ECONOMETRIC CHALLENGES FROM FISCAL POLICY RESEARCH

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**Empirical Work on Fiscal Policy**

- **VAR literature**: small models identified using
  - calibrated elasticities (Blanchard-Perotti)
  - sign restrictions (Mountford-Uhlig)
  - narrative approach (Ramey-Shapiro, Romer-Romer)
  - recursive structure (Caldara-Kamps)

- **Empirical results include**:  
  - dynamic responses to “fiscal experiments”
  - tax and spending multipliers
  - interpretations of history

- **DSGE literature**: scant but growing
What’s Missing From this Work?

1. No check that the VARs are invertible
   - ensures exogenous shocks recoverable from data
   - two sources: absence of debt & information flows
   - more likely to be a problem in small models
   - agents may intrinsically have more info than econometrician

2. No government budget constraint imposed
   - how do we know the “experiments” make sense?
   - two issues: accounting & economics
   - expansions in gov’t debt *must* be matched by higher expected present values of surpluses
   - *how* policies are expected to adjust determines effects of experiment
Invertibility issues previously noted
- Hansen-Sargent, Lippi-Reichlin
- Largely treated as cautionary note

Present value relations ubiquitous in DSGE models
- saddle-path conditions expressible as type of PV
- asset-pricing relations
- asset stocks imply PV’s

Non-invertibility wreaks havoc on PV relations

This talk: pull themes of invertibility and PV relations though discussion of “What Has Financed Government Debt?” (joint w/ Hess Chung)
**Objective**

I: Are small fiscal VARs invertible?
- Systematically expand information set
- Encompassing system includes variables in gov’t bc
- Typical estimated systems *not* invertible
- Expanding system changes results

II: Impose intertemporal GBC on identified VAR
- What is the PV funding of debt arising from shocks to taxes, spending, transfers?
- What are the roles of surpluses and discount rates?
- Over what horizon do we need to look to see present-value balance?
SIMPLE EXAMPLE OF NON-INVERTIBILITY

- The economic model

\[ b_t = rb_{t-1} + s_t, \quad r > 1 \]
\[ s_t = \gamma b_{t-1} + e_t, \quad |r - \gamma| < 1 \]
\[ b_t = \sum_{j=1}^{\infty} r^{-j} E_t s_{t+j}, \quad \text{PV constraint} \]

- The econometrician at \( t \) observes \( \{s_j\}, j \leq t \) uses

\[ s_t = (r - \gamma) s_{t-1} + h_t, \quad h_t \equiv e_t - re_{t-1} \]
\[ e_t = \sum_{j=1}^{\infty} r^{-j} h_{t+j} \]
Simple Example of Non-Invertibility

- Impossible to recover $e_T$ from $\{h_j\}, j \leq T$
- $\tilde{e}_t \equiv \sum_{j=0}^{\infty} r^{-j}(e_{t-j} - re_{t-j-1})$ a Wold innovation for $h_t$
- $\tilde{e}_t$ does not satisfy PV relation
- PV relation implies $(E_t - E_{t-1}) \sum_{j=0}^{\infty} r^{-j}s_{t+j} = 0$
- Project onto history of $\{s_t\}$ with operator $E_t^{(S)}$

$$(E_t^{(S)} - E_{t-1}^{(S)}) \sum_{j=0}^{\infty} r^{-j}s_{t+j} = \tilde{e}_t \frac{(r/\gamma)(1 - r^{-2})}{r - \gamma} \neq 0$$

- Non-invertible: fails to satisfy PV constraint
Testing if VARs are Invertibility

- $f_t$: encompassing model ("economic agents")
- Project onto smaller info set w/ matrix $P$
- $f_t P$: projection model ("econometrician")
- Test Villaverde-Ramirez-Sargent-Watson condition
- Report how fiscal impacts vary w/ info set
- Smaller models—like those in the literature—fail test for invertibility
**Identifying Fiscal VARs**

- Reduced form: \( f_t = B_0 + f_{t-1}B + u_t \)
- Structural form: \( f_tA_0 = \bar{A} + f_{t-1}A + \epsilon_tJ \)
  - \( J \): block diagonal w/ fiscal shocks in one block
- Follow Blanchard-Perotti: calibrate automatic feedback elasticities
- Example: tax innovation
  \[
  u_t(T) = u_t(Y)A_{Y,T} + u_t(\pi)A_{\pi,T} + \epsilon_t(T) + \epsilon_t(G)J_{G,T} + \epsilon_t(Z)J_{Z,T}
  \]
- Calibrate \( A_{I,J} \)'s
- Fiscal block recursive: \( G, T, Z \)
Invertibility Matters

Taxes & transfers separate
Add investment

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**Theory**

**Empirics**

**Non-Invertibility II**

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**Invertibility Matters**

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**Empirical Challenges From Fiscal Policy Research**

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Add government debt

**Invertibility Matters**

### Theory

#### Empirics

#### Econometric Challenges from Fiscal Policy Research
How Serious is the Non-Invertibility?

- If projected system not invertible
  - Shocks of encompassing model, $\epsilon_t$, depend on past & future shocks of projected model, $\epsilon_t^P$
  - Can compute coefficients in
    \[
    \epsilon_t = \sum_{j=1}^{\infty} \epsilon_{t+j}^P q_j + \phi_t
    \]
    $\phi_t$: info at $t$ & earlier
  - If $q$’s sizeable
    - Econometrician’s info set lags agents’ info set
    - A problem for id’n. schemes that rely on timing restrictions
HOW SERIOUS IS THE NON-INVERTIBILITY?
Lags from proposal to implementation of fiscal changes (Shu-Chun Yang, *EL*: for taxes $\approx 9$ months)

- Economic agents read newspapers
- Continuously updating beliefs about future policy
  - Candidate Bush II: ran on tax cuts
  - 9/11: portended persistently higher $G$
- Yang, *JME*, examines this in an RBC model
  - Foresight: not invertible for reasonable parameters
  - Drastically alters inferences about tax effects: underestimated or wrong-signed elasticities
- Cannot deal with this in standard id. VAR
- May need all the structure of DSGE model
EMPIRICAL MODEL: LINEARIZATION

- Budget identity

\[
\sum_{j=1}^{\infty} (B_t(j) - B_{t-1}(j+1))Q_t(j) = B_{t-1}(1) - S_t
\]

- With \(V_t\) the nominal market value of debt, in real terms

\[
\frac{V_t}{P_t} = \frac{1}{P_t} \sum_{j=1}^{\infty} B_t(j)Q_t(j) = \frac{P_{t-1}}{P_t Q_{t-1}(1)} \frac{V_{t-1}}{P_{t-1}} - \frac{S_t}{P_t} + \omega_t
\]

\[
\omega_t \equiv \frac{1}{P_t} \sum_{j=1}^{\infty} \left( Q_t(j) - \frac{Q_{t-1}(j+1)}{Q_{t-1}(1)} \right) B_{t-1}(j+1)
\]
Impose Euler equation to get bond prices
Impose transversality condition
Obtain linearized intertemporal GBC

\[ \hat{v}_t = k + E_t \sum_{j=1}^{\infty} \beta^j \frac{s}{\nu} \left( \frac{-\hat{R}_{t+j-1} + \hat{\pi}_{t+j}}{1 - \beta} + \hat{s}_{t+j} \right) \]
CONSTRANING THE VAR

With the VAR

\[ f_t = B_0 + f_{t-1}B + u_t \]

Let \( \hat{x}_t = f_tC_x \); gbc implies the restrictions

\[ \beta B \left( C_v + \frac{1}{\beta} C_\pi + \frac{\tau}{v} C_\tau - \frac{g}{v} C_G - \frac{z}{v} C_z \right) - (C_v + C_R) = 0 \]

and an expression restricting deterministic growth terms, which we do not impose

Also need to impose that \( \beta B \) does not have explosive eigenvalues
Unconstrained VAR with Debt

What the GBC Does
Constrained VAR with Debt

WHAT THE GBC DOES

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ECONOMETRIC CHALLENGES FROM FISCAL POLICY RESEARCH
### What Finances Fiscal Policy Shocks: Surplus v. Discount Rate?

<table>
<thead>
<tr>
<th>Shock to</th>
<th>Std Dev</th>
<th>$\Delta B$</th>
<th>$S$</th>
<th>$R$</th>
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<tr>
<td>Taxes</td>
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<td>-.2365</td>
<td>-.1296</td>
<td>-.0835</td>
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<tr>
<td>Spending</td>
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<td>.0375</td>
<td>-.1462</td>
<td>.1701</td>
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<tr>
<td>Transfers</td>
<td>.0056</td>
<td>.0035</td>
<td>.1028</td>
<td>-.1187</td>
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</tbody>
</table>

**Table:** Present-Value Funding Decomposition.
## Decomposing the Present-Value of Surpluses

<table>
<thead>
<tr>
<th>Shock to</th>
<th>$\Delta B$</th>
<th>$T$</th>
<th>$G$</th>
<th>$Z$</th>
</tr>
</thead>
<tbody>
<tr>
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<td>.4260</td>
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<td>-1.6848</td>
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<tr>
<td>Transfers</td>
<td>.0035</td>
<td>-.1976</td>
<td>.1891</td>
<td>.1114</td>
</tr>
</tbody>
</table>

**Table:** Policy Block Present-Value Funding Decomposition.
Changes in debt due to taxes
Changes in debt due to taxes or spending

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Present-Value Funding Horizons

Changes in debt due to taxes, spending, or transfers
WHAT FINANCED THE 1975.2 TAX CUT?
SURPLUS v. DISCOUNT RATE
What Financed the 1975.2 Tax Cut?

Surplus Components

Present-Value Funding

- PV Taxes
- PV Transfers
- PV Spending
- PV R
- 5x Debt

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WHAT WILL FINANCE THE LAST SEVEN YEARS OF FISCAL POLICY SHOCKS?

**Image Description:**
- The image contains a graph with the title "Present-Value Funding".
- The x-axis represents the years 2000 to 2006.
- The y-axis ranges from -0.02 to 0.02.
- The graph plots four series: PV Surplus, PV Discount Rate, and Debt.
- The graph shows fluctuating values for each of these series over the years.

**Table Data:**
- PV Surplus
- PV Discount Rate
- Debt

**Graph Key:**
- Red line represents PV Surplus.
- Blue line represents PV Discount Rate.
- Black line represents Debt.

**Text at the Bottom:**
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- Econometric Challenges From Fiscal Policy Research
It depends on the shock:
- For tax cuts, mostly future taxes
- For transfers, mostly future transfers
- For spending, large role for discount rate changes

Powerful interactions among fiscal variables

Present-value balance can take a long time: a few decades (taxes) to almost a century (expenditures)

Small VAR fiscal systems likely not invertible
Econometric Challenges

- Understanding fiscal policy requires estimating long-run relations
- PV calculations sensitive to modeling of long-run dynamics
- Are VAR estimates of long-run expectations reliable?
- Need identification schemes that are robust to invertibility problems
- May need to estimate DSGE model: which one???