Fiscal Volatility Shocks and Economic Activity

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Motivation

Ben Bernanke [July 18, 2012]:

“The recovery in the United States continues to be held back by a number of other headwinds, including still-tight borrowing conditions for some businesses and households, and – as I will discuss in more detail shortly – the restraining effects of fiscal policy and fiscal uncertainty.”

New York Times [September 30, 2013]:

“The Senate, which returns Monday afternoon, is expected to overwhelmingly reject a bill passed by the Republican-controlled House this weekend that would delay the full effect of President Obama’s health care law as a condition for continuing to finance the government past Monday. But no one -not even House Republicans themselves- seemed to know what would happen next.”
Objective

- **Quantify** the effects of fiscal volatility shocks on economic activity.

- We estimate tax and spending processes for the U.S. with time-variant volatility using a Particle filter and an McMc.

- We feed the estimated rules into an equilibrium business cycle model estimated to the U.S. economy using a SMM.

- We simulate the equilibrium using a third-order perturbation.
Main Results I

1. We find a considerable amount of time-varying volatility in all four fiscal instruments.

2. After a fiscal volatility shock, output, consumption, hours, and investment drop on impact and stay low for several quarters.
   Main transmission mechanism: an endogenous increase in mark-ups.
   Upward pricing bias due to the shape of the profit function.

3. Fiscal volatility shocks are “stagflationary”: inflation goes up while output falls.

4. We estimate a CEE-style VAR and an ACEL-style VAR to document that, after a fiscal volatility shock, markups significantly increase.
Why the “Stagflation”?

- Steady-state profits: \((P_j/P)^{1-\epsilon} y - mc \left( P_j/P \right)^{-\epsilon} y\)

```
<table>
<thead>
<tr>
<th>FV-G-K-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiscal Volatility</td>
</tr>
</tbody>
</table>
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*Period profits*

```
<table>
<thead>
<tr>
<th>relative price ((P_j/P))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.95</td>
</tr>
<tr>
<td>-0.2</td>
</tr>
<tr>
<td>11</td>
</tr>
</tbody>
</table>
```
5. A two-standard deviations fiscal volatility shock has an effect similar to a 30 b.p. innovation in the FFR as estimated by a SVAR.

6. At the ZLB, the effects are much bigger: 1.7 percent fall of output if we are at the ZLB for 8 quarters.

7. Most important channel: larger uncertainty about the future tax rate on capital income.

8. An accommodative monetary policy increases the effect of fiscal volatility shocks.
How Do We Quantify Fiscal Volatility Shocks?

- Volatility is not directly observed.

- No data (surveys, asset prices...) or very limited (SPF for $g$, but short horizon (5qtrs)).

- Instead, we estimate a stochastic volatility process as in Fernández-Villaverde et al. (2011).
Empirical Model

- Fiscal instruments follow:

\[ x_t = \rho_x x_{t-1} + \phi_{x,y} \tilde{y}_{t-1} + \phi_{x,b} \left( \frac{b_{t-1}}{y_{t-1}} \right) + \exp(\sigma_{x,t}) \varepsilon_{x,t} \]

\[ \sigma_{x,t} = (1 - \rho_{\sigma_x}) \sigma_x + \rho_{\sigma_x} \sigma_{x,t-1} + \left( 1 - \rho_{\sigma_x}^2 \right)^{1/2} \eta_x u_{x,t} \]

- \( x \in \{g, \tau_c, \tau_l, \tau_k\} \).

- Fiscal shocks: \( \varepsilon_{x,t} \).

- Volatility shock: \( u_{x,t} \).

- No direct effect on taxes.
Data

- Construct aggregate (average) effective tax rates from NIPA (Mendoza et al., 1994; Leeper et al., 2010): consumption, labor and capital income taxes.

- General government \( (= \text{federal} + \text{state} + \text{local}) \).

- Spending rule: ratio of government expenditures to GDP.

- Federal debt (held by the public) from St. Louis Fed.

- Data sample: 1970Q1 - 2010Q2.
Estimation of Fiscal Rules

- Instrument by instrument (easily extended).
- No correlation of shocks (easily extended).
- Particle filter + Bayesian methods.
- Flat priors.
- 20,000 draws from posterior (5,000 additional burn-in draws) using McMc.
- 10,000 particles to perform the evaluation of the likelihood.
Smoothed Volatility

Government spending

Labor Tax

Capital Tax

Consumption Tax
Forecast Dispersion

**Labor Tax**

**Consumption Tax**

**Capital Tax**

**Government spending**

- Stoch Vola + 2 Std. Dev Shock
- Stoch Vola, No Shock
- Without Stoch Vol
Key Ingredients

- Representative household.
- Labor supply flexible, but wages with quadratic adjustment cost.
- Investment adjustment costs, but flexible utilization margin of capital.
- Prices with quadratic adjustment cost.
- Fiscal rules as discussed above + Taylor rule for monetary policy.
Estimation

- General point: problems for calibration in non-linear models.


- We use a SMM to estimate most parameters.

- Parameters for fiscal instruments laws of motion: median of our posteriors.

- Third-order perturbation solution. Why?
Experiment to Understand Fiscal Volatility Shocks

\[ x_t = \rho_x x_{t-1} + \phi_{x,y} \tilde{y}_{t-1} + \phi_{x,b} \left( \frac{b_{t-1}}{y_{t-1}} \right) + \exp(\sigma_{x,t}) \varepsilon_{x,t} \]

\[ \sigma_{x,t} = (1 - \rho_{\sigma_x}) \sigma_x + \rho_{\sigma_x} \sigma_{x,t-1} + \left(1 - \rho_{\sigma_x}^2\right)^{1/2} \eta_x u_{x,t} \]

- At time 0, the economy is hit by a fiscal volatility shock to capital income tax.

- Taxes are constant today.

- Two-standard deviation shocks to \( u_{x,t} \)'s. Meant to capture current fiscal outlook.

Fiscal Volatility Shocks

output  cons.  invest.  hours

marg. cost  inflation (bps)  nom. rate (bps)  wages

0 10

0

0 10

−0.05
−0.1

−0.06
−0.04
−0.02

−1.5
−1
−0.5

−1.5
−1
−0.5

0

20
40

0

−0.02
−0.04
−0.06

−0.06
−0.04
−0.02

−0.06
−0.04
−0.02

20
40

0

−0.05
−0.1

−0.06
−0.04
−0.02

−1.5
−1
−0.5

−1.5
−1
−0.5

0

FV-G-K-R

Fiscal Volatility

16/39
Fiscal Volatility Shocks (black solid) vs. 30bps Monetary Shock (red dots)

- Output
- Consumption
- Investment
- Hours
- Marginal cost
- Inflation (bps)
- Nominal rate (bps)
- Wages
The Effect of the ZLB

- Output
- Consumption (cons.)
- Investment (invest.)
- Hours
- Marginal cost
- Inflation (bps)
- Nominal rate (bps)
- Wages

Graphs showing the effect of the zero lower bound (ZLB) on various economic indicators.
\[
\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{1-\phi_R} \left(\frac{\Pi_t}{\Pi}\right)^{(1-\phi_R)\gamma_{\Pi} \uparrow = 1.5} \left(\frac{y_t}{\overline{y}}\right)^{(1-\phi_R)\gamma_{\overline{y}} \uparrow = 0.5} e^{\sigma_m \xi_t}
\]
Degree of Nominal Rigidities

- **output**, **consumption**, **investment**, **hours**

- **marginal cost**, **inflation (bps)**, **nominal rate (bps)**, **wages**

- **blue**: (Calvo) $\phi_p = 0.1$
- **red**: (Calvo) $\phi_w = 0.1$
- **magenta**: (Calvo) $\phi_p = 0.1$ and $\phi_w = 0.1$
Agenda

- Additional ingredients?
  - Financial frictions.
  - Non-convexities.
  - "Investment" into labor relationships.
  - Human capital.

- Feedback from higher levels of debt to tax volatility?
Conclusion

- High fiscal volatility is a concern for policymakers.
- But, how big are the effects of fiscal volatility shocks?
- Our simulations indicate that the effect can be important.
- Key role for monetary policy in propagation.
- Modeling of political-economic equilibrium that leads to these shocks remains an open issue.
## Estimated Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Labor</th>
<th>Consumption</th>
<th>Capital</th>
<th>Government Spending</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_{x}$</td>
<td>0.99</td>
<td>0.99</td>
<td>0.97</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
<td>[0.975, 0.999]</td>
<td>[0.981, 0.999]</td>
<td>[0.93, 0.996]</td>
<td>[0.948, 0.992]</td>
</tr>
<tr>
<td>$\sigma_{x}$</td>
<td>$-6.01$</td>
<td>$-7.09$</td>
<td>$-4.96$</td>
<td>$-6.13$</td>
</tr>
<tr>
<td></td>
<td>$[-6.27, -5.75]$</td>
<td>$[-7.34, -6.78]$</td>
<td>$[-5.29, -4.66]$</td>
<td>$[-6.49, -5.39]$</td>
</tr>
<tr>
<td>$\phi_{x,y}$</td>
<td>0.031</td>
<td>0.001</td>
<td>0.044</td>
<td>$-0.004$</td>
</tr>
<tr>
<td></td>
<td>[0.011, 0.055]</td>
<td>[0.000, 0.005]</td>
<td>[0.004, 0.109]</td>
<td>$[-0.02, 0.00]$</td>
</tr>
<tr>
<td>$\phi_{x,b}$</td>
<td>0.003</td>
<td>0.0006</td>
<td>0.004</td>
<td>$-0.008$</td>
</tr>
<tr>
<td></td>
<td>[0.00, 0.007]</td>
<td>[0.00, 0.002]</td>
<td>[0.00, 0.016]</td>
<td>$[-0.012, -0.003]$</td>
</tr>
<tr>
<td>$\rho_{\sigma_{x}}$</td>
<td>0.31</td>
<td>0.65</td>
<td>0.76</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>[0.06, 0.57]</td>
<td>[0.08, 0.91]</td>
<td>[0.47, 0.92]</td>
<td>[0.43, 0.99]</td>
</tr>
<tr>
<td>$\eta_{x}$</td>
<td>0.94</td>
<td>0.60</td>
<td>0.57</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>[0.73, 1.18]</td>
<td>[0.31, 0.93]</td>
<td>[0.33, 0.88]</td>
<td>[0.13, 1.15]</td>
</tr>
</tbody>
</table>

**Notes:** The posterior median and a 95% probability interval.

- Persistent mean-dynamics.
- Stochastic volatility is significant and moderately persistent.
Relation with Other Measures of Uncertainty

- How much do we believe our empirical results?

- Bloom et al. (2011) measure uncertainty using news media coverage, tax provisions set to expire, and disagreement among forecasters.

- Surprisingly high correlation of their uncertainty measure with our smoothed volatilities.

- For instance, correlation of uncertainty with volatility of capital taxes: 0.56.
Households I

- Household maximizes:

\[ E_0 \sum_{t=0}^{\infty} \beta^t d_t \left\{ \frac{(c_t - b_h c_{t-1})^{1-\omega}}{1-\omega} - \psi \int_0^1 \frac{l_{j,t}^{1+\vartheta}}{1+\vartheta} dj \right\} \]

- Intertemporal shock \( d_t \):

\[ \log d_t = \rho_d \log d_{t-1} + \sigma_d \varepsilon_{dt}, \varepsilon_{dt} \sim N(0,1) \]

- Savings:

1. Invest, \( i_t \).

2. Hold government bonds, \( B_t \), with nominal gross interest rate \( R_t \).
Households II

- Budget constraint:

\[ (1 + \tau_{c,t})c_t + i_t + b_t + \Omega_t + \int_0^1 AC_{j,t}^w dj = \]

\[ (1 - \tau_{l,t}) \int_0^1 w_{j,t} l_{j,t} dj + (1 - \tau_{k,t}) r_{k,t} u_t k_{t-1} + \tau_{k,t} \delta k_{t-1}^b + \]

\[ + b_{t-1} \frac{R_{t-1}}{n_t} + F_t. \]

- Real wage adjustment costs for labor type \( j \):

\[ AC_{j,t}^w = \frac{\phi_w}{2} \left( \frac{w_{j,t}}{w_{j,t-1}} - 1 \right)^2 y_t \]

- Quadratic cost \( \neq \) Calvo. Remember: non-linear solution!

- We also computed the model with Calvo pricing.
Households III

▶ Labor packer:

\[ l_t = \left( \int_0^1 \frac{\epsilon_w - 1}{\epsilon_w} l_{j,t} \, dj \right)^{\frac{\epsilon_w}{\epsilon_w - 1}} \]

▶ Demand for each type of labor:

\[ l_{j,t} = \left( \frac{w_{j,t}}{w_t} \right)^{-\epsilon_w} l_t \]

▶ By a zero-profit condition:

\[ w_t = \left( \int_0^1 w_{j,t}^{1-\epsilon_w} \right)^{\frac{1}{1-\epsilon_w}} \]
Households IV

- Capital accumulation:

\[ k_t = (1 - \delta(u_t)) k_{t-1} + \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) i_t \]

where:

\[ \delta(u_t) = \delta + \Phi_1(u_t - 1) + \frac{1}{2} \Phi_2(u_t - 1)^2 \]

- Quadratic adjustment cost:

\[ S \left[ \frac{i_t}{i_{t-1}} \right] = \frac{\kappa}{2} \left( \frac{i_t}{i_{t-1}} - 1 \right)^2 \]

which implies \( S(1) = S'(1) = 0 \) and \( S''(1) = \kappa \).

- Book value of capital:

\[ k^b_t = (1 - \delta) k^b_{t-1} + i_t \]
Firms I

- Competitive producer of a final good:

\[ y_t = \left( \int_0^1 y_{it} \frac{\epsilon-1}{\epsilon} \, di \right)^{\frac{\epsilon}{\epsilon-1}} \]

- Buys intermediate goods at price \( P_{i,t} \) and charges \( P_t \).

- Demand:

\[ y_{it} = \left( \frac{P_{it}}{P_t} \right)^{-\epsilon} y_t \]

- Price index:

\[ P_t = \left( \int_0^1 P_{it}^{1-\epsilon} \, di \right)^{\frac{1}{1-\epsilon}} \]
Firms II

- Intermediate good producer with market power:

\[ y_{it} = A_t k_{it}^{\alpha} I_{it}^{1-\alpha} - \phi \]

- \( A_t \) is neutral productivity:

\[ \log A_t = \rho_A \log A_{t-1} + \sigma_A \varepsilon_{At}, \varepsilon_{At} \sim \mathcal{N}(0, 1) \text{ and } \rho_A \in [0, 1) \]

- Intermediate producer sets prices at cost:

\[ AC_{i,t}^p = \frac{\phi p}{2} \left( \frac{P_{i,t}}{P_{i,t-1}} - \Pi \right)^2 y_{i,t} \]
Government

- Monetary authority follows Taylor rule:

\[ \frac{R_t}{R} = \left( \frac{R_{t-1}}{R} \right)^{1-\phi_R} \left( \frac{\Pi_t}{\Pi} \right)^{(1-\phi_R)\gamma_{\Pi}} \left( \frac{y_t}{y} \right)^{(1-\phi_R)\gamma_y} e^{\sigma_m \xi_t} \]

- Fiscal authority’s budget constraint:

\[ b_t = b_{t-1} \frac{R_{t-1}}{\Pi_t} + g_t - \left( c_t \tau_{c,t} + w_t l_t \tau_{l,t} + r_k \tau_{k,t} u_t k_{t-1} \tau_{k,t} - \delta k_{t-1}^b \tau_{k,t} + \Omega_t \right) \]

- Transfers:

\[ \Omega_t = \Omega + \phi_{\Omega,b} (b_{t-1} - b) \]

where \( \phi_{\Omega,b} > 0 \).
Aggregation and Solution

- Aggregate demand:

\[ y_t = c_t + i_t + g_t + \frac{\phi_p}{2} (\Pi_t - \Pi)^2 y_t + \frac{\phi_w}{2} \left( \frac{w_t}{w_{t-1}} - 1 \right)^2 y_t \]

- Aggregate supply:

\[ y_t = A_t (u_t k_{t-1})^\alpha I_t^{1-\alpha} - \phi \]

- Market clearing.

- Definition of equilibrium is standard.
### Preferences and consumer

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.9945</td>
<td>Estimated</td>
</tr>
<tr>
<td>$\omega$</td>
<td>2</td>
<td>Standard choice</td>
</tr>
<tr>
<td>$\nu$</td>
<td>2</td>
<td>Chetty (2011)</td>
</tr>
<tr>
<td>$\psi$</td>
<td>75.66</td>
<td>Estimated</td>
</tr>
<tr>
<td>$b_h$</td>
<td>0.75</td>
<td>CEE (JPE, 2005)</td>
</tr>
<tr>
<td>$\phi_w$</td>
<td>4889</td>
<td>ACEL (RED, 2011)</td>
</tr>
<tr>
<td>$\epsilon$</td>
<td>21</td>
<td>ACEL (RED, 2011)</td>
</tr>
</tbody>
</table>

### Cost of utilization and investment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Phi_1$</td>
<td>0.0165</td>
<td>From utilization FOC</td>
</tr>
<tr>
<td>$\Phi_2$</td>
<td>0.0001</td>
<td>Estimated</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>3</td>
<td>Estimated</td>
</tr>
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</table>
## Estimation II

### Firms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>1</td>
<td>Normalization</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.36</td>
<td>Standard choice.</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.011</td>
<td>Estimated.</td>
</tr>
<tr>
<td>$\phi_p$</td>
<td>236.10</td>
<td>Gali and Gertler (JME, 1999).</td>
</tr>
<tr>
<td>$\epsilon_w$</td>
<td>21</td>
<td>ACEL (RED, 2011).</td>
</tr>
</tbody>
</table>

### Monetary policy and lump-sum taxes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Pi$</td>
<td>1.0045</td>
<td>Estimated.</td>
</tr>
<tr>
<td>$\phi_R$</td>
<td>0.6</td>
<td>Estimated.</td>
</tr>
<tr>
<td>$\gamma_{\Pi}$</td>
<td>1.25</td>
<td>FGR (2010).</td>
</tr>
<tr>
<td>$\gamma_y$</td>
<td>1/4</td>
<td>FGR (2010).</td>
</tr>
<tr>
<td>$\Omega$</td>
<td>-4.3e-2</td>
<td>Follows from gov. budget constraint.</td>
</tr>
<tr>
<td>$\phi_{\Omega,b}$</td>
<td>0.0005</td>
<td>Small number to stabilize debt.</td>
</tr>
<tr>
<td>$b$</td>
<td>2.64</td>
<td>Estimated.</td>
</tr>
</tbody>
</table>
Estimated III

<table>
<thead>
<tr>
<th>Shocks</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_A$</td>
<td>0.95</td>
<td>King and Rebelo (1999).</td>
</tr>
<tr>
<td>$\sigma_A$</td>
<td>0.001</td>
<td>Estimated.</td>
</tr>
<tr>
<td>$\rho_d$</td>
<td>0.18</td>
<td>Smets and Wouters (AER, 2007).</td>
</tr>
<tr>
<td>$\sigma_d$</td>
<td>0.078</td>
<td>Estimated.</td>
</tr>
<tr>
<td>$\sigma_m$</td>
<td>0.0001</td>
<td>Estimated.</td>
</tr>
</tbody>
</table>

- Parameters for fiscal instruments laws of motion: median of our posteriors.
The Role of Precautionary Price Setting

output

cons.

invest.

hours

marg. cost

infl.

nom. rate

wages

FV-G-K-R

Fiscal Volatility
Without Automatic Responses

\[ x_t = \rho x x_{t-1} + \phi_{x,y} \tilde{y}_{t-1} + \phi_{x,b} \left( \frac{b_{t-1}}{y_{t-1}} \right) + \exp(\sigma_{x,t}) \varepsilon_{x,t} \]

- black: benchmark.
- red: no response to output.
- blue: no response to output or debt.
Decomposing Fiscal Volatility Shocks

- black: benchmark.
- red: volatility shock only on capital income taxes.