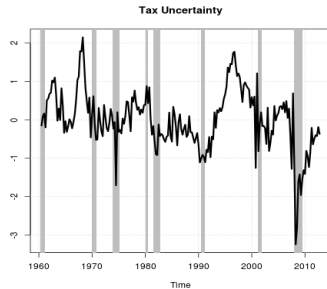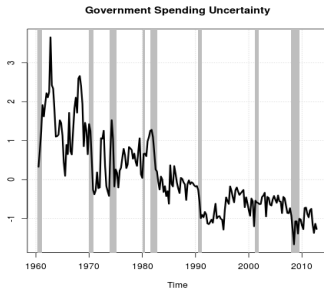
**Fiscal Uncertainty with Common Component Removed - Pearson Correlations**

|                  | Gov Spending | Tax Revenue | Transfers | Government Debt |
|------------------|--------------|-------------|-----------|-----------------|
| Gov Spending     | 1.00         | -           | -         | -               |
| Tax Revenue      | 0.40         | 1.00        | -         | -               |
| Transfers        | -0.17        | -0.23       | 1.00      | -               |
| Government Debt  | -0.21        | -0.32       | -0.18     | 1.00            |

**Correlation of RMSE with Coincident Index**

|                  | Gov Spending | Tax Revenue | Transfers | Government Debt |
|------------------|--------------|-------------|-----------|-----------------|
| Coincident Index | 0.75         | 0.78        | 0.99      | 0.91            |
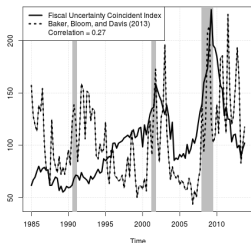
Learning Gain = 0.01
Correlation = 0.27
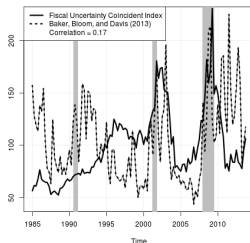
Learning Gain = 0.02
Correlation = 0.17
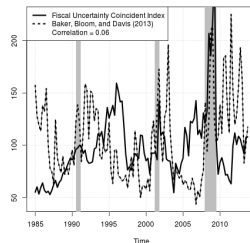
Learning Gain = 0.04
Correlation = 0.06

- Close match post-2000
- Higher correlation with more empirically plausible learning gains
- BBD - Headline news is likely endogenous
- BBD - Tax policy expiration is forward looking
- BBD is a general economic policy uncertainty index

## Dependent Variables: Macroeconomic Outcomes

- Real GDP
- Consumption
- Investment
- Inflation
- Employment
- Unemployment

## Key Explanatory Variables: Fiscal Uncertainty Variables

- Government Exp (unique)
- Tax Receipts (unique)
- Transfer Payments (unique)
- Government Debt (unique)
- Coincident Index

(First lag to avoid endogeneity)

## Controls

- Lags of all the dependent variables in every model.
- Lags of all the fiscal policy variables

## Specifications

- Lag lengths $= 1, 2,$ and $4$
- Learning gain parameters: 0.01, 0.02, and 0.04

| Fiscal Uncertainty | Dependent Variables (Column Headings) | | | | | |
|---|---|---|---|---|---|---|
| - Row Headings - | Real GDP | Consumption | Investment | Employment | Unemployment | Inflation |
| Government Exp | −0.04 | 0.06 | −0.06 | −0.68** | 0.55*** | 0.02 |
| (Standard Error) | (0.11) | (0.07) | (0.08) | (0.28) | (0.13) | (0.25) |
| Tax Receipts | 0.36*** | 0.07 | 0.26*** | 0.39 | −0.22 | 0.05 |
| (Standard Error) | (0.11) | (0.06) | (0.09) | (0.28) | (0.14) | (0.15) |
| Transfer Payments | −0.01 | −0.03 | 0.01 | −0.49** | 0.19*** | 0.01 |
| (Standard Error) | (0.08) | (0.04) | (0.04) | (0.23) | (0.06) | (0.12) |
| Government Debt | 0.05 | −0.03 | 0.09 | −1.27 | 0.25 | 0.12 |
| (Standard Error) | (0.10) | (0.06) | (0.06) | (0.88) | (0.16) | (0.17) |
| Coincident Index | −0.41*** | −0.21*** | −0.19*** | 0.13 | −0.22* | −0.36** |
| (Standard Error) | (0.10) | (0.05) | (0.07) | (0.38) | (0.14) | (0.16) |
| Joint Wald | 4.02*** | 3.80*** | 2.54** | 3.21*** | 4.27*** | 1.29 |
| Adjusted R-square | 0.32 | 0.98 | 0.96 | 0.83 | 0.87 | 0.81 |
| AIC | 466.15 | 198.35 | 257.72 | 666.99 | 398.54 | 632.69 |
| BIC | 549.83 | 282.03 | 341.40 | 750.67 | 482.22 | 716.37 |

| Fiscal Uncertainty - Row Headings - | Dependent Variables (Column Headings) | | | | | |
|---|---|---|---|---|---|---|
| | Real GDP | Consumption | Investment | Employment | Unemployment | Inflation |
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**1. Common fiscal uncertainty dampens aggregate demand**

| Fiscal Uncertainty - Row Headings - | Dependent Variables (Column Headings) | | | | | |
|---|---|---|---|---|---|---|
| | Real GDP | Consumption | Investment | Employment | Unemployment | Inflation |
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**2. Transfers and Gov Exp uncertainty drags on employment**

| Fiscal Uncertainty - Row Headings - | Dependent Variables (Column Headings) | | | | | |
|---|---|---|---|---|---|---|
| | Real GDP | Consumption | Investment | Employment | Unemployment | Inflation |
| Government Exp | −0.04 | 0.06 | −0.06 | −0.68** | 0.55*** | 0.02 |
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| Coincident Index | −0.41*** | −0.21*** | −0.19*** | 0.13 | −0.22* | −0.36** |
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**3. Debt uncertainty drags on employment (significant in most other specifications)**

| Fiscal Uncertainty - Row Headings - | Dependent Variables (Column Headings) | | | | | |
|---|---|---|---|---|---|---|
| | Real GDP | Consumption | Investment | Employment | Unemployment | Inflation |
| Government Exp | −0.04 | 0.06 | −0.06 | −0.68** | 0.55*** | 0.02 |
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| Transfer Payments | −0.01 | −0.03 | 0.01 | −0.49** | 0.19*** | 0.01 |
| (Standard Error) | (0.08) | (0.04) | (0.04) | (0.23) | (0.06) | (0.12) |
| Government Debt | 0.05 | −0.03 | 0.09 | −1.27 | 0.25 | 0.12 |
| (Standard Error) | (0.10) | (0.06) | (0.06) | (0.88) | (0.16) | (0.17) |
| Coincident Index | −0.41*** | −0.21*** | −0.19*** | 0.13 | −0.22* | −0.36** |
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**4. Tax uncertainty boosts investment and real GDP**

- Fernández-Villiverde et. al. (2011): Fiscal uncertainty is a "once-in-a-decade" concern
- Baker, Bloom, and Davis (2013): Build-up of uncertainty from 2006-2011
- Focus on general fiscal uncertainty (coincident index)
  - Find when it is highest - 2009:Q2 (with all learning gains)
  - Find quarter in decade preceding when it was lowest - 2005:Q4
  - Change in macroeconomic activity attributed to this buildup

**Magnitude of Extreme Change in Coincident Fiscal Uncertainty**
**(Learning Gain = 0.02)**

| Largest Value Coincident Fiscal Uncertainty = 4.77 | Date: 2009 Quarter 2 |
|---|---|
| Smallest Value in Decade Preceding = -0.34 | Date: 2005 Quarter 4 |

**Estimated Impact - ARDL(2)**

| Variable | Impact | 95% Lower Bound | 95% Upper Bound |
|---|---|---|---|
| Real GDP | −2.07*** | −3.04 | −1.11 |
| Consumption | −1.06*** | −1.57 | −0.54 |
| Investment | −0.96*** | −1.64 | −0.29 |
| Employment | 0.65 | −3.15 | 4.45 |
| Unemployment | −1.14* | −2.49 | 0.21 |
| Inflation | −1.85** | −3.50 | −0.20 |

Fiscal Uncertainty Reduces Economic Activity

- General measure for fiscal uncertainty associated with:
  - lower real GDP,
  - lower consumption,
  - lower investment.
- Uncertainty regarding specific fiscal variables
  - Government expenditures, transfer payments, and government debt associated with reductions in employment / increases in unemployment
  - Tax uncertainty associated with increases in investment and real GDP
- General fiscal uncertainty significant drag during the Great Recession:
  - Responsible for a 1% to 3% decrease in real GDP
  - Decreased consumption by about 1% of real GDP
  - Decreased investment by about 1% of real GDP