Fiscal and Monetary Policy in Australia: an SVAR Model

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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
  - Blanchard and Perotti (2002) and Perotti (2002)
  - Mountford and Uhlig (2009)
  - Kirchner et al (2010)
- The role of debt
  - Chung and Leeper (2007), Favero and Giavazzi (2007)
- Mixed nature of data: non-stationary and stationary
  - temporary and permanent shocks

Solutions proposed for identifying fiscal policy

- Ordering using institutional timing
  - Blanchard and Perotti (2002), Perotti (2002)
- Sign restrictions
  - Canova and de Nicoló (2002), Uhlig (2005), Peersman (2005)
- 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)

Modelling Australia

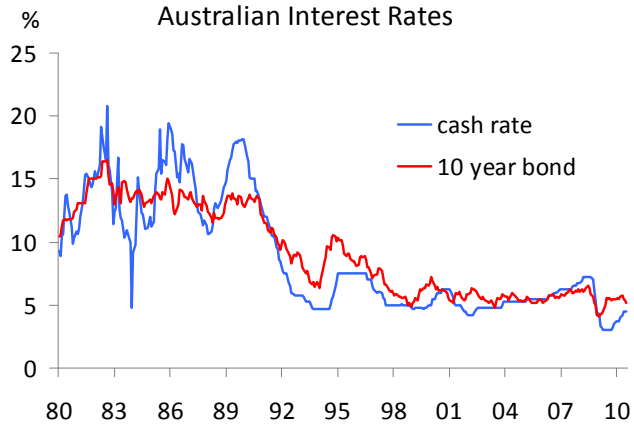
- Timely issue in the Australian economy
  - Australian fiscal stimulus of $42 billion (about 4% of annual GDP)
  - did it prevent a recession?
  - has it been too stimulatory?
- Existing SVAR model to form the framework
  - Dungey and Pagan (2000, 2009)
  - detailed 11 variable model of the Australian economy
  - + govt expenditure, govt revenue, debt/GDP
- Fiscal policy models

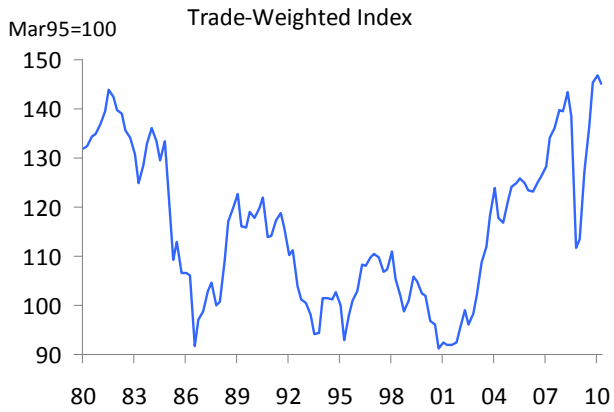
A quick primer on the Australian economy

- 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

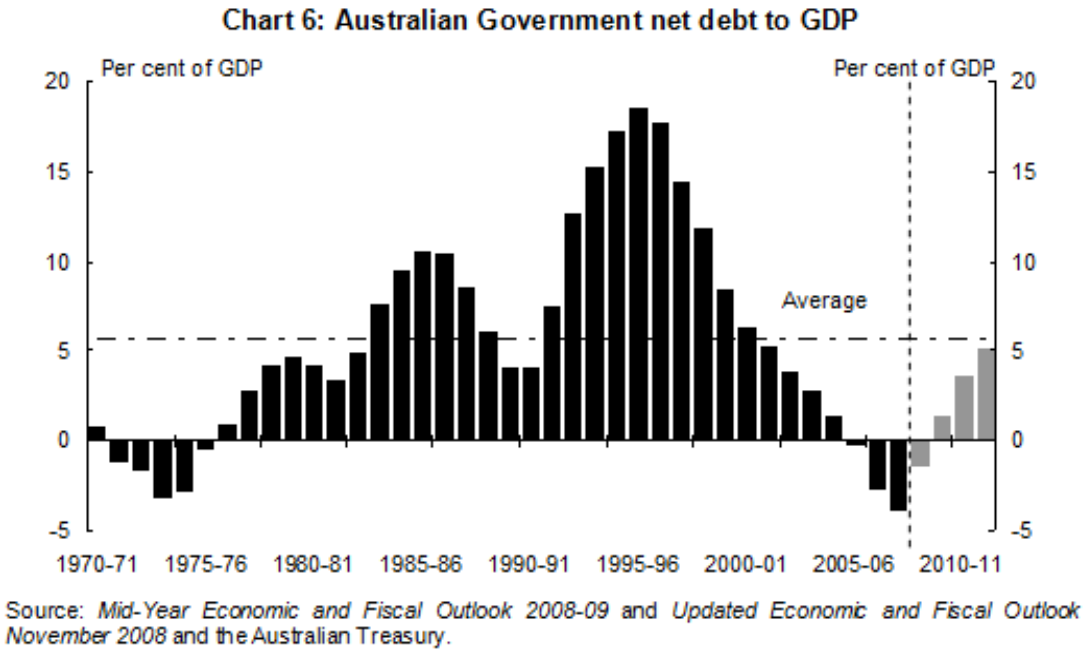
Monetary Policy

- floating exchange rate since December 1983
- inflation targeter since 1992ish





Fiscal Policy



Source: *Mid-Year Economic and Fiscal Outlook 2008-09* and *Updated Economic and Fiscal Outlook November 2008* and the Australian Treasury.

- latest estimates have net debt/GDP about 8%

source: DiMarco, Piri and Yeung (2009) Australian Treasury

Outline

- 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

$$B(L)Y_t = \varepsilon_t, \tag{1}$$

VECM form:

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

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

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

and $F(1) = F = \beta_\perp \left[\alpha'_\perp \Psi\left(L\right)\beta_\perp\right]\alpha_\perp^{-1}$,

Permanent and Temporary Shocks

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

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

for the shocks in ε_{2jt}, to be transitory requires

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

equivalently α_1 the coefficient on the permanent shocks must equal zero.

Sign restrictions

- Residuals

$$v_t = B_0^{-1}\varepsilon_t \tag{4}$$

- Define $\widehat{S}$ as having the estimated standard deviations of the structural residuals on the diagonal

$$\begin{aligned} \widehat{v}_t &= \widehat{B}_0^{-1}\widehat{S}\widehat{S}^{-1}\widehat{\varepsilon}_t & (5)\\ &= \widehat{T}\widehat{\eta}_t & (6) \end{aligned}$$

- Impact matrix $\widehat{T}$
- Estimated shocks $\widehat{\eta}_t$
- Define a rotation matrix: Q such that $Q^{'}Q = QQ^{'} = I$

$$\begin{aligned} \widehat{e}_t &= TQ'Q\eta_t & (7)\\ &= T^*\eta_t^*. & (8) \end{aligned}$$

- rotations are orthogonal but produce alternative impulse responses

Choose between rotations

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

variable / shock		$absorption_t$	GDP_t
tax:	τ_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 ϕ^d
  - minimize $\phi^{d\prime}\phi^d$
  - 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
- D*ebt/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

	data properties		cointegrating vectors		
Exogenous			1	2	3
US GDP		$I(1)$	*		
Terms of trade	$I(0)$				
Real US interest rate	$I(0)$				
US Q ratio	$I(0)$				
Exports		$I(1)$	*		
Endogenous					
Government Taxation Revenue		$I(1)$	*		*
Government Expenditure		$I(1)$	*		*
Absorption (GNE)	$I(0)$			*	
Debt to GDP ratio	$I(0)$				
GDP		$I(1)$	*	*	
Inflation	$I(0)$				
Cash rate	$I(0)$				
Real Exchange Rate		$I(1)$		*	

Restrictions on Australian variables

	Dependent variables								
	tax	g	abs	q	debt	gdp	inf	short	twi
tax	$+\bullet$	$\bullet$	$\bullet\circ$		$\circ\bullet$	$\bullet$			$\bullet\circ$
g	$\bullet$	$+\bullet$	$\bullet\circ$		$\circ\bullet$	$\bullet$			$\bullet\circ$
q	$\bullet$	$\bullet$	$\bullet\circ$	$\bullet\circ$	$\circ\bullet$	$\bullet\circ$			
abs	$-\bullet$	$+\bullet$	$\bullet\circ$	$\bullet$		$\bullet\circ$	$\bullet\circ$	$\bullet\circ$	$\bullet\circ$
debt	$\bullet$	$\bullet$			$\bullet\circ$	$\bullet\circ$			$\bullet\circ$
gdp	$\bullet$	$\bullet$	$\bullet$	$\bullet$	$\circ\bullet$	$\bullet\circ$			$\bullet\circ$
inf	$\bullet$	$\bullet$	$\bullet$	$\bullet$		$\bullet$	$\bullet\circ$	$\bullet\circ$	$\bullet\circ$
short	$\bullet$	$\bullet$	$\bullet$	$\bullet$		$\bullet$		$\bullet\circ$	$\bullet\circ$
twi	$\bullet$	$\bullet$	$\bullet$	$\bullet$		$\bullet$	$\bullet$	$\bullet$	$\bullet\circ$
exogenous			*tot*	y^*, *tot*		y^*, *xpts*	*tot*		y^*, i^*
				rus, q^*		*tot*			*px* / *m*

$+, -$ sign; $\circ$ contemporaneous; $\bullet$ lags ($p = 3$ in levels)

Properties of the data

Nonstationarity and Cointegration

- Testing suggests the following properties of the data

Non-stationary	Stationary
$y^*, xpts$	$tot, (r^* - \pi^*), q^*,$
g, tax, gdp, abs, twi	$q, debt, \pi, r$

- Cointegration tests

$$\{y^*, xpts, g, tax, y\} \tag{9}$$

$$\{y, abs, twi\} \tag{10}$$

- Impose for fiscal sustainability

$$\{g, t\} = [1 - a] \tag{11}$$

Transitory and Permanent Shocks

- 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

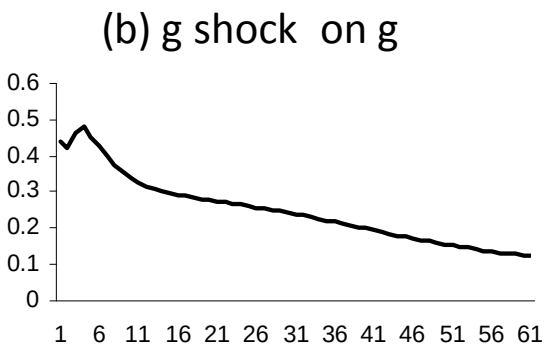
7 non stationary variables

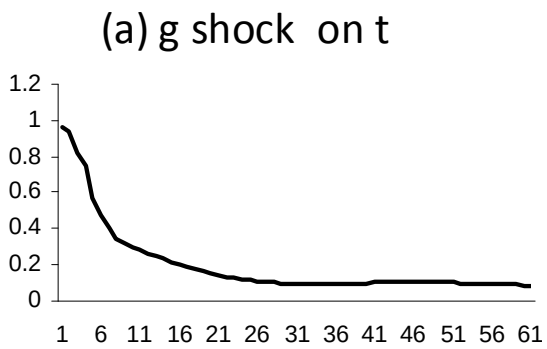
4 permanent shocks	y^*, xpt, abs, gdp
3 temporary shocks	g, t, twi

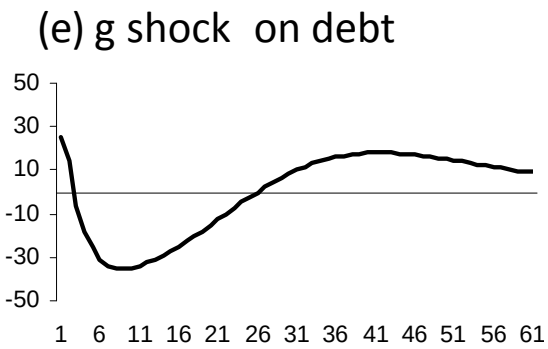
7 stationary variables

4 temporary shocks	$tot, q^*, (r^* - \pi^*)$
	$q, debt, \pi, short$

Government Expenditure Shock



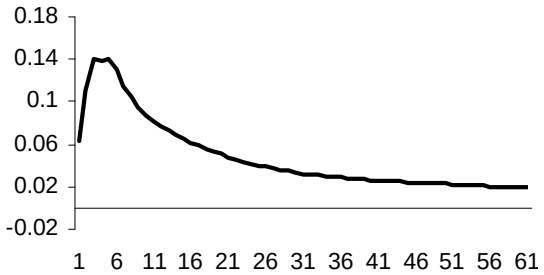




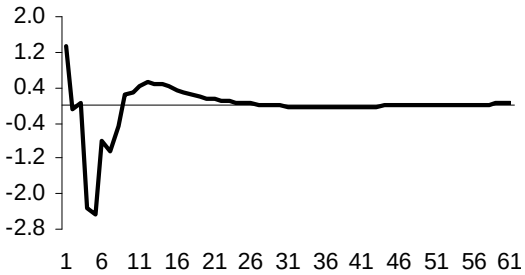
- This shows a 1se shock to government expenditure
  - temporary shock
  - results in increased revenue collection
  - initial increase in debt/GDP
  - subsequent pay down of debt

Government Expenditure Shock

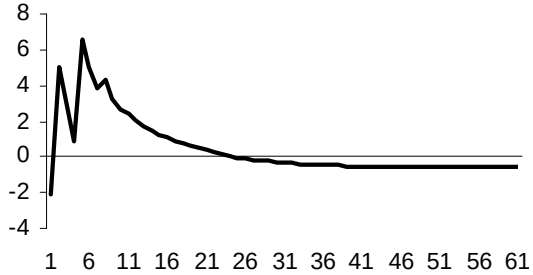
(f) g shock on gdp



(g) g shock on inf

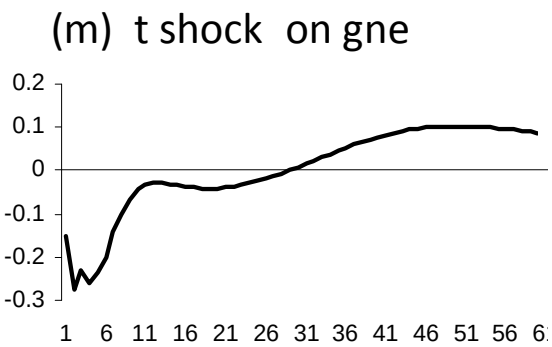


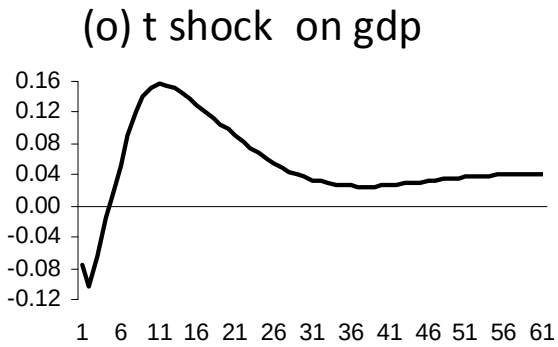
(h) g shock on cash

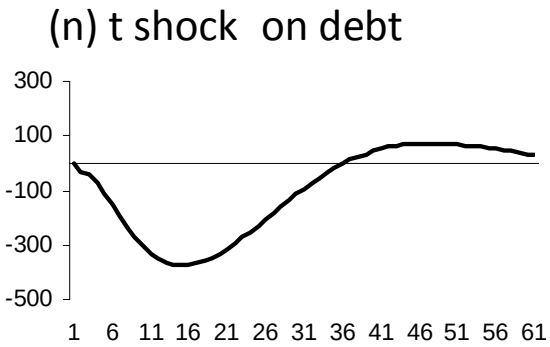


- g shock results in increased GDP and GNE (this is the sign restriction)
  - cash rate rises and inflation falls
  - domestic currency appreciates
  - consistent with g increase being investment rather than consumption expenditure

Taxation Shock

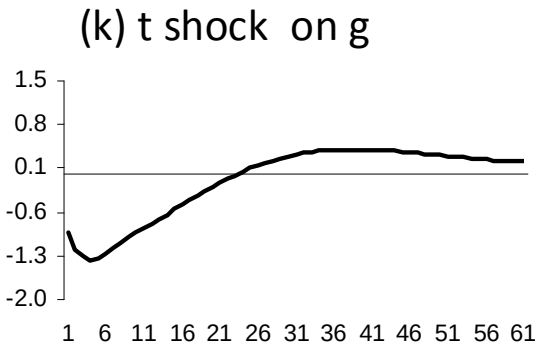


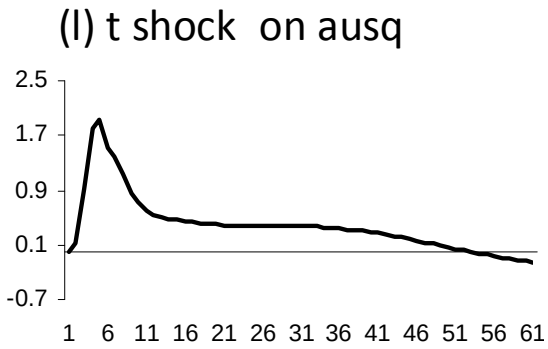


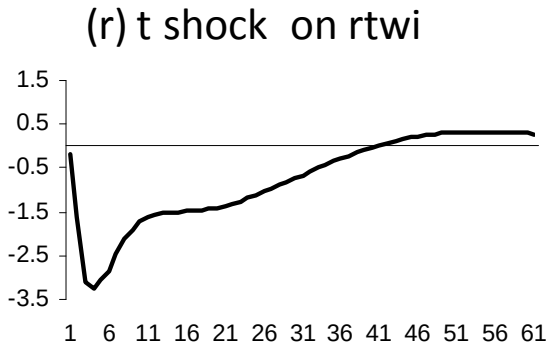


- This shows a 1se shock to net taxation revenue
  - temporary shock so there are no long run effects
  - fall in absorption (this is the sign restriction)
  - gdp falls then rises (also seen in Dungey and Fry for NZ)
  - debt to GDP is reduced

Taxation Shock



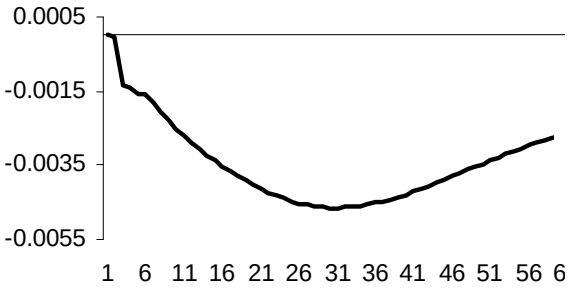




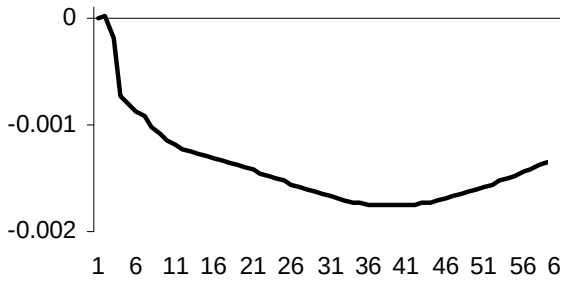
- This shows a 1se shock to net taxation revenue
  - decreased debt, increased GDP
  - reduced government expenditure through automatic stabilisers
  - improved investment confidence
  - higher interest rates and higher inflation, not higher real interest rates so depreciation of the currency

Monetary Policy shock

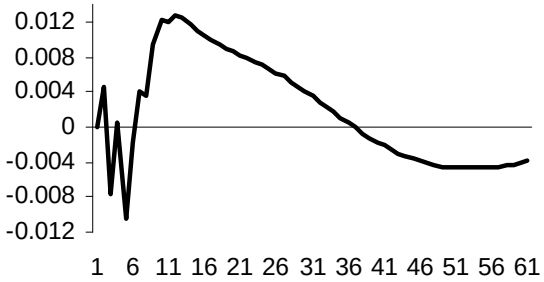
(v) cash shock on gne



(x) cash shock on gdp



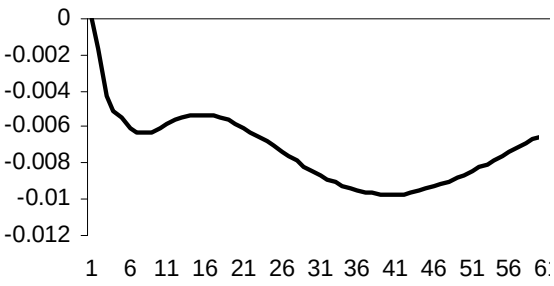
(y) cash shock on inf



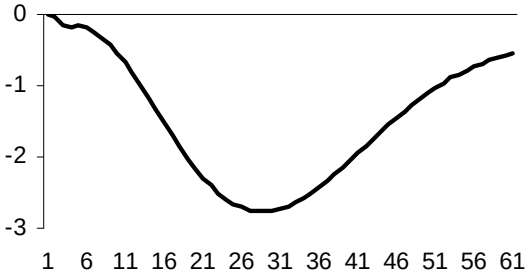
- 100bp cash shock
  - decreases GNE and GDP
  - initial inflation response a bit uncertain
  - price puzzle problem after 18 months.....

Interacting responses:

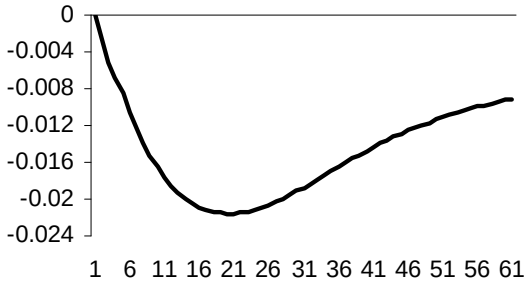
(s) cash shock on t



(w) cash shock on debt



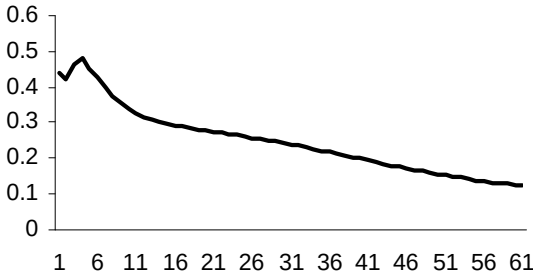
(t) cash shock on g



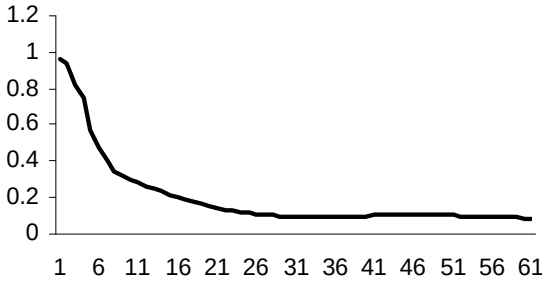
-
  - cash shock slows the economy so reduces taxation revenue
  - but reduction in tax $<$ reduction in GDP, so debt/GDP falls
  - fall in government expenditure also, this is not clear?

Interacting responses:

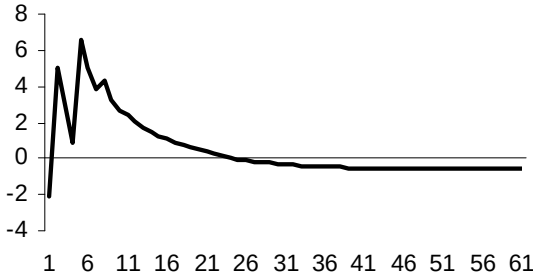
(b) g shock on g



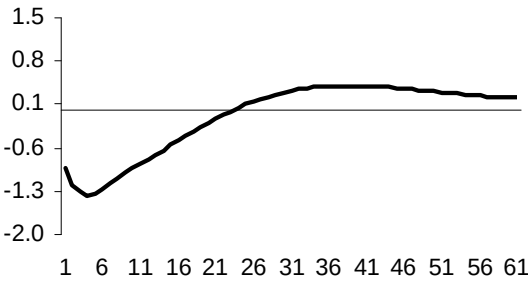
(a) g shock on t



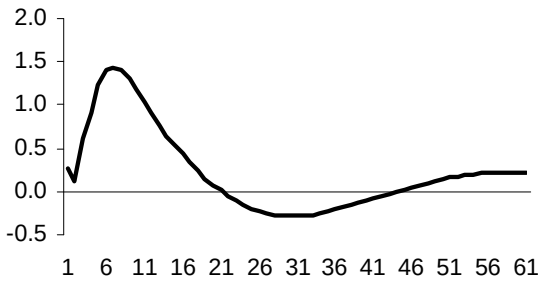
(h) g shock on cash



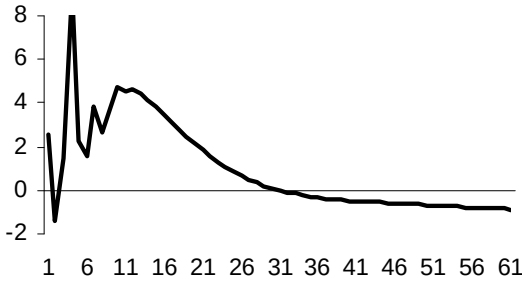
(k) t shock on g



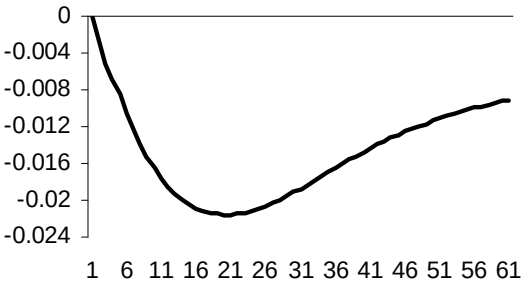
(j) t shock on t



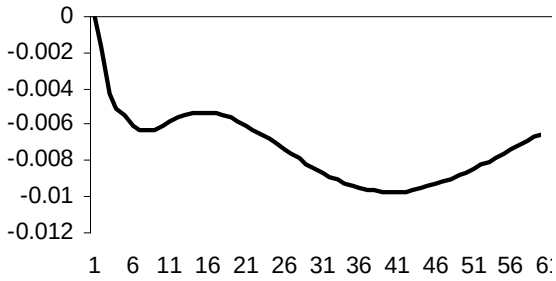
(q) t shock on cash



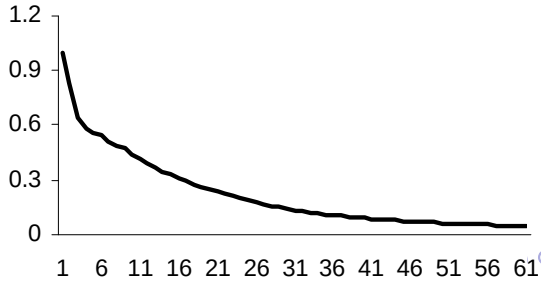
(t) cash shock on g



(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 dont know ε_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 ε_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
  - Inclusion of long term relationships: Pagan and Pesaran (2007)
  - 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.