Introduction

- Ronald Reagan (November 1979):
  
  "The key to restoring the health of the economy lies in cutting taxes"

- News about future taxes then arrived throughout 1980

- January 1981 Reagan took the Office

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- Tax reductions through 1984
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The process of changing taxes entails two kinds of lags:

1. **inside lag**: between when new tax law is initially proposed and when it is passed

2. **outside lag**: between when the legislation is signed into law and when it is implemented
This paper has three parts:

- How foresight and optimizing behavior create equilibria with non-fundamental MA representation?

- How much it matters in practice?

- How to deal with non-fundamental equilibria.
Consider the MA(1) model

\[ x_t = e_t - \theta e_{t-1}, \quad |\theta| < 1 \]

Second order procedures do not identify \( \theta \), since

\[ x_t = e^*_t - \frac{1}{\theta} e^*_{t-1} \]

with \( \text{Var}(e^*_t) = \theta^2 \text{Var}(e_t) \) leads to the same second order moments

\[ \text{Var}(x_t) = \text{Var}(e_t)(1 + \theta^2) \quad , \quad \rho = \frac{\theta}{1 + \theta^2} \]
Analytical Example: Standard Growth Model

- HH maximizes the expected log utility
  \[ E_0 \sum_{t=0}^{\infty} \beta^t \log(C_t) \]

- \[ C_t + K_t + T_t \leq (1 - \tau_t)A_tK_{t-1}^\alpha \]

- The Gov adjusts the lump-sum transfers s.t. \( T_t = \tau_t Y_t \)

- We also assume: \( G = 0, \delta = 1, \) Labor supplied inelastically.
Analytical Example: Standard Growth Model

The equilibrium conditions are given by:

\[ \frac{1}{C_t} = \alpha \beta E_t \left[ (1 - \theta_{t+1}) \frac{1}{C_{t+1}} \frac{Y_{t+1}}{K_t} \right] \]

\[ C_t + K_t = Y_t = A_t K_{t-1}^\alpha \]

Log linearize and solve to get a second-order difference equation:

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

where \( \theta = \alpha \beta (1 - \tau) < 1 \)
Analytical Example: Standard Growth Model

- Assuming i.i.d. technology shocks, the solution is:

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

- Assuming \( \hat{\tau}_t = \epsilon_{\tau,t-q} \), and solving for various degrees of fiscal foresight:

1. \( q=0 \) implies: \( k_t = \alpha k_{t-1} + \epsilon_{A,t} \)

2. \( q=1 \) implies: \( k_t = \alpha k_{t-1} + \epsilon_{A,t} - \kappa \epsilon_{\tau,t} \)

3. \( q=2 \) implies: \( k_t = \alpha k_{t-1} + \epsilon_{A,t} - \kappa \{ \epsilon_{\tau,t-1} + \theta \epsilon_{\tau,t} \} \)

4. \( q=3 \) implies: \( k_t = \alpha k_{t-1} + \epsilon_{A,t} - \kappa \{ \epsilon_{\tau,t-2} + \theta \epsilon_{\tau,t-1} + \theta^2 \epsilon_{\tau,t} \} \)
Analytical Example: Standard Growth Model

- Using lag operators we can write:

\[ (1 - \alpha L)k_t = -\kappa (L + \theta)\epsilon_{\tau,t} \]

- Fundamentalness requires the equilibrium process to be invertible in current and past \( k_t \Rightarrow |\theta| > 1 \)

- Unique saddle path solution requires \( |\theta| < 1 \)

- \( \{\epsilon_{\tau,t-j}\}_{j=0}^{\infty} \) is not fundamental for \( \{k_{t-j}\}_{j=0}^{\infty} \)
Analytical Example: Standard Growth Model

- The econometricians information set

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

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

\[
= -\kappa \{ \theta \epsilon_{\tau, t-1}^* + \epsilon_{\tau, t}^* \}
\]

where

\[
\epsilon_{\tau, t}^* = \left[ \frac{L + \theta}{1 + \theta L} \right] \epsilon_{\tau, t} = (L + \theta) \sum_{j=0}^{\infty} -\theta^j \epsilon_{\tau, t-j}
\]

\[
= \theta \epsilon_{\tau, t} + (1 - \theta^2) \epsilon_{\tau, t-1} - \theta(1 - \theta^2) \epsilon_{\tau, t-2} + \cdots
\]
(a) Response of $K$ with $q = 2$
Quantitative Importance of Foresight

- The information flows was chosen to be: \( \hat{\tau}_t = \epsilon_{\tau,t-q} \)

- These miss altogether the inside lags

- Generalize the information flows to a flexible one to capture both inside and outside lags:

\[
\hat{\tau}_t^L = \rho \hat{\tau}_{t-1}^L + \sum_{j=0}^{J} \phi_j [\sigma^L \epsilon_{\tau,t-j}^L + \xi \sigma^K \epsilon_{\tau,t-j}^K]
\]

\[
\hat{\tau}_t^K = \rho \hat{\tau}_{t-1}^K + \sum_{j=0}^{J} \phi_j [\sigma^K \epsilon_{\tau,t-j}^K + \xi \sigma^L \epsilon_{\tau,t-j}^L]
\]
Representative agent maximizes time-separable discounted utility over consumption and leisure.

The agent supplies labor and capital to a representative firm.

Cobb-Douglas technology.

The government budget constraint satisfies:

$$G_t + T_t = \tau_t^L w_t l_t + \tau_t^K r_t^K k_{t-1}$$
NK: Smets and Wouters (2007)

- Extends the RBC model to incorporate real and nominal rigidities.
- Adds external habit formation, differentiated labor types, a monopolistically competitive intermediate goods sector, variable capital utilization, wage and price rigidities, and a monetary authority that follows a Taylor-type rule for setting nominal interest rates.
- Government spending policies follow the process

\[ \hat{X}_t = \rho_X \hat{X}_{t-1} + \gamma_X \hat{s}_t^B + \sigma_X \epsilon_t^X \]

where \( \hat{s}_t^B = \frac{B_{t-1}}{Y_{t-1}} \).
Timeline of inside and outside lags reveal:

1. Foresight varies considerably from one tax legislation to the next.
2. Most tax changes entail substantial inside and outside lags.

Examine the implications of alternative information flows
### INFORMATION FLOW PROCESSES

<table>
<thead>
<tr>
<th>Process</th>
<th>Lags</th>
<th>Description</th>
<th>Coefficients</th>
</tr>
</thead>
</table>
| I       | Inside       | 6 qtrs, smooth news        | \( \phi_j = \frac{1}{6}, j = 1, 2, \ldots, 6 \)  
\( \phi_0 = \phi_7 = \phi_8 = 0 \) |
| II      | Inside       | 6 qtrs, concentrated news  | \( \phi_1 = \phi_2 = \phi_3 = 0.05, \phi_4 = 0.25 \)  
\( \phi_5 = \phi_6 = 0.3, \phi_0 = \phi_7 = \phi_8 = 0 \) |
| III     | Outside      | 8-qtr phase-in             | \( \phi_j = 0, j \neq 8 \)  
\( \phi_8 = 1 \) |
| IV      | Outside      | 2-qtr phase-in             | \( \phi_j = 0, j \neq 2 \)  
\( \phi_2 = 1 \) |
### Output Multipliers for a Labor Tax Change, Correlated with a Capital Tax Change

<table>
<thead>
<tr>
<th>Info Process</th>
<th>0 qtr</th>
<th>4 qtrs</th>
<th>8 qtrs</th>
<th>12 qtrs</th>
<th>20 qtrs</th>
<th>Peak (qtr)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Real Business Cycle Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Actual</td>
<td>0.19</td>
<td>−1.14</td>
<td>−1.48</td>
<td>−1.11</td>
<td>−0.65</td>
<td>−1.71 (6)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−0.31</td>
<td>−1.35</td>
<td>−1.27</td>
<td>−0.97</td>
<td>−0.59</td>
<td>−1.57 (5)</td>
</tr>
<tr>
<td>Bias</td>
<td>−0.50</td>
<td>−0.21</td>
<td>0.20</td>
<td>0.14</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>−263%</td>
<td>19%</td>
<td>14%</td>
<td>12%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>II Actual</td>
<td>0.15</td>
<td>−0.54</td>
<td>−1.40</td>
<td>−1.05</td>
<td>−0.61</td>
<td>−1.62 (6)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−0.56</td>
<td>−1.46</td>
<td>−1.19</td>
<td>−0.91</td>
<td>−0.55</td>
<td>−1.48 (2)</td>
</tr>
<tr>
<td>Bias</td>
<td>−0.71</td>
<td>−0.92</td>
<td>0.21</td>
<td>0.14</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>−473%</td>
<td>−169%</td>
<td>15%</td>
<td>13%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>III Actual</td>
<td>0.09</td>
<td>0.16</td>
<td>−1.51</td>
<td>−1.12</td>
<td>−0.64</td>
<td>−1.51 (8)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−1.44</td>
<td>−1.09</td>
<td>−0.82</td>
<td>−0.64</td>
<td>−0.39</td>
<td>−1.44 (0)</td>
</tr>
<tr>
<td>Bias</td>
<td>−1.54</td>
<td>−1.24</td>
<td>0.69</td>
<td>0.49</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>−1641%</td>
<td>−784%</td>
<td>46%</td>
<td>43%</td>
<td>39%</td>
<td></td>
</tr>
<tr>
<td>IV Actual</td>
<td>0.16</td>
<td>−1.34</td>
<td>−1.00</td>
<td>−0.76</td>
<td>−0.45</td>
<td>−1.56 (2)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−1.41</td>
<td>−1.06</td>
<td>−0.81</td>
<td>−0.62</td>
<td>−0.38</td>
<td>−1.41 (0)</td>
</tr>
<tr>
<td>Bias</td>
<td>−1.57</td>
<td>0.28</td>
<td>0.20</td>
<td>0.14</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>−962%</td>
<td>21%</td>
<td>20%</td>
<td>18%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td><strong>New Keynesian Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Actual</td>
<td>−0.08</td>
<td>−0.36</td>
<td>−0.48</td>
<td>−0.43</td>
<td>−0.24</td>
<td>−0.48 (8)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−0.07</td>
<td>−0.44</td>
<td>−0.57</td>
<td>−0.51</td>
<td>−0.28</td>
<td>−0.57 (8)</td>
</tr>
<tr>
<td>Bias</td>
<td>0.01</td>
<td>−0.09</td>
<td>−0.09</td>
<td>−0.08</td>
<td>−0.04</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>11%</td>
<td>−24%</td>
<td>−20%</td>
<td>−18%</td>
<td>−18%</td>
<td></td>
</tr>
<tr>
<td>II Actual</td>
<td>−0.06</td>
<td>−0.27</td>
<td>−0.43</td>
<td>−0.40</td>
<td>−0.23</td>
<td>−0.43 (9)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−0.09</td>
<td>−0.37</td>
<td>−0.42</td>
<td>−0.37</td>
<td>−0.19</td>
<td>−0.42 (7)</td>
</tr>
<tr>
<td>Bias</td>
<td>−0.03</td>
<td>−0.10</td>
<td>0.00</td>
<td>0.04</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>−51%</td>
<td>−37%</td>
<td>1%</td>
<td>9%</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>III Actual</td>
<td>−0.03</td>
<td>−0.12</td>
<td>−0.32</td>
<td>−0.37</td>
<td>−0.26</td>
<td>−0.37 (12)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−0.14</td>
<td>−0.10</td>
<td>−0.08</td>
<td>−0.06</td>
<td>−0.01</td>
<td>−0.14 (0)</td>
</tr>
<tr>
<td>Bias</td>
<td>−0.11</td>
<td>0.01</td>
<td>0.24</td>
<td>0.32</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>−340%</td>
<td>13%</td>
<td>76%</td>
<td>85%</td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>IV Actual</td>
<td>−0.06</td>
<td>−0.30</td>
<td>−0.33</td>
<td>−0.28</td>
<td>−0.14</td>
<td>−0.33 (7)</td>
</tr>
<tr>
<td>Estimated</td>
<td>−0.15</td>
<td>−0.24</td>
<td>−0.26</td>
<td>−0.22</td>
<td>−0.11</td>
<td>−0.26 (7)</td>
</tr>
<tr>
<td>Bias</td>
<td>−0.08</td>
<td>0.07</td>
<td>0.07</td>
<td>0.06</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>% bias</td>
<td>−128%</td>
<td>22%</td>
<td>22%</td>
<td>22%</td>
<td>25%</td>
<td></td>
</tr>
</tbody>
</table>
Solving the problem

- The Narrative Approach: Ramey (2012) augmented the VAR by news of military spending
- Conditioning on Asset Prices: If asset markets are efficient, asset prices should contain all available information
- Direct Estimation of DSGE Model: Specify the entire structure of the economy