Fiscal and Monetary Policy in Australia: an SVAR Model

Mardi Dungey and Renée Fry

University of Tasmania, CFAP University of Cambridge, CAMA Australian National University

September 2010
Challenges of modelling fiscal policy in a VAR

- Identification problem
  - because \( g \) and \( tax \) are highly correlated its is difficult for VARs to distinguish these empirically

- Dynamics of govt expenditure and tax shocks

- Extracting automatic versus pure shocks
  - Mountford and Uhlig (2009)
  - Kirchner et al (2010)

- The role of debt

- Mixed nature of data: non-stationary and stationary
  - temporary and permanent shocks
Solutions proposed for identifying fiscal policy

Ordering using institutional timing

Sign restrictions

TVP-VAR
  - Kirchner et al (2010)

Our approach - combine (Dungey and Fry 2009):
  - traditional restrictions - Dungey and Pagan (2009)
  - sign restrictions
  - long run restrictions - Pagan and Pesaran (2009)
Timely issue in the Australian economy

- Australian fiscal stimulus of $42 billion (about 4% of annual GDP)
- did it prevent a recession?
- has it been too stimulatory?

Existing SVAR model to form the framework

- Dungey and Pagan (2000, 2009)
- detailed 11 variable model of the Australian economy
- + govt expenditure, govt revenue, debt/GDP

Fiscal policy models
A quick primer on the Australian economy

An almost unprecedented period of expansion from 1992-2010.

contributing conditions:

- productivity boost in 1990s
- increased wage flexibility
- low inflation
- improved terms of trade
- financial market deregulation and expansion

some consequences

- housing price boom
- fiscal consolidation
- Floating exchange rate since December 1983
- Inflation targeter since 1992ish
latest estimates have net debt/GDP about 8%

source: DiMarco, Piri and Yeung (2009) Australian Treasury
Identification of the benchmark model
  - traditional restrictions
  - sign restrictions
  - temporary and permanent shocks

Data

Empirical results
  - Impulse response functions

Some serious problems
  - research directions

Conclusions
Writing the SVAR

Take account of potential mixed $I(1)$ and $I(0)$ variables with cointegrating relationships

$$B(L)Y_t = \varepsilon_t, \quad (1)$$

VECM form:

$$\Psi(L)\Delta Y_t = -\Pi Y_{t-1} + e_t, \quad (2)$$

Say $k$ variables, $n$ are $I(1)$ with $r < n$ cointegrating vectors then $\Pi = \alpha'\beta$ is of reduced rank

Common trends representation:

$$\Delta Y_t = F(L)e_t = F(L)(B_0)^{-1}\varepsilon_t, \quad (3)$$

and $F(1) = F = \beta_\perp [\alpha_\perp \Psi(L)\beta_\perp] \alpha_\perp^{-1}$,
Permanent and Temporary Shocks

If the first \((n - r)\) shocks are permanent then

\[
\Delta Y_t = F(L)(B_0)^{-1} \begin{pmatrix} \varepsilon_{1jt} \\ \varepsilon_{2jt} \end{pmatrix},
\]

for the shocks in \(\varepsilon_{2jt}\), to be transitory requires

\[
FB_0^{-1} \begin{pmatrix} 0_{(n-r) \times r} \\ I_{r+k} \end{pmatrix} = 0,
\]

equivalently \(\alpha_1\) the coefficient on the permanent shocks must equal zero.
Sign restrictions

- Residuals
  \[ \nu_t = B_0^{-1}\epsilon_t \]  
  \[ \text{(4)} \]

- Define \( \hat{S} \) as having the estimated standard deviations of the structural residuals on the diagonal
  \[ \hat{\nu}_t = \hat{B}_0^{-1}\hat{S}\hat{S}^{-1}\hat{\epsilon}_t \]
  \[= \hat{T}\hat{\eta}_t \]
  \[ \text{(5)} \]
  \[ \text{(6)} \]

- Impact matrix \( \hat{T} \)
- Estimated shocks \( \hat{\eta}_t \)
- Define a rotation matrix: \( Q \) such that \( Q'Q = QQ' = I \)

\[ \hat{e}_t = TQ'Q\eta_t \]
\[= T^*\eta_t^*. \]
\[ \text{(7)} \]
\[ \text{(8)} \]

- rotations are orthogonal but produce alternative impulse responses
Choose between rotations

- Use criteria on sign restrictions to choose rotations which are acceptable

\[ \text{variable/shock} \quad absorption_t \quad GDP_t \]

- tax: \( \tau_t \) -
- govt expenditure: \( g_t \) +

- not enough….multiple shocks problem
  - can have both shocks in a rotation look like a, say, tax shock. Then we need to sort them out.
  - If one set of impulses contains both \( g \) and tax shock
    - second set has say only \( g \) shock
    - then assume first set refers to a tax shock
  - Here never the case that both sets contain both shocks
    - Dungey and Fry 2009 use relative sizes to sort this out.
Impulse responses

- In the sign restrictions
  - Choose the median but retain orthogonality (Fry and Pagan, 2007)
  - standardize impulses
  - group into $\phi^d$
  - minimize $\phi^d \phi^d$
  - the corresponding $Q^d$ matrix is used to calculate impulses
- This ensures that impulses from the same model are selected
- In a purely orthogonal system also ensures the system remains orthogonal
Data

- Standard for most variables, interesting ones are G, T and debt/GDP, data compiled for us by Australian Treasury.

- associated problems:
  - data frequency: move from annual to quarterly
  - changing basis of accounts
  - adjustments for large expenditures associated with defense or large projects
  - seasonal adjustment and lack of compatibility between component series

- Government expenditure: Consumption + Expenditure
- Government taxation revenue: Tax - transfers
- Debt/GDP ratio: annual ABS data interpolated using the Chow-Lin (1971) using the IFS series for first part of the sample and OECD data for rest.
## Selection of variables

<table>
<thead>
<tr>
<th></th>
<th>Data properties</th>
<th>Cointegrating vectors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exogenous</strong></td>
<td></td>
<td>1 2 3</td>
</tr>
<tr>
<td>US GDP</td>
<td>/ (1)</td>
<td>*</td>
</tr>
<tr>
<td>Terms of trade</td>
<td>/ (0)</td>
<td></td>
</tr>
<tr>
<td>Real US interest rate</td>
<td>/ (0)</td>
<td></td>
</tr>
<tr>
<td>US Q ratio</td>
<td>/ (0)</td>
<td></td>
</tr>
<tr>
<td>Exports</td>
<td>/ (1)</td>
<td>*</td>
</tr>
<tr>
<td><strong>Endogenous</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government Taxation Revenue</td>
<td>/ (1)</td>
<td>* *</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>/ (1)</td>
<td>* *</td>
</tr>
<tr>
<td>Absorption (GNE)</td>
<td>/ (0)</td>
<td>*</td>
</tr>
<tr>
<td>Debt to GDP ratio</td>
<td>/ (0)</td>
<td></td>
</tr>
<tr>
<td>GDP</td>
<td>/ (1)</td>
<td>* *</td>
</tr>
<tr>
<td>Inflation</td>
<td>/ (0)</td>
<td></td>
</tr>
<tr>
<td>Cash rate</td>
<td>/ (0)</td>
<td></td>
</tr>
<tr>
<td>Real Exchange Rate</td>
<td>/ (1)</td>
<td>*</td>
</tr>
</tbody>
</table>
## Restrictions on Australian variables

### Dependent variables

<table>
<thead>
<tr>
<th></th>
<th>tax</th>
<th>g</th>
<th>abs</th>
<th>q</th>
<th>debt</th>
<th>gdp</th>
<th>inf</th>
<th>short</th>
<th>twi</th>
</tr>
</thead>
<tbody>
<tr>
<td>tax</td>
<td>+●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
<td>●●</td>
</tr>
<tr>
<td>g</td>
<td>●</td>
<td>+●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>q</td>
<td>●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>abs</td>
<td>−●</td>
<td>+●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>debt</td>
<td>●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>gdp</td>
<td>●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>inf</td>
<td>●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>short</td>
<td>●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>twi</td>
<td>●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●●</td>
</tr>
<tr>
<td>exogenous</td>
<td>tot</td>
<td>y*, tot</td>
<td>rus, q*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>y*, xpts</td>
<td>tot</td>
<td>y*, i*</td>
<td>px/m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+, − sign; ○ contemporaneous; ● lags (p = 3 in levels)
Testing suggests the following properties of the data

<table>
<thead>
<tr>
<th>Non-stationary</th>
<th>Stationary</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y^*$, xpts</td>
<td>$tot, (r^* - \pi^<em>), q^</em>$,</td>
</tr>
<tr>
<td>$g, tax, gdp, abs, twi$</td>
<td>$q, debt, \pi, r$</td>
</tr>
</tbody>
</table>

Cointegration tests

\[
\{y^*, xpts, g, tax, y\} \quad (9)
\]
\[
\{y, abs, twi\} \quad (10)
\]

Impose for fiscal sustainability

\[
\{g, t\} = [1 - a] \quad (11)
\]
Amongst the 7 nonstationary variables (\(y^*, xpt, g, tax, gdp, abs, twi\))

- 3 cointegrating relationships
- implies 3 temporary shocks and 4 permanent ones

Choose the permanent shocks

- the external sector is permanent: \(y^*, xpt\)
- 2 domestic shocks need to be permanent
  - \(abs\) permanent - domestic preferences shock
  - \(gdp\) permanent - domestic technology shock
  - if either of \(g\) or \(tax\) is temporary, then the other needs be temporary or the fiscal sustainability condition will be violated \(\Rightarrow\) \(g\) and \(tax\) are temporary
  - not \(twi\)
Summary of data properties

7 non stationary variables
   4 permanent shocks  $y^*, xpt, abs, gdp$
   3 temporary shocks  $g, t, twi$

7 stationary variables
   4 temporary shocks  $tot, q^*, (r^* - \pi^*)$
   $q, debt, \pi, short$
This shows a 1se shock to government expenditure

- temporary shock
- results in increased revenue collection
- initial increase in debt/GDP
- subsequent pay down of debt
Government Expenditure Shock

- $g$ shock results in increased GDP and GNE (this is the sign restriction)
  - cash rate rises and inflation falls
  - domestic currency appreciates
  - consistent with $g$ increase being investment rather than consumption expenditure
This shows a 1se shock to net taxation revenue

- temporary shock so there are no long run effects
- fall in absorption (this is the sign restriction)
- gdp falls then rises (also seen in Dungey and Fry for NZ)
- debt to GDP is reduced
This shows a 1se shock to net taxation revenue:
- decreased debt, increased GDP
- reduced government expenditure through automatic stabilisers
- improved investment confidence
- higher interest rates and higher inflation, not higher real interest rates
  so depreciation of the currency
Monetary Policy shock

- 100bp cash shock
  - decreases GNE and GDP
  - initial inflation response a bit uncertain
  - price puzzle problem after 18 months.....
Interacting responses:

- cash shock slows the economy so reduces taxation revenue
- but reduction in tax < reduction in GDP, so debt/GDP falls
- fall in government expenditure also, this is not clear?
Interacting responses:

(b) g shock on g

(a) g shock on t

(h) g shock on cash

(k) t shock on g

(j) t shock on t

(q) t shock on cash

(t) cash shock on g

(s) cash shock on t

(z) cash shock on cash
Problems

- Already have monetary policy shocks not behaving quite as we thought
  - and differ from source model (Dungey and Pagan 2009)
    - adding $g$, $tax$, $debt$?
    - additional cointegrating relationship
    - making absorption a permanent rather than transitory shock

- Problems in sign restrictions literature (Fry and Pagan 2010)
  - we don't know $\varepsilon_t$ for the shocks identified with sign restrictions
  - thus no confidence intervals can be bootstrapped
  - no variance decompositions and historical decompositions
  - thus far no breakdowns of contributions by various policy shocks
Next steps

- Attempt to identify some bounds on $\varepsilon_t$ for the sign restriction identified shocks
- Sort out why monetary policy shocks are behaving so differently to baseline model
- THEN
  - project model into the crisis period
  - examine the deviation of the projected model from observed data during the crisis
  - allow us to examine the contribution of the $g$ and cash shocks to the better than anticipated $y$ outcomes in the crisis period
Contributions of the Paper

- **Technical Contributions**
  - Combination of identification methods to include fiscal and monetary policy in a SVAR for Australia
  - Mixed I(0) and I(1) data
  - Identification of permanent and temporary shocks
Contributions of the Paper

• Analytical Contributions
  
  • So far to find direction of monetary, government expenditure and government revenue shocks on output and inflation
  
  • Aim to be able to find contribution of these shocks to observed outcomes
  
  • Aim to project into the crisis period to find the contributions of policy shocks to the better than anticipated outcomes.