Fiscal Policy Uncertainty and Its Macroeconomic Consequences

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Economics Department Seminar
March 9, 2015

Purpose 1: Quantify Fiscal Uncertainty

Existing Contributions

- Time-varying volatility of a DSGE fiscal shock:
  Fernández-Villiverde 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-Villiverde 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
2. Tax Revenue
3. Net Transfers
4. Government Debt

Least-squares learning for each.

Construct an uncertainty measure for each.

Impact on Macroeconomy

Incorporate measures of fiscal uncertainty in ARDL models for:

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-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.

Macroeconomic Volatility (more generally)

- Justiniano and Primiceri (2008, *AER*)
- Bloom (2009, *Econometrica*)
- Bloom et. al. (2012)
- Fernández-Villiverde et. al. (2011b, *AER*)

- Bi, Leith, and Leeper (2013): Timing and composition of fiscal contractions
- Davig, Leeper, and Walker (2010): Uncertainty re: unfunded entitlement programs is stagflationary
- Davig and Foerster (2014): Uncertainty re: expiring tax provisions decrease investment and employment
- Richter and Throckmorton (2014):
  - Uncertainty regarding future debt target
  - Welfare improving or reducing, depending on expectation relative to realization.
  - Uncertainty extending the "Bush tax cuts" were welfare reducing.

- Baker (2013): Uncertainty reduces economic activity
- Hollmayr and Matthes (2013):
  - Switching in fiscal behavior equations
  - Bayesian learning regarding fiscal behavior
  - Permanent fiscal changes have a *relatively* small impact
  - More macroeconomic volatility

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

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.

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:

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

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.

OLS Regression

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

- $X_\tau = [1 \; f_{\tau-1}' \; y_\tau \; c_\tau \; I_\tau \; u_\tau]'$ is vector of regressors.
- "Expected" 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 τ: $\omega_\tau = (1-\gamma)\gamma^\tau$.

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:

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

- 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-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?

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.

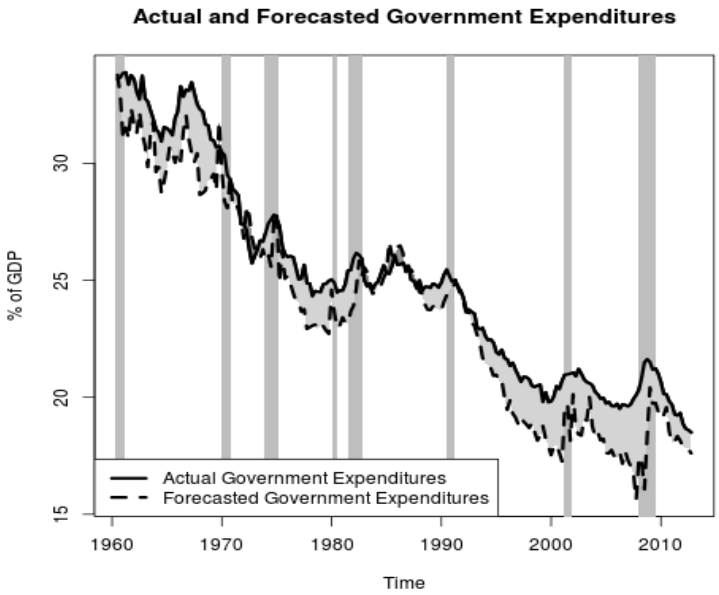
Some basis in the literature:

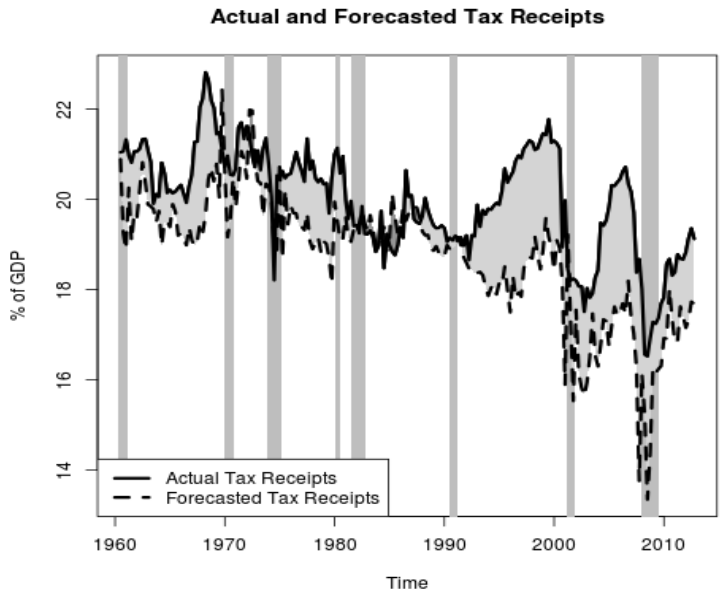
- Herro and Murray (2013): Monetary policy uncertainty.
- Orlik and Veldkamp (2013): Macro uncertainty - forecast uncertainty with Bayesian learning

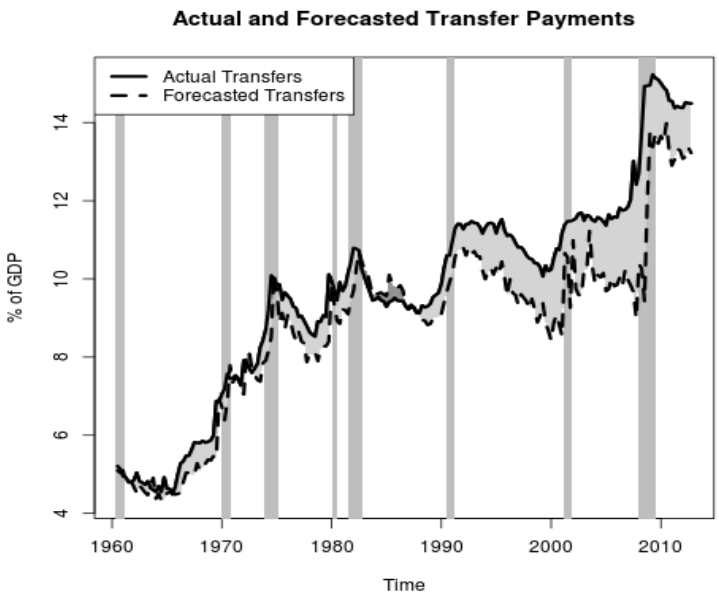
Shortcomings

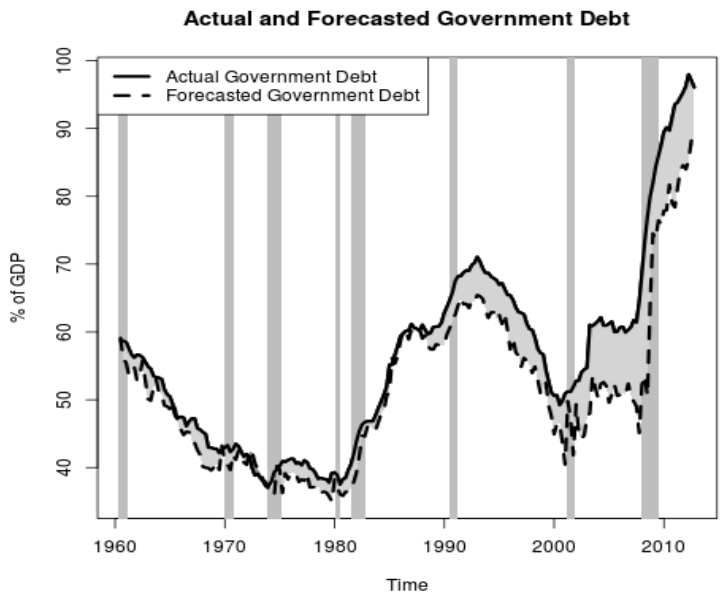
- Learning models do not consider government budget constraint
- Backward looking - ignores policy announcements, upcoming policy expiration
- Long-horizon fiscal problems.

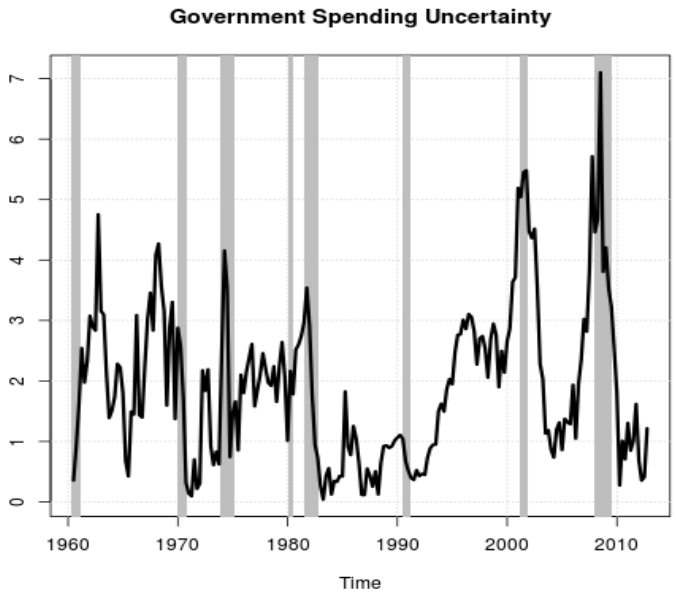
Fiscal Policy - Actual and Predicted










Government Spending Uncertainty
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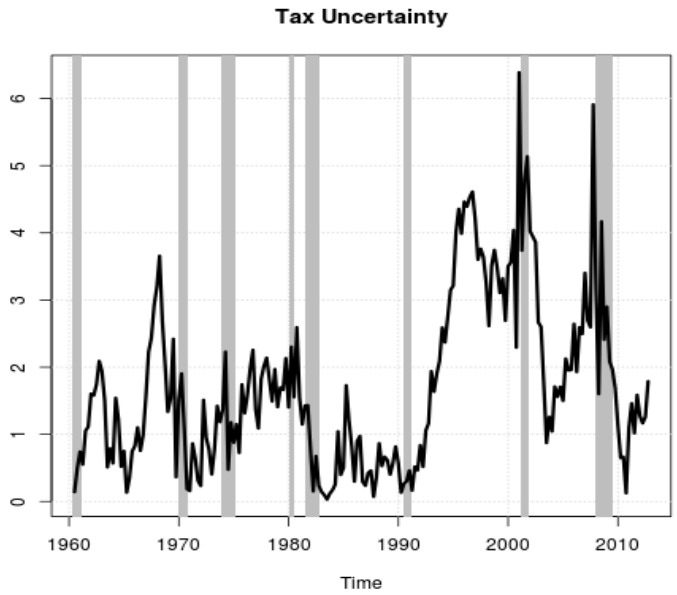
Tax Uncertainty
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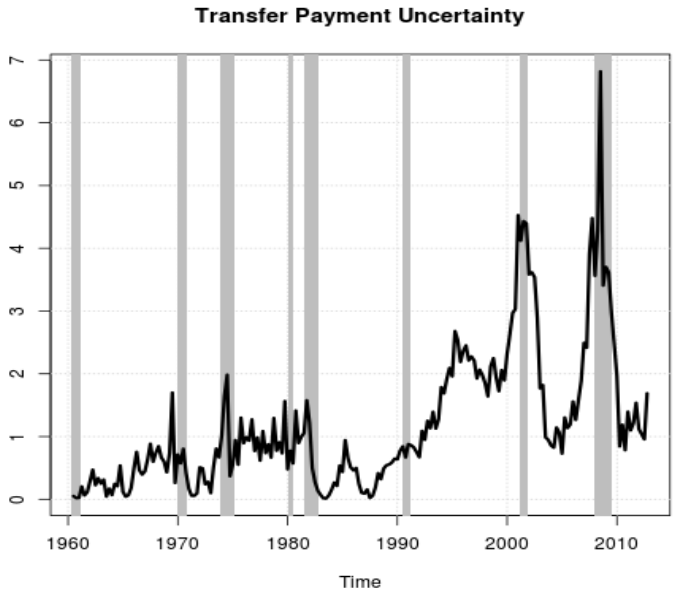
Transfer Payment Uncertainty
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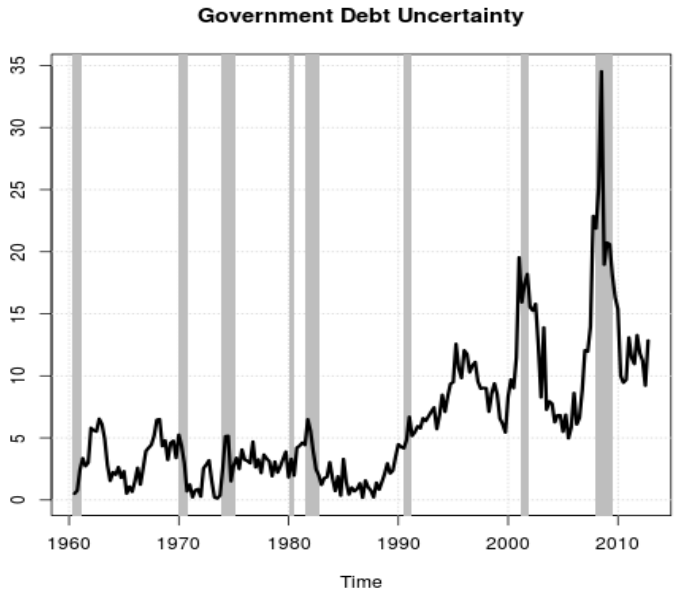
Government Debt Uncertainty
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Time

- 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

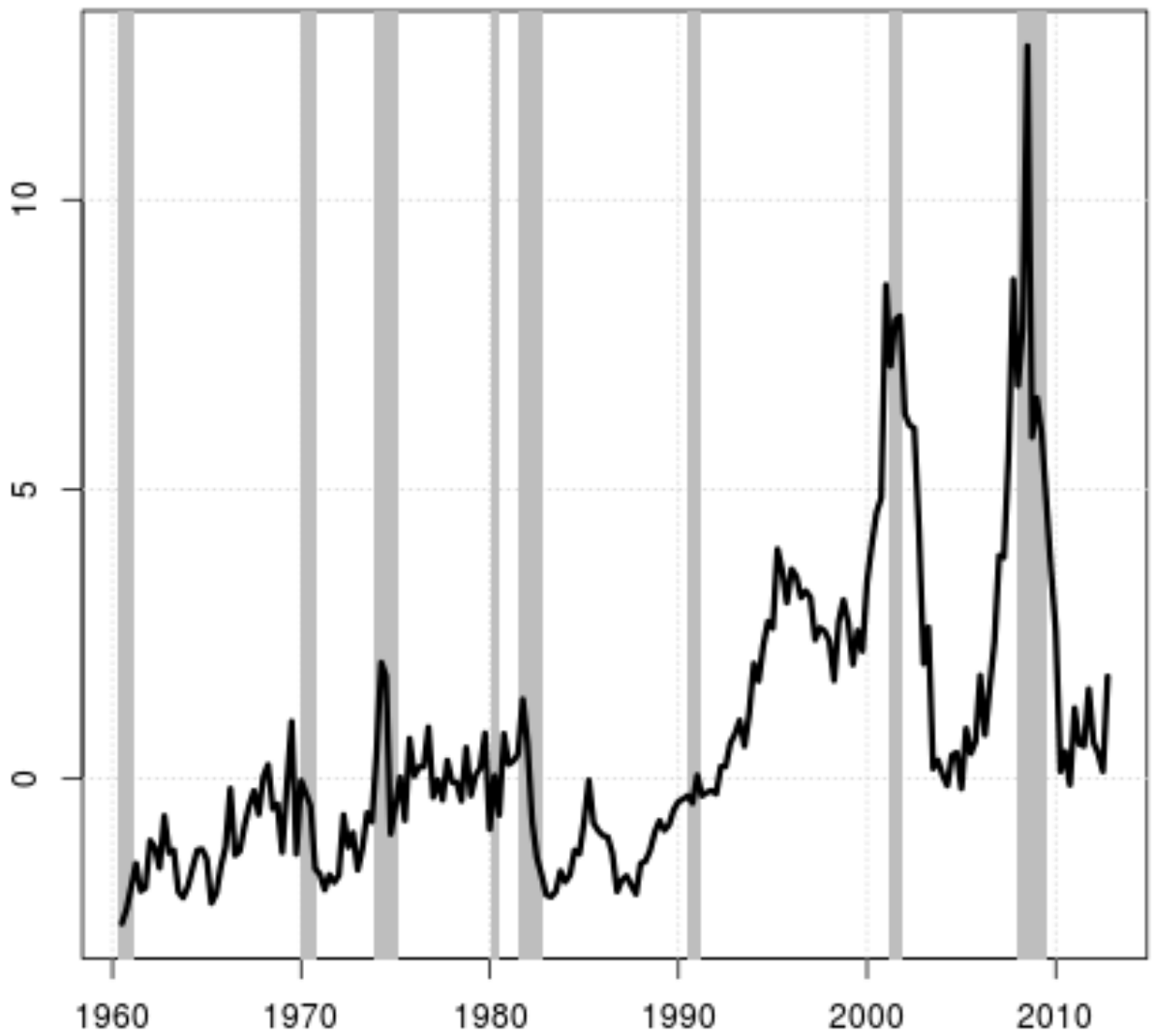
- Strip out the common component of fiscal uncertainty
- Construct a general measure of fiscal uncertainty
- Take care of potential multicolinearity problem
- Compare to Baker, Bloom, and Davis (2013) (BBD)

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
  - λ_t: general fiscal uncertainty
  - $m_0 + e_t$: "unique" component of fiscal uncertainty.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Government Spending Uncertainty
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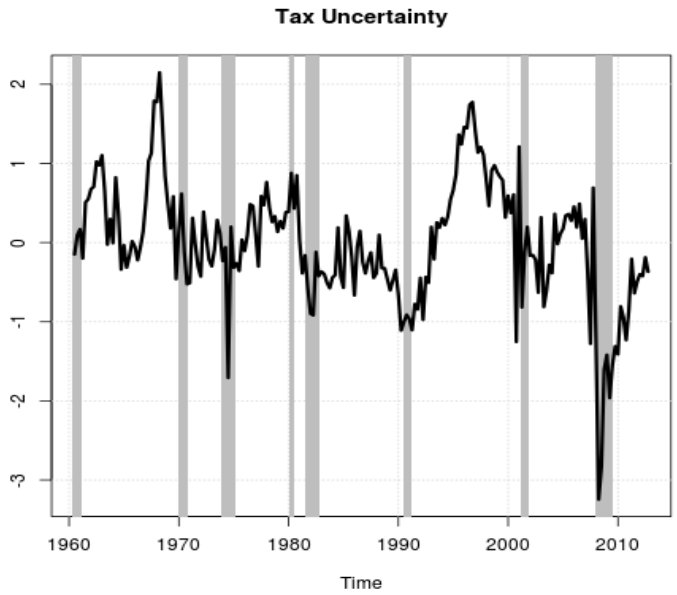
Tax Uncertainty
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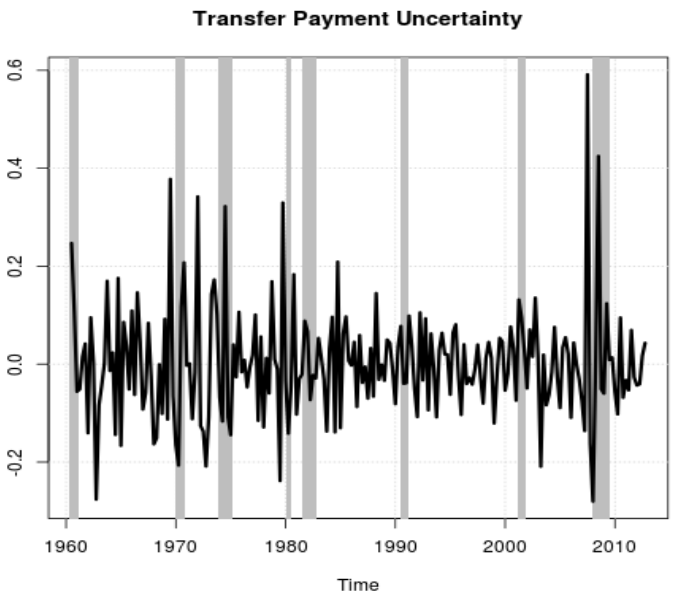
Transfer Payment Uncertainty
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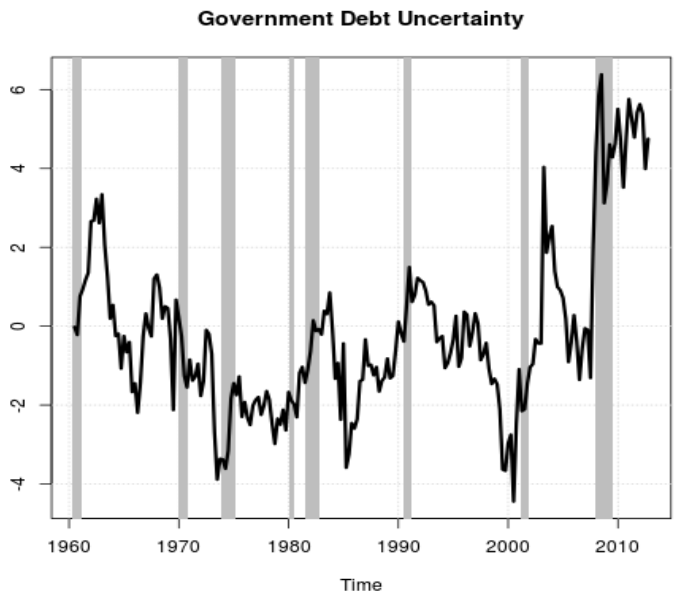
Government Debt Uncertainty
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Time

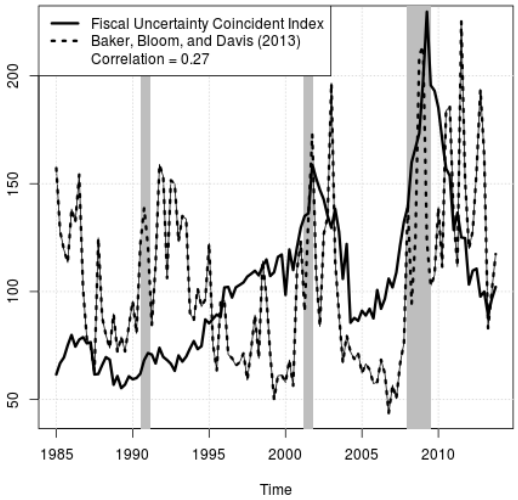
Fiscal Uncertainty with Common Component Removed - Pearson Correlations

	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

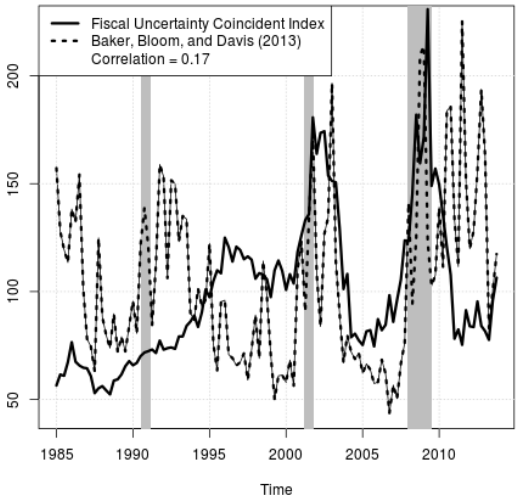
Correlation of RMSE with Coincident Index

	Gov Spending	Tax Revenue	Transfers	Government Debt
Coincident Index	0.75	0.78	0.99	0.91

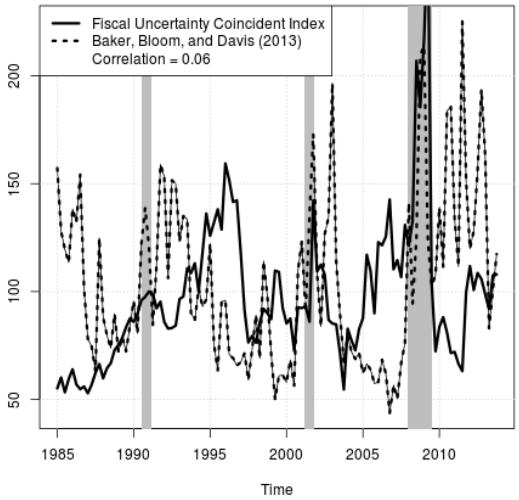
Relationship with Baker et. al. (2013)



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

Autoregressive Distributed Lag Model

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

ARDL Results (Learning Gain = 0.02, Lags = 2)

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
(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

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1. Common fiscal uncertainty dampens aggregate demand

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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

2. Transfers and Gov Exp uncertainty drags on employment

ARDL Results (Learning Gain = 0.02, Lags = 2)

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
(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

3. Debt uncertainty drags on employment (significant in most other specifications)

ARDL Results (Learning Gain = 0.02, Lags = 2)

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
(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**
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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

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