

# Identifying Fiscal Policy Uncertainty and Its Macroeconomic Consequences

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## Quantify Fiscal Policy Uncertainty

- Time-varying volatility of a DSGE fiscal shock:  
Fernández-Villaverde et. al. (2011), Born and Pfeifer (2011).
- Index based on newspaper headlines and other real world stuff:  
Baker et. al. (2013)

## Present Paper

- Market participants behave like empirical economists - they estimate fiscal policy rules.
- Least-squares learning re: fiscal policy behavior
- Eg: Early sections of Fernández-Villaverde et. al. (2011), Born and Pfeifer (2011).
- Forecast uncertainty: Fiscal policy uncertainty should be related to the variance of forecasts.

## Fiscal Policy Variables

- |                       |   |
|-----------------------|---|
| ① Government Spending | <i>Least-squares learning for each.</i>           |
| ② Tax Revenue         |   |
| ③ Net Transfers       | <i>Construct an uncertainty measure for each.</i> |
| ④ Government Debt     |   |

## Impact on Macroeconomy

Incorporate measures of fiscal uncertainty in a VAR including:

- ① Consumption
- ② Investment
- ③ Real GDP
- ④ Unemployment

## Historical Economic and Political Crises

- Financial crisis and historic economic downturn.
- Large monetary and fiscal policy responses, fiscal policy multiplier debate is still active.
- U.S. Government Debt to GDP reaching historical levels.
- Simultaneous calls from left and right calling for opposing fiscal responses.

## Ben Bernanke - July 2012 Monetary Policy Report to Congress

*"The most effective way that the Congress could help to support the economy right now would be to work to address the nation's fiscal challenges.... **Doing so earlier rather than later would help reduce uncertainty and boost household and business confidence.**"*

### Time-varying Fiscal Volatility

- Fernández-Villaverde 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.
- Johansen (2012): Matters more at ZLB.

### Macroeconomic Impact of Volatility

- Bloom (2009, *Econometrica*)
- Bloom et. al. (2012)
- Fernández-Villaverde et. al. (2011b, *AER*)

### Fiscal Uncertainty

Baker (2013): Reduces economic activity

## Fiscal Uncertainty Reduces Economic Activity

- Investment is adversely affected by,
  - Government spending uncertainty
  - Tax uncertainty
- Consumption and real GDP adversely affected by,
  - Tax uncertainty
  - Government debt uncertainty
  - These findings are less robust than above to VAR specification.

## But it may boost the labor market!

Unemployment decreases with transfers uncertainty.

## 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:**

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



## OLS Regression

$$\hat{\alpha}_t = \left( \sum_{\tau=0}^t X_{\tau} X'_{\tau} \right)^{-1} \left( \sum_{\tau=0}^t X'_{\tau} f_{i,\tau} \right)$$

- $X_{\tau} = [1 \ f'_{\tau-1} \ y_{\tau} \ c_{\tau} \ l_{\tau} \ u_{\tau}]'$  is vector of regressors.
- Predicted fiscal policy action:  $E_t^* f_{i,t} = X'_t \hat{\alpha}_t$
- Unexplained policy:  $\hat{\epsilon}_t = f_{i,t} - X'_t \hat{\alpha}_t$

## Recursive Formulation

The OLS regression coefficients can be rewritten as:

$$\hat{\alpha}_{i,t} = \alpha_{i,t-1} + \gamma_t R_t^{-1} X_t (f_t - X'_t \hat{\alpha}_t)$$

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

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

## Recursive Formulation

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

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

- 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

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

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

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

## 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

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

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

- Unexplained fiscal policy:

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

- Forecast uncertainty  $\sim$  Root (weighted) mean squared error:

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

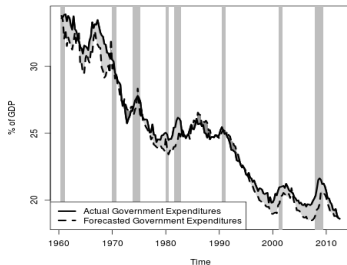
## Time-varying Volatility

- Eg: Fernández-Villaverde et. al. (2011), Born and Pfeifer (2011), Johansen (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?

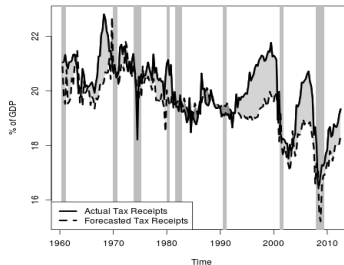
## Forecast Uncertainty

- 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.

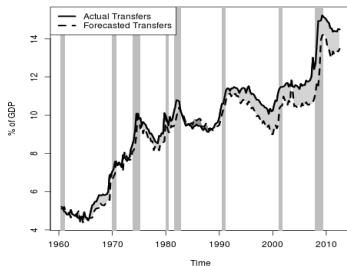
## Actual and Forecasted Government Expenditures



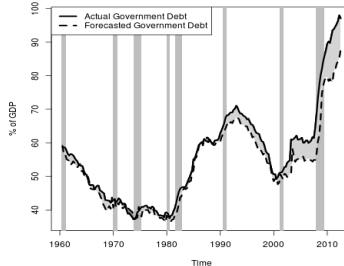
## Actual and Forecasted Tax Receipts

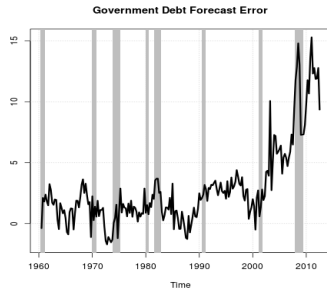
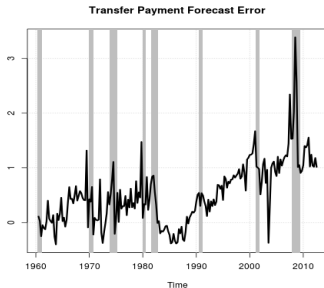
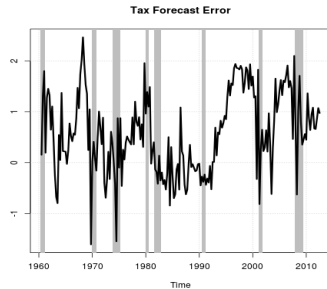
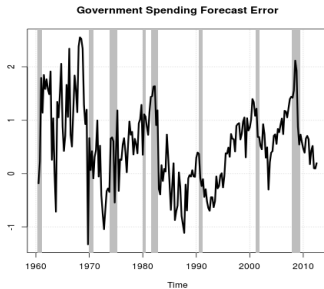


## Actual and Forecasted Transfer Payments

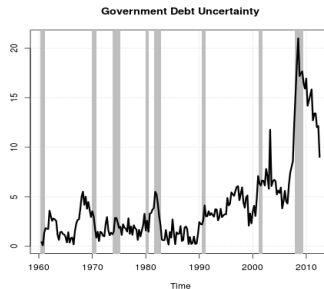
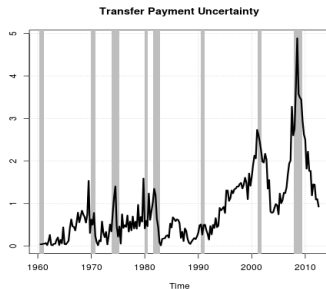
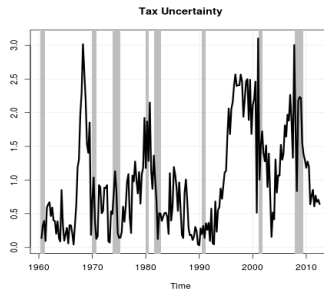
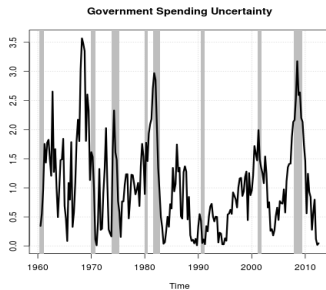


## Actual and Forecasted Government Debt









- Uncertainty concerning transfers and debt reached unprecedented levels during Great Recession.
  - Transfers uncertainty: Nearly 5% of GDP
  - Government debt uncertainty: Exceeded 20% of GDP
- Tax and government spending uncertainty reached near highs of about 3% 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, not much action prior to 1991)

- Answer this with a reduced form vector autoregression in:
  - 1 Real GDP
  - 2 Consumption
  - 3 Investment
  - 4 Unemployment
- Augment explanatory variables with fiscal policy uncertainty variables (first lag)
- Consider VAR lag lengths: 1, 2, and 4.
- Consider learning gain parameters:  $\gamma = 0.01, 0.02, 0.03$ .

Dependent Variable: Real GDP

Learning Gain:  $\gamma = 0.01$ 

	1 Lag	2 Lags	4 Lags
Expenditures Uncertainty (Standard Error) <sup>2</sup>	-0.191* (0.116)	-0.091 (0.113)	-0.234** (0.121)
Tax Uncertainty (Standard Error)	-0.050 (0.208)	-0.170 (0.216)	-0.226 (0.219)
Transfers Uncertainty (Standard Error)	0.270 (0.191)	0.410 (0.141)	0.465 (0.112)
Debt Uncertainty (Standard Error)	-0.077** (0.039)	-0.071** (0.040)	-0.031 (0.046)
Joint F-test	4.1***	2.7**	2.8**
Adjusted R-square	0.240	0.346	0.409
AIC	478.9	456.7	451.6
BIC	532.3	543.5	605.1

Dependent Variable: Real GDP

Learning Gain:  $\gamma = 0.01$ 

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Some evidence expenditures uncertainty decreases real GDP.

Dependent Variable: Real GDP

Learning Gain:  $\gamma = 0.01$ 

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**Fiscal policy uncertainty matters one way or another.**

Dependent Variable: Consumption

Learning Gain:  $\gamma = 0.01$ 

	1 Lag	2 Lags	4 Lags
Expenditures Uncertainty (Standard Error) <sup>2</sup>	0.073 (0.072)	0.065 (0.067)	0.010 (0.058)
Tax Uncertainty (Standard Error)	-0.080 (0.083)	-0.179* (0.119)	-0.065 (0.129)
Transfers Uncertainty (Standard Error)	0.070 (0.089)	0.123 (0.081)	0.089 (0.081)
Debt Uncertainty (Standard Error)	-0.052*** (0.020)	-0.035* (0.026)	-0.026 (0.026)
Joint F-test	3.8***	2.6**	0.8
Adjusted R-square	0.980	0.980	0.981
AIC	179.4	187.7	198.2
BIC	232.8	274.5	351.7



Dependent Variable: Consumption

Learning Gain:  $\gamma = 0.01$ 

	1 Lag	2 Lags	4 Lags
Expenditures Uncertainty (Standard Error) <sup>2</sup>	0.073 (0.072)	0.065 (0.067)	0.010 (0.058)
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Some evidence that debt uncertainty decreases consumption.

Dependent Variable: Consumption

Learning Gain:  $\gamma = 0.01$ 

	1 Lag	2 Lags	4 Lags
Expenditures Uncertainty (Standard Error) <sup>2</sup>	0.073 (0.072)	0.065 (0.067)	0.010 (0.058)
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**Fiscal policy uncertainty likely influences consumption.**

Dependent Variable: Investment  
Learning Gain:  $\gamma = 0.01$

	1 Lag	2 Lags	4 Lags
Expenditures Uncertainty (Standard Error) <sup>2</sup>	-0.248*** (0.064)	-0.152*** (0.058)	-0.216*** (0.063)
Tax Uncertainty (Standard Error)	-0.223* (0.163)	-0.209* (0.141)	-0.296*** (0.126)
Transfers Uncertainty (Standard Error)	0.319 (0.115)	0.339 (0.103)	0.391 (0.092)
Debt Uncertainty (Standard Error)	0.008 (0.035)	0.012 (0.021)	0.035 (0.020)
Joint F-test	5.3***	3.0**	4.2***
Adjusted R-square	0.943	0.958	0.962
AIC	304.0	249.7	243.4
BIC	357.4	336.4	396.9

Dependent Variable: Investment  
Learning Gain:  $\gamma = 0.01$

	1 Lag	2 Lags	4 Lags
Expenditures Uncertainty (Standard Error) <sup>2</sup>	-0.248*** (0.064)	-0.152*** (0.058)	-0.216*** (0.063)
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**Expenditures uncertainty decreases investment.**

Dependent Variable: Investment  
Learning Gain:  $\gamma = 0.01$

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**Tax uncertainty likely decreases investment.**

Dependent Variable: Investment

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**Fiscal policy uncertainty likely influences investment.**

Dependent Variable: Unemployment  
Learning Gain:  $\gamma = 0.01$

	1 Lag	2 Lags	4 Lags
Expenditures Uncertainty (Standard Error) <sup>2</sup>	0.049 (0.035)	-0.002 (0.031)	0.018 (0.030)
Tax Uncertainty (Standard Error)	0.185 (0.099)	0.115 (0.088)	0.119 (0.079)
Transfers Uncertainty (Standard Error)	-0.107** (0.048)	-0.115** (0.052)	-0.108*** (0.045)
Debt Uncertainty (Standard Error)	0.008 (0.023)	0.016 (0.015)	0.013 (0.015)
Joint F-test	7.6***	2.6**	2.1*
Adjusted R-square	0.977	0.982	0.982
AIC	23.8	-22.1	1.2
BIC	77.2	64.7	154.7

Dependent Variable: Unemployment  
Learning Gain:  $\gamma = 0.01$

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**Transfers uncertainty decreases unemployment.**



Dependent Variable: Unemployment  
Learning Gain:  $\gamma = 0.01$

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**Fiscal policy uncertainty likely influences unemployment.**

## Fiscal Uncertainty Reduces Economic Activity

- Investment is adversely affected by,
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  - Tax uncertainty
- Consumption and real GDP adversely affected by,
  - Tax uncertainty
  - Government debt uncertainty
  - These findings are less robust than above to VAR specification.

But it may boost the labor market!

Unemployment decreases with transfers uncertainty.