Fiscal Foresight & Information Flows

Eric M. Leeper†, Todd B. Walker† & Shu-Chun S. Yang*

† Indiana University
*Congressional Budget Office

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The Ohio State University Workshop
“News” Papers are a Growth Industry

- Three main areas

  1. Technology

     - R & D signals technological improvement
     - improvements are gradual and adoption even more gradual
“News” Papers are a Growth Industry

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    - R & D signals technological improvement
    - improvements are gradual and adoption even more gradual

    - Findings: news about TFP may be contractionary or expansionary

    - Proposed “fixes”—adjustment costs, special preferences
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  2. Government spending
     - new programs or wars usually debated & often phased in
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  1. Technology
  2. Government spending
    - new programs or wars usually debated & often phased in
  - Findings: anticipated spending may crowd out or crowd in private consumption
  - Proposed “fixes”—special preferences, unique data sets, new empirical methods
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  - 2. Government spending
  - 3. Taxation

- Legislative & implementation lags
- Agents know changes several quarters or years before they occur
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- Three main areas
  1. Technology
  2. Government spending
  3. Taxation
    - Legislative & implementation lags
    - Agents know changes several quarters or years before they occur
    - Findings: anticipated tax increases may have little effect, be expansionary, or be contractionary
    - Proposed “fixes”—unique data sets, new empirical methods
Common Themes of “News” Papers

- Agents base decisions on information not included in typical data sets
- News produces equilibria that are nonfundamental
- Difficult to build agents’ information into econometric work
- Creates an *additional* identification problem: aligning information sets correctly
- Modeling of information flows becomes central to inferences
Paper’s Contributions

1. Focus on important practical issue—tax policy—that produces nonfundamental equilibria, linking economic theory to an econometric literature [Hansen-Sargent]
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4. Goes beyond treating fundamentalness as $0 - 1$ to assess its *quantitative* importance in class of models in wide use
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2. Nonfundamentalness arises from agents’ optimal intertemporal decisions, which discount future taxes

3. Alternative specifications of tax information flows yield diverse empirical findings about anticipated tax changes

4. Goes beyond treating fundamentalness as $0 - 1$ to assess its quantitative importance in class of models in wide use
   - tax multipliers estimated with conventional methods (e.g., VARs) can be wildly inaccurate
An anticipated tax cut

- has little or no effect [Poterba-Summers, Blanchard-Perotti, Romer-Romer]
- is expansionary in the short run [Mountford-Uhlig]
- is strongly contractionary in the short run [Mertens-Ravn, Branson-Fraga-Johnson, House-Shapiro]
An anticipated tax cut
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Sources of the diverse results
  ▶ invalid instruments for fiscal foresight
  ▶ no modeling of fiscal behavior that gives rise to foresight (information flows)
  ▶ nonfundamentalness not directly confronted
Example 1: Moore’s Law
### Example 2: Infrastructure Spending

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
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<tr>
<td><strong>Budget</strong></td>
<td>61,782</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Authorization</strong></td>
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<tr>
<td><strong>Outlays</strong></td>
<td>5,508</td>
<td>12,654</td>
<td>13,301</td>
<td>9,808</td>
<td>7,801</td>
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**Billions of Dollars**

American Recovery & Reinvestment Act 2009. Transportation and Housing and Urban Development Portion

Source: Congressional Budget Office (2009)
### Example 3: Tax Reform 1986

<table>
<thead>
<tr>
<th>Year</th>
<th>Long-term</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>1984</td>
<td>134.1</td>
<td>135.0</td>
</tr>
<tr>
<td>1985</td>
<td>164.9</td>
<td>167.0</td>
</tr>
<tr>
<td>1986</td>
<td>315.7</td>
<td>322.2</td>
</tr>
<tr>
<td>1987</td>
<td>—</td>
<td>137.4</td>
</tr>
<tr>
<td>1988</td>
<td>—</td>
<td>153.8</td>
</tr>
<tr>
<td>1989</td>
<td>—</td>
<td>145.6</td>
</tr>
<tr>
<td>1990</td>
<td>—</td>
<td>113.2</td>
</tr>
</tbody>
</table>

Capital Gains Realizations in Billions

Source: Auerbach & Slemrod (1997)
Neo-Classical Growth Model

- Log preferences; inelastic labor supply; complete depreciation of capital; proportional income tax
- Euler equation

\[ \frac{1}{C_t} = \alpha \beta E_t(1 - \tau_{t+1}) \frac{1}{C_{t+1}} \frac{Y_{t+1}}{K_t} \]
Neo-Classical Growth Model

- Log preferences; inelastic labor supply; complete depreciation of capital; proportional income tax
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\frac{1}{C_t} = \alpha \beta E_t(1 - \tau_{t+1}) \frac{1}{C_{t+1}} \frac{Y_{t+1}}{K_t}
\]

- Equilibrium (linearized) capital accumulations obeys

\[
k_t = \alpha k_{t-1} + a_t - (1 - \theta) \left( \frac{\tau}{1 - \tau} \right) \sum_{i=0}^{\infty} \theta^i E_t \hat{\tau}_{t+1+i}
\]

where \( \theta = \alpha \beta (1 - \tau) < 1 \) and \( a_t = \varepsilon_{A,t} \) is exogenous technology process (i.i.d.)

- Agent discounts tax rates in usual way
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where \( \theta = \alpha \beta (1 - \tau) < 1 \) and \( a_t = \varepsilon_{A,t} \) is exogenous technology process (i.i.d.)

- Agent discounts tax rates in usual way
- How does agent discount tax news?
Tax news arrives $q$ periods before tax rates change

$$\hat{\tau}_t = \varepsilon_{\tau,t-q}$$

(generalizations examined later)
Tax news arrives $q$ periods before tax rates change

$$\hat{\tau}_t = \varepsilon_{\tau,t-q}$$

(generalizations examined later)

Agent’s information set at $t$ consists of variables dated $t$ and earlier, *including* exogenous shocks

$$\Omega_t = \{\varepsilon_{A,t-j}, \varepsilon_{\tau,t-j}\}_{j=0}^{\infty}$$
Various Degrees of Foresight

\( q = 0: \)

\[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} \]
Various Degrees of Foresight

$q = 0$:

\[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} \]

$q = 1$:

\[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} - (1 - \theta) \left( \frac{\tau}{1 - \tau} \right) \varepsilon_{\tau,t} \]
Various Degrees of Foresight

$q = 0$:

\[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} \]

$q = 1$:

\[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} - (1 - \theta) \left( \frac{\tau}{1 - \tau} \right) \varepsilon_{\tau,t} \]

$q = 2$:

\[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} - (1 - \theta) \left( \frac{\tau}{1 - \tau} \right) \left\{ \varepsilon_{\tau,t-1} + \theta \varepsilon_{\tau,t} \right\} \]

$q = 3$:

\[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} - (1 - \theta) \left( \frac{\tau}{1 - \tau} \right) \left\{ \varepsilon_{\tau,t-2} + \theta \varepsilon_{\tau,t-1} + \theta^2 \varepsilon_{\tau,t} \right\} \]
Econometrician’s Estimates: I

- Econometrician’s conditioning set: \( \{ k_{t-j}, a_{t-j} \}_{j=0}^{\infty} \)

- Need to find the econometrician’s information set: What is \( \{ k_{t-j} \}_{j=0}^{\infty} \equiv ??? \)
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- Wold representation for capital (dropping \( a_t \))

\[
(1 - \alpha L)k_t = -\kappa(L + \theta) \left[ \frac{1 + \theta L}{L + \theta} \right] \left[ \frac{L + \theta}{1 + \theta L} \right] \varepsilon_{\tau,t}
\]

\[
= -\kappa(1 + \theta L) \varepsilon_{\tau,t}^*
\]

\[
= -(1 - \theta) \left( \frac{\tau}{1 - \tau} \right) \left\{ \theta \varepsilon_{\tau,t-1}^* + \varepsilon_{\tau,t}^* \right\}
\]
Econometrician’s Discounting: I

- Econometrician recovers current and past $\varepsilon^*_\tau$ \textit{not} $\varepsilon_\tau$, which are “old news” to the agent.

$$\varepsilon^*_{\tau, t} = \theta \varepsilon_{\tau, t} + (1 - \theta^2) \varepsilon_{\tau, t-1} - \theta (1 - \theta^2) \varepsilon_{\tau, t-2} + \theta^2 (1 - \theta^2) \varepsilon_{\tau, t-3} + \cdots$$
Econometrician’s Discounting: I

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  $$\varepsilon^*_{\tau,t} = \theta \varepsilon_{\tau,t} + (1 - \theta^2) \varepsilon_{\tau,t-1} - \theta (1 - \theta^2) \varepsilon_{\tau,t-2} + \theta^2 (1 - \theta^2) \varepsilon_{\tau,t-3} + \cdots$$

- Econometrician discounts innovations incorrectly because information set lags agents’
  - econometrician: $k_t$ depends on $\theta \varepsilon^*_{\tau,t-1} + \varepsilon^*_{\tau,t}$
  - agents: $k_t$ depends on $\varepsilon_{\tau,t-1} + \theta \varepsilon_{\tau,t}$
Impulse Response Functions: I

True Response of $k$ to Higher Expected Taxes
Impulse Response Functions: I

Responses of $k$ to Higher Expected Taxes
Foresight is more pernicious than the simplest case suggests.

Make more plausible assumption that econometrician does not observe technology: \( \{ \hat{\tau}_t-k_j \}_{j=0}^\infty \)

Does \( \{ \hat{\tau}_t-k_j \}_{j=0}^\infty \equiv \{ \varepsilon_{\tau,t-j}, \varepsilon_{A,t-j} \}_{j=0}^\infty \)?
NO: Econometrician’s shocks convolute news agents’ receive

\[ \varepsilon_{\tau,t}^* = a_1\varepsilon_{\tau,t-2} - a_2\varepsilon_{\tau,t-1} + a_3\varepsilon_{A,t-2} + a_4\varepsilon_{A,t-1} \]

\[ \varepsilon_{A,t}^* = -a_4\varepsilon_{\tau,t-1} - a_3\varepsilon_{\tau,t} - a_2\varepsilon_{A,t-1} + a_1\varepsilon_{A,t} \]

\( a \)'s and \( b \)'s are complicated functions of \( \alpha, \beta \) and \( \tau \); by construction, \( \varepsilon_{\tau,t}^* \perp \varepsilon_{A,t}^* \)
NO: Econometrician’s shocks convolute news agents’ receive

\[ \varepsilon^*_\tau,t = a_1 \varepsilon_\tau,t-2 - a_2 \varepsilon_\tau,t-1 + a_3 \varepsilon_A,t-2 + a_4 \varepsilon_A,t-1 \]

\[ \varepsilon^*_A,t = -a_4 \varepsilon_\tau,t-1 - a_3 \varepsilon_\tau,t - a_2 \varepsilon_A,t-1 + a_1 \varepsilon_A,t \]

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Econometrician gets effects of both taxes and technology wrong

Conclude taxes don’t matter; everything driven by technology
Impulse Response Functions: II

True Response of $k$ to Higher Expected Taxes
Impulse Response Functions: II

Responses of $k$ to Higher Expected Taxes
Impulse Response Functions: III

▶ Have shown that depending on econometrician’s information set, may infer that higher expected taxes are contractionary (Mountford & Uhlig)

▶ are contractionary (Mountford & Uhlig)
Impulse Response Functions: III

- Have shown that depending on econometrician’s information set, may infer that higher expected taxes
  - are contractionary (Mountford & Uhlig)
  - have little effect (Poterba, Blanchard & Perotti, Romer & Romer)

- Now show may infer higher expected taxes are expansionary (Mertens & Ravn, House & Shapiro)

- Consider effects of variations in $\sigma_a/\sigma_\tau$ (relative volatility of technology and taxes)

- alters the signal-extraction problem econometrician faces

- as $\sigma_a/\sigma_\tau \rightarrow 0$, problem gets worse

- infer higher expected taxes are increasingly expansionary
Impulse Response Functions: III

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Responses of $k$ to Higher Expected Taxes

Impulse Response Functions: III
Impulse Response Functions: III

Responses of $k$ to Higher Expected Taxes
Impulse Response Functions: III

Falling $\sigma_a/\sigma_\tau$

Responses of $k$ to Higher Expected Taxes
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Responses of $k$ to Higher Expected Taxes
As vary econometrician’s information set

- by adding or subtracting data
- by changing signal-extraction problem

Can obtain *any* inference about effects of news about higher future taxes

Connects to findings in empirical literature
Anticipated Tax Hike: Contractionary
Anticipated Tax Hike: No Effect
Anticipated Tax Hike: Expansionary
Robustness

1. Do results from simple model carry over to more complex settings?
   - extend model specification—a “serious” model
   - generalize information flows

2. How do model elements alter the effects of foresight?
   - do various propagation mechanisms make econometric problem less severe?

3. How sensitive are results to alternative assumptions about information flows?
   - relax rigid assumptions above and in “news” literature
Jazzing Up Information Flows—Intuition

▶ Tax process

$$\hat{\tau}_t = \rho_1 \hat{\tau}_{t-1} + \cdots + \rho_n \hat{\tau}_{t-n} + \varepsilon_{\tau,t-2}$$

$$\alpha \beta (1 - \tau) < (1 + \rho_1)^{-1} \Rightarrow \text{nonfundamental}$$
Jazzing Up Information Flows—Intuition

- **Tax process**

  \[ \hat{\tau}_t = \rho_1 \hat{\tau}_{t-1} + \cdots + \rho_n \hat{\tau}_{t-n} + \varepsilon_{\tau,t-2} \]

  \[ \alpha \beta (1 - \tau) < (1 + \rho_1)^{-1} \Rightarrow \text{nonfundamental} \]

- **Tax process**

  \[ \hat{\tau}_t = \psi \varepsilon_{\tau,t-2} + (1 - \psi) \varepsilon_{\tau,t-1} \quad \psi \in (0, 1) \]

- **Capital Dynamics**

  \[ k_t = \alpha k_{t-1} + \varepsilon_{A,t} - \left( \frac{(1 - \theta) \tau}{1 - \tau} \right) \left\{ [1 - \psi (1 - \theta)] \varepsilon_{\tau,t} + \psi \varepsilon_{\tau,t-1} \right\} \]

- **If more recent news receives the heavier discount,**

  \[ 1 - \psi (1 - \theta) < \psi \], then the equilibrium will be nonfundamental
Quantitative Assessment in a Serious Model

- Use Smets-Wouters as laboratory
- Includes elastic labor supply, habit formation, variable capital utilization, investment adjustment costs, price and wage rigidities, capital and labor taxes
- Estimated with US data 1983:Q1 to 2008:Q1 using Bayesian methods
- 10 observables: $C, I, L, W, R, \pi, G, Z, T^K, T^L$
- Monetary policy: Taylor rule
- Fiscal policy: $\tau^K_t, \tau^L_t$ exogenous; $G, Z$ stabilize debt
- No foresight
- Quantify bias in inferences of tax effects if ignore foresight
Simulation Procedure

1. Use posterior modes of parameters from estimated model without foresight
   - modify tax rules to allow foresight

   \[ \tau^i_t = \rho_i \tau^i_{t-1} + \sum_{j=0}^{4} \psi_j \varepsilon_{i,t-j} \]

   with \( \sum_j \psi_j = 1 \) for \( i = K, L \)

   - \( \psi \)'s are weights that imply trajectories of expected tax rates
   - this constitutes “truth”
Simulation Procedure

2. Draw parameters for information flows—the $\psi$’s in

$\sum_j \psi_j \epsilon_{i,t-j}$

- process for flows

$$\psi_4 \sim 1 - \beta(1.5, 5); \quad \psi_1, \psi_2, \psi_3 \sim U[0, .15]$$

- $\psi_4$ is left skewed between 0 and 1 with mean of 0.77 and standard deviation of 0.15 following work on tax information flows by Yang (2008)

  - very conservative period of foresight
  - $\psi$’s reflect average degree of foresight
  - temporally correlated information flows “best case” for VAR

- need not imply nonfundamental representation
Simulation Procedure

3. Compute implied VAR with Kalman filter
   ▶ define state space so observer equation includes...
   ▶ ... 10 variables: \( Y, C, I, L, R, \pi, G, T^K, T^L, B \)
   ▶ employ correct recursive identification
   ▶ calculate dynamic multipliers for \( \tau^K \)
     ▶ obtain distribution for degree of foresight
     ▶ derive distribution for errors in inference
   ▶ only source of bias is foresight
Exercise moves beyond 0 – 1 treatment of nonfundamentalness

Ask if inference errors are quantitatively important
  - address this in model from class being used for policy analysis
  - includes typical frictions & rigidities
  - model fit to data in same way as policy models
Information Flows and Tax Multipliers

Bias in $K$-Tax Multipliers: VAR Estimates Relative to Truth
Information Flows and Tax Multipliers

Bias in $K$-Tax Multipliers: VAR Estimates Relative to Truth
Bias in $K$-Tax Multipliers: VAR Estimates Relative to Truth
Summary of Experiment

- Ignoring foresight in estimated VARs...
  - is quantitatively important in models used at policy institutions
  - affects predictions of how taxes affect all macro variables
  - errors can be large: > 100%
  - is not just a “short-run” problem
    - propagation mechanisms in DSGE model also propagate errors
  - (Needed refinement: restrict $\psi_i$ draws to produce smooth responses)
1. Use future data

- simple case: $\tau_t = \varepsilon_{t-2} \Rightarrow$ include $\tau_{t+2}$ in time $t$ VAR
- fine idea if...
  - taxes truly exogenous
  - information flows known
  - period of foresight known
Solutions: The Usual Suspects

1. Use future data
2. Expand the econometrician’s information set
   - add financial variables [Sims, Beaudry-Portier]
   - add revenue forecasts [Romer-Romer]
   - factor models
     - need strong identifying assumptions in all cases
     - confounds effort to extract economically meaningful shocks
   - expanding information set a good idea, but should not be done willy-nilly
Solutions: The Usual Suspects

1. Use future data
2. Expand the econometrician’s information set
3. Apply clever identification schemes
   - theory supports any response of economic activity to anticipated tax increase
   - there are two distinct identification problems
     - aligning information sets
     - extracting economic shocks
   - to do the second, must achieve the first
Solutions: The Usual Suspects

1. Use future data
2. Expand the econometrician’s information set
3. Apply clever identification schemes
4. Root flipping

- estimate VARMA & flip roots inside unit circle
- apply priors on which responses are “reasonable”
- root flipping aligns information sets
- sign restrictions extract shocks
- in principle a good idea
  - need to know information flows
  - need to know number of dimensions of news
Solutions: The Usual Suspects

1. Use future data
2. Expand the econometrician’s information set
3. Apply clever identification schemes
4. Root flipping
5. Estimate a DSGE model
   ▶ in principle a good idea & should work
      ▶ need to know information flows
      ▶ need to know number of dimensions of news
Promising Lines of Attack

- Model information flows
- Nature of information varies across types of news
  - technology news evolves very slowly—over decades
  - some fiscal news evolves slowly (demographics)
    other is higher frequency
- Use fresh data to learn about information flows
  - Ramey’s narrative work on $G$
  - Romer-Romer’s and Yang’s descriptive work on tax legislation
  - movements in muni-Treasury spreads
  - research on diffusion of technology
Promising Lines of Attack

- News often seems to arrive in clusters
  - “news” and “no-news” regimes
  - “news” regimes: 1990s about TFP; early 2000s about taxes; currently about spending
  - “no-news” regimes: by late 1990s settled into high-growth TFP; after 2003 no new tax legislation
  - most models seek quarterly news even if there isn’t any

- May help to separate the two identification problems

- Help to formulate priors over news flows—now treated dogmatically

- Lead to specifying DSGE models with news
Pessimism & Optimism

- **Pessimism**
  - identifying effects of news is difficult
  - no general solution
  - existing solutions are fragile

- **Optimism**
  - beginning to understand the nature of the problem
  - importance of modeling information flows
  - points in new directions & to new data sources
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Municipal Bond Market

- “Implicit tax rate”: investor at this tax rate is indifferent between tax-exempt bond and taxable bond
- $R_m = \text{return on muni}, \ R = \text{return on taxable bond with same credit risk and maturity. Implicit tax rate is } \tau_I = 1 - R_m/R$
Municipal Bond Market

- “Implicit tax rate”: investor at this tax rate is indifferent between tax-exempt bond and taxable bond
- $R_m =$ return on muni, $R =$ return on taxable bond with same credit risk and maturity. Implicit tax rate is $\tau_I = 1 - R_m/R$
- Fortune: “... implicit tax rate is a statistically significant predictor of personal income tax rates, and that the information content rose during the period of personal income tax rate variability of the 1980s.”
- Short end (less than 5 years) of yield curve accurate predictor of future tax events [Chalmers, Fortune, Poterba-Rueben]
Example: Exploiting Munis Data

- In VAR $\tau_I$ predicts marginal tax rate, average tax rates on capital & labor, tax revenues
- But $\tau_I$ innovations are not pure tax news—liquidity and other microstructure considerations
- Require identifying restrictions to isolate tax news from other variability
- Obtain estimates of macroeconomic impacts of tax news
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- But $\tau_I$ innovations are not pure tax news—liquidity and other microstructure considerations
- Require identifying restrictions to isolate tax news from other variability
- Obtain estimates of macroeconomic impacts of tax news
- Also extract two kinds of information from work with munis
  1. period of foresight
  2. moving-average weights on news
- Use this information to impose structure on information flows in DSGE models