Economic Modelling 26 (2009) 1147–1160

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

The identification of fiscal and monetary policy in a structural VAR[☆]

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ARTICLE INFO

Article history:
Accepted 5 May 2009

JEL classification:
E62
E63
C32
C50

Keywords:
Identification
Fiscal policy
Monetary policy
SVAR
Permanent and transitory shocks
Sign restrictions

ABSTRACT

Good economic management depends on understanding shocks from monetary policy, fiscal policy and other sources affecting the economy and their subsequent interactions. This paper presents a new methodology to disentangle such shocks in a structural VAR framework. The method combines identification via sign restrictions, cointegration and traditional exclusion restrictions within a system which explicitly models stationary and non-stationary variables and accounts for both permanent and temporary shocks. The usefulness of the approach is demonstrated on a small open economy where policy makers are actively considering the interaction between monetary and fiscal policies.

1. Introduction

For any country, effective economic management depends on understanding the nature of shocks hitting the economy and their subsequent economic interactions. In particular, interactions of monetary policy shocks with fiscal policy and other variables, fiscal policy shocks with monetary policy and other variables, and macroeconomic shocks with both fiscal and monetary policy are of importance for policy makers. This paper contributes a new methodology for disentangling these effects empirically in a structural vector autoregression framework (SVAR).

Empirical macroeconomic modelling is often undertaken in a SVAR, where identification of policy shocks usually occurs in one of three ways.[1] The first is through traditional normalisation and restrictions on the contemporaneous relationships between variables. This is widely applied to monetary policy (for a review see Bagliano and Favero, 1998) and only recently to fiscal policy using institutional detail and calibrated elasticities as identification tools (Blanchard and Perotti, 2002; Perotti, 2002; Chung and Leeper, 2007; Favero and Giavazzi, 2007). The second is the newer sign restriction identification method which imposes restrictions on the set of impulse responses to shocks considered acceptable from the possible choice of orthogonal systems (Faust, 1998; Canova and de Nicoló, 2002; Mountford and Uhlig, 2008). The third approach is to take account of the longer run properties of the model, in one form as a vector error correction model (VECM), or as an extension of Blanchard and Quah (1989), or in the recognition of the correspondence between SVARs and VECMs, see Jacobs and Wallis (2007), which allows the use of cointegrating relationships as a tool of identification as in Pagan and Pesaran (2008).

Here the approach is to build a model containing fiscal, monetary and other macroeconomic variables drawing on elements of these three

☆ For useful comments and discussions we are grateful to Muge Adalet, Hilde Bjørnland, Bob Buckle, John Carran, Lance Fisher, Viv Hall, Jørn Halvorsen, Ólan Henry, Jan Jacobs, Junsang Lee, Michael McKenzie, Adrian Pagan, Rodney Strachan, Christie Smith, and two anonymous referees, and to Nathan McLellan, Michael Ryan and Robert St Clair for assistance with data collation and Tugrul Vehbi for research assistance. The authors acknowledge support from the New Zealand Treasury and ARC Discovery Grant DP0664024. The views, opinions, findings and conclusions or recommendations expressed in the paper are strictly those of the author(s), do not necessarily represent and should not be reported as those of the New Zealand Treasury.

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[1] In some circumstances VAR methods are inappropriate. Sometimes models cannot be written as a finite order VAR in the first place or are unable to be recovered, or suffer from small sample problems; see Lippi and Reichlin (1994); Cooley and Dwyer (1995); Faust and Leeper (1997); Canova and Pina (2005); Fry and Pagan (2005); Chari et al (2008); Fernandez-Villaverde et al (2007); and Leeper et al. (2008) amongst others for discussion.

0264-9993/$ – see front matter
doi:10.1016/j.econmod.2009.05.001

identification methods. Short-run restrictions on the non-fiscal variables are provided via the existing traditional SVAR restrictions. The fiscal policy shocks are identified using a minimal set of sign restrictions, leaving other relationships to be data determined.[2] These restrictions are applied in conjunction with information from the cointegrating relationships between the macroeconomic variables to model the long run, allowing for both permanent and transitory components and a mixture of stationary and non-stationary variables. The current paper is the first to combine these three techniques and allows us to make a more structured analysis while still adhering to the VAR tradition of letting the data determine the dynamics in the economy, particularly for the less commonly modelled fiscal policy shocks.

The study of fiscal policy shocks and policy interactions in SVAR models is relatively limited but has largely built on the Blanchard and Perotti (2002) fiscal policy framework: for example Perotti (2002) for a range of OECD countries. More recently, Chung and Leeper (2007) and Favero and Giavazzi (2007) build on Blanchard and Perotti and show the importance of accounting for the level of government debt. Mountford and Uhlig (2008) use the Blanchard and Perotti fiscal variables but an alternative sign restriction based identification scheme. Canova and Pappa (2007) also utilise the sign restriction method for examining fiscal policy in a monetary union. The latter papers all focus on the US.[3]

The application in this paper is to the small open economy of New Zealand, one of the few countries which has coherent fiscal data available for modelling.[4] New Zealand was the first country to adopt inflation targeting, in 1990, and consequently has the longest available time series for a small open economy in an inflation targeting environment. It also adopted a Fiscal Responsibility Act in 1994. Further, policy attention in New Zealand is currently focussed on the interactions between fiscal and monetary policy (Finance and Expenditure Committee, 2008). There is a well-established SVAR modelling framework for New Zealand, which has resolved many non-fiscal related model specification issues, and this is drawn on for the short-run restrictions for the non-fiscal variables; see particularly Buckle et al. (2007) and references therein.

The rest of this paper proceeds as follows. Section 2 presents a coherent VAR framework in which three types of identification restrictions are simultaneously applied and illustrates how to obtain impulse response functions and historical decompositions under this structure. Section 3 outlines the variables and data properties for the New Zealand example, characterising the stationarity and cointegration results necessary to apply the modelling framework. The specification of the model is described in Section 4 and the results are presented in Section 5 in terms of impulse response functions and historical decompositions. Section 6 concludes.

2. The empirical methodology

This section shows how to nest three identification methods in a SVAR. These are specifically, the traditional short-run restrictions, sign restrictions and long run restrictions. Both permanent and transitory shocks are identified following Pagan and Pesaran (2008).

Consider a standard VAR(p) where the data y_t are expressed in levels,

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

where $B(L)=B_0-B_1L-B_2L^2-\ldots-B_pL^p$. Usually identification proceeds through restrictions on the B_0 and $\Omega=E(\varepsilon_t\varepsilon_t')$ matrices or in the case of Blanchard and Quah (1989), restrictions on long run impact effects. Sign restrictions provide a further alternative. Defining $\hat{S}$ as containing the estimated standard deviations of the structural residuals along the diagonal with zeros elsewhere, the relationship between the estimated reduced form and structural errors is

$$\begin{aligned}\hat{e}_t &= \hat{B}_0^{-1}\ \hat{S}\ \hat{S}^{-1}\hat{\varepsilon}_t \\ &= T\eta_t,\end{aligned} \tag{2}$$

where $\hat{B}_0^{-1}$ is the inverse of the estimated matrix of contemporaneous coefficients, T is designated an impact matrix, and η_t are the estimated shocks with unit variances. The original shocks can be redefined as a function of an orthonormal matrix Q, in this paper the Given's rotation matrix, which by definition has the properties $Q'Q=QQ'=I$ such that

$$\hat{e}_t = TQ'Q\eta_t \tag{3}$$

$$= T^*\eta_t^*. \tag{4}$$

The new set of estimated shocks η_t^* also has the property that their covariance matrix is I since $E\ (\eta_t^*\eta_t^{*\prime})=QE\ (\eta_t\eta_t')\ Q'=I$. Thus there is a combination of shocks η_t^* that has the same covariance matrix as η_t but which will have a different impact upon y_t through their impulse responses. The initial arbitrary shocks are rotated to produce an alternative set of shocks while maintaining the desirable property that the shocks remain orthogonal. The choice of Q is determined by examination of the signs of the impulse response functions. Defining $B_0^*=(T^*S^{-1})^{-1}$, and $B_i^*=B_i$ for all $i\neq 0$; the VAR(p) can be rewritten as

$$B^*(L)y_t = \varepsilon_t, \tag{5}$$

where $B^*(L)=B_0^*-B_1^*L-B_2^*L^2-\ldots-B_p^*L^p$.

The VAR(p) expressed in either Eq. (1) or (5) depending on whether sign restrictions are imposed, can be written in a corresponding reduced form in differences as follows (for convenience the notation assumes the imposition of sign restrictions, but to remove them simply impose $B^*(L)=B(L)$):

$$\Psi(L)\Delta y_t = -\Pi y_{t-1} + e_t, \tag{6}$$

where $e_t=B_0^{*-1}\varepsilon_t$ and $\Psi(L)=(I_n-\Psi_1-\Psi_2-\ldots\Psi_{p-1})$ with Ψ_j being the appropriate transformation of the structural parameters.[5] In the case where all variables in y_t are $I(1)$ and there are $r<n$ cointegrating relationships between them, the matrix Π will be rank deficient and in the usual notation $\Pi=\alpha'\beta$ where α and β are of full rank.[6]

The inclusion of $I(0)$ variables in y_t is relatively straightforward by simply recognising that the k $I(0)$ variables are treated in exactly the

[2] Leeper, Walker and Yang (2008) suggest that non-fiscal policy shocks are not well identified by sign restrictions.

[3] Canova and Pappa (2007) also apply their model to Europe.

[4] Common problems with time series of fiscal data are moves from accrual to cash accounts within recent sample periods, lack of seasonally adjusted data, insufficient frequency of data (many series are available only on an annual basis), adjustments for large defense expenditure items, consistent debt data and compatibility of component series – see Blanchard and Perotti (2002) for their approach to the US data.

[5] For example, in the case of a VAR(3) in levels the appropriate transformations are $\Pi=(B_0{}^*)^{-1}(B_0{}^*-B_1^*-B_2^*+B_3^*)$, $\Psi_1=(B_0^*)^{-1}(B_3^*-B_2^*)$ and $\Psi_2=-(B_0^*)^{-1}B_3^*$.

[6] Greater orders of integration are prevented via the assumption that the eigenvalues of $(B_0^*)^{-1}\ B_i^*$ exist for all i, and lie inside the unit circle.