Dynamic Budgetary Adjustments in the Australian State Government Finance Sector: An Econometric Approach

Vincent C. Blackburn, Richard Gerlach and Vasilis Sarafidis*

This paper seeks to add to the literature on State and local government fiscal policy adjustment and shock adjustment modeling in an inter-temporal context, with a focus on Australian Fiscal Federation Arrangements. Vector Error Correction Models are estimated using aggregated state and local “Government Finance Statistics” data from 1961-2005 to examine, compare and contrast dynamic budgetary adjustments and fiscal policy in the Australian federation of states. Findings include clear similarities in fiscal policy regarding expenditure when: (i) tax revenues; (ii) net debt receipts; and (iii) grant revenues are increasing, across states. Further, clear differences among the states are found in (i) debt servicing and taxation changes as grant revenue increases; (ii) tax regimes in response to increasing net debt receipts; and (iii) debt servicing and taxation policy in times of increasing expenditure. Overall, the states have mostly been marginally unaffected by interest or unemployment rate changes over the period examined. Our results illustrate that the states’ limited fiscal elbow room has not stopped them developing contrasting fiscal policies or stopped specific state issues affecting fiscal adjustments at a local level.

Keywords: dynamic budgetary adjustment, intertemporal budget constraint, government finance, VAR, VECM

JEL classification: H70, H72

1 Introduction

Contemporary studies of State and local government fiscal policy adjustment in an
inter-temporal context are commonplace in US, Canadian, Scandinavian and European Union settings. This literature has rarely reported any Australian empirical studies, although a limited number (for example, Blackburn, 1979 and 1980) have addressed the problem within a structural equation setting. One aim of this paper is to re-address this imbalance for Australia, by initially focusing on rigorous non-structural Vector Error Correction modelling (VECM) in order to analyse public budgetary adjustment behavior. The insights from this method are important because they provide an alternative viewpoint to the stream of theory-based structural studies.1 Existing budget adjustment studies range from those examining risk sharing in federations (Sorensen and Yosha, 1998), shock adjustment analytics (Poterba, 1994), event studies (Darby et al., 2005) and studies focusing mainly on EU fiscal consolidation issues (von Hagen and Harden, 1995); VECMs have also been used to examine US State and local government fiscal restrictions on government growth (Buettner and Wildasin, 2006).

In contemporary federations, the composition of prevailing fiscal structures represent a challenge to fiscal discipline. Most federal government systems prefer to decentralise public budgetary responsibilities and typically there is a continual need to control spending, design and evaluate grant allocations (by taking account of equity and efficiency considerations), as well as restraining the size of sub-federal deficits. This concern about potential excessive state or local government spending and deficits has motivated the empirical literature on fiscal adjustment patterns. Roubini and Sachs (1989) set in train a series of studies that determine how economic and political institutions can account for differences in patterns of public sector spending and deficit behaviour across OECD countries. The particular issues relating to fiscal federalism contexts have been most commonly addressed in econometric analyses of the fiscal performance of the US States and Canadian provinces. Key contributors have been Alt and Lowry (1994), Bayoumi and Eichengreen (1995), Bohn (1991), Bohn and Inman (1996), Holtz-Eakin (1998) and Sorensen et al. (2001). These studies generally conclude that restrictions may be helpful to secure fiscal discipline at the sub-national level, but that the design of the restrictions and the agreed framework of fiscal institutions are important. Indeed, related literature on “soft budget constraints” has recently emerged and deals with

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1The comparative outcome of these rival methodologies however will be investigated in future work.
the consequences of inter-governmental fiscal laxity (Vigneault, 2005).

This paper presents an econometric investigation of the fiscal adjustments in State and local governments, aggregated to the State level, in the Australian federation. Perhaps more than in any other federation, the Australian Commonwealth government arranges the financing of the State/local sector governments, such that they have limited local discretion or fiscal elbow room (refer to Figures A1 and A2 in Appendix A). In other words, the Australian federation has one of the highest percentages of vertical fiscal imbalance, i.e. all the elastic and growing revenue sources are under the control of the Commonwealth and the most costly domestic spending programs are undertaken at the State/local level. Australia fits into the pattern described by von Hagen and Eichengreen (1996) as having a high level of fiscal restrictions. Economic shocks are basically handled by Commonwealth government fiscal policy, and revenues for State and local governments are smoothed out via grants.\(^2\) The Commonwealth government is intimately concerned about the distribution of grants between State and local governments in each State, as well as the mix between grants and taxes. State/local taxes usually change when economic cycles change and the distribution of GST and income tax revenues becomes more important in States avoiding deficits. Shock adjustment modelling is clearly not well developed in an inter-temporal context in the Australian federation and is accordingly the focus of this paper. Several rival methodologies are available from the literature. The early contribution of Gramlich (1978, 1991) in the US, adapted by Blackburn (1979) to Australia with a Generalised Adjustment Model (GAM) dynamic set up of the Brainard-Tobin type (1968), applies a simple model based on a community preference function including private consumption, State/local public consumption, capital asset provision and stocks of balances. Given the State/local Government budget constraint, demand functions for State/local current expenditures, capital expenditures, taxes and stocks

\(^2\)Since 2000, Commonwealth General Purpose grants have been sourced from the Goods and Services Tax (GST) and other Specific Purpose grants from Commonwealth personal income taxes. The GST, which replaced the Commonwealth wholesale sales tax, was introduced in July 2000 as a growth tax for the States and is collected at a uniform rate (10%) across Australia by the Commonwealth Government. Its proceeds are distributed to the States according to highly complex equalisation principles by the Commonwealth Grants Commission. The Commonwealth Government and each State and Territory have control over the tax rates and tax base coverage of the GST. Personal income tax revenue decisions with regards to changes in the tax base and rates are at the sole discretion of the Commonwealth government, something that dates back to 1942 - a year that States conceded control of Personal Income taxes as a war time emergency measure.
of balances are derived (details in Blackburn, 1979). This budget constraint, in a modelling sense, implies that state and local fiscal decisions are made subject to the condition that the sum of all expenditures (including the increase in financial assets), must equal the sum of all reserves (including the increase in financial liabilities), all measured on a National Accounts basis. More recently, Buettner and Wildasin (2006), following Bohn (1991), analyse impulse - response functions (IRFs) within a panel VECM framework using a data set of more than 1,000 US local governments. Rather than emphasise the sustainability of sub-federal fiscal policies, Buettner and Wildasin focus on the adjustment process that maintains fiscal balance.

This paper uses a VECM approach in order to investigate the dynamics of the combined State/local government policy making separately in each of the six States in Australia from 1961/62 to 2004/05. The models examine the possible paths of fiscal adjustment at the sub-national level in response to fiscal imbalances due to innovations in grants, spending or net debt receipts. This is achieved through the use of IRFs, after adjusting for various known interventions in the data, for example, the inception date of GST revenue for the States. Section 2 describes the data, models and methods involved; Section 3 presents the resulting analyses, while Section 4 concludes.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Components (GFS categories)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Own Revenue ( R_t )</td>
<td>Total Taxes, Total General Charges Total Miscellaneous General Revenue excluding Interest Revenue.</td>
</tr>
<tr>
<td>(ii) Commonwealth Grants ( Z_t )</td>
<td>Grants form Commonwealth Government.</td>
</tr>
<tr>
<td>(iii) Net Debt Receipts ( NDR_t )</td>
<td>Interest Revenue net of Total Interest Payments on General Government Debt.</td>
</tr>
<tr>
<td>(iv) General Government Expenditure ( G_t )</td>
<td>Total General Expenditure including Commonwealth grants expenditures and excluding Interest on General Government Debt.</td>
</tr>
<tr>
<td>(v) General Debt ( D_t )</td>
<td>(iv)-(i)-(ii)-(iii)</td>
</tr>
</tbody>
</table>
2 Methodology

2.1 Preliminary data analysis

The empirical analysis in this paper employs annual data for each of the six Australian States from the Australian Bureau of Statistics (ABS) “Government Finance Statistics” (GFS) data set for the period 1961/62 to 2004/05. This annual data covers the Operating Statement of State and local governments in each Australian State jurisdiction and is contained in the electronic version of the ABS Government Finance Statistics, Cat No. 5512.0.

The dataset comprises four fiscal variables, which are constructed from the ABS GFS data set. There are three revenue variables, Own-source Revenues, which includes tax revenues, general charges and miscellaneous revenues (excluding interest revenues), Commonwealth Grants, defined as grants received from the Commonwealth government and finally Net Debt Receipts, which is defined as interest receipts net of debt-service expenditure. There is also a variable on the expenditure side, General Government Expenditure. Table 2 presents some descriptive statistics with fiscal variables scaled in terms of population size while deflated by the GDP deflator. The mean value of real per-capita Own Revenues across the six States is about AUD2,477.\(^3\) The variation of the variable is rather small, ranging between a minimum value of AUD2,319 for South Australia and a maximum of AUD2,615 for New South Wales (NSW). The mean value of Commonwealth Grants is about AUD1,801. In this case, however, there is large variation among States with a standard deviation of about AUD376. As expected, the state with the maximum value of grant receipts is Tasmania (Tas.), with a yearly average value of about AUD2,452, while Victoria (Vic.) and New South Wales receive the least portions - about AUD1,443 and AUD1,460 respectively.

Net Debt Receipts have a mean value of about AUD-206 (indicating debt payments) and a standard deviation equal to AUD70 approximately. The maximum value of Net Debt Receipts in the sample is still negative and corresponds to

\(^{3}\)Mean values refer to the average across states of the yearly average within each state. Similarly, the standard deviation is computed from the yearly averages, therefore it is based on six figures.
Queensland (Qld), while the state with the highest interest payments burden is Victoria. General Expenditure averages to about AUD4,161 with a standard deviation of about AUD275. The smallest per capita Expenditure occurs in the state of New South Wales and the largest one in Tasmania. The mean value of the residual difference between the first four components (denoted as general government deficit) is positive, indicating that on average the States run a deficit. However, there is a significant variation in the sample between a deficit of as much as AUD340 per capita (Victoria) and a surplus of about AUD66 (Tasmania). The fiscal variables show modest mean values of annual growth in Own Revenues and Expenditure, without, however, substantial variation across them.

The bottom of table 2 reports some population statistics, with the average population size being around 2,500,000, (1961/62-2004/05 yearly average) which, however, ranges from 432,000 for Tasmania to 5,412,000 for New South Wales.

<table>
<thead>
<tr>
<th>Fiscal Variables</th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own Revenues</td>
<td>2,477.191</td>
<td>102.096</td>
<td>2,318.758</td>
<td>2,615.059</td>
</tr>
<tr>
<td>Commonwealth Grants</td>
<td>1,801.054</td>
<td>376.426</td>
<td>1,443.287</td>
<td>2,451.975</td>
</tr>
<tr>
<td>Net Debt Receipts</td>
<td>-205.789</td>
<td>70.338</td>
<td>-311.174</td>
<td>-118.018</td>
</tr>
<tr>
<td>General Expenditure</td>
<td>4,161.407</td>
<td>274.461</td>
<td>3,891.463</td>
<td>4,581.314</td>
</tr>
<tr>
<td>General Deficit</td>
<td>88.951</td>
<td>161.504</td>
<td>-65.767</td>
<td>340.172</td>
</tr>
</tbody>
</table>


Figure 1a shows time series plots for these variables for State and local governments combined for NSW, Vic., Qld and Tas. The plot for Western Australia
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(WA) is similar to that for Qld, while South Australia’s (SA) plot is similar to Vic. These are not shown for brevity’s sake. In summary, the overall picture for the state/local fiscal variables shows the following aspects; firstly, Own Revenues, Grants and Expenditure all display long term increases, indicating non-stationary means and possibly the existence of a long-run relationship between the fiscal variables, with such a relationship seeming most apparent between Grants and Expenditure. Net Debt Receipts also exhibit a similar behaviour across States, with the exception of Qld (and WA). In particular, all States, except Qld and WA, seemed to experience some problems with debt in the early 1990s, which was subsequently eradicated by 2000. This fits well with established knowledge, since it is well known that SA and Vic. were having high credit risk characteristics, as regarded by Rating Agencies in the early-to-mid ‘90s.

Queensland and WA on the other hand have profited most from a zero debt policy goal. In particular, after the 1995 State election the incoming NSW government of Premier Carr legislated to reduce General Government debt to zero by 2020. Premier Carr introduced the “General Government Debt Elimination Act” at a time when Australian States were recovering from a period of recession in the early 1990’s. Achieving a position of fiscal sustainability in NSW required the reduction of the level of debt in short, medium and long term perspectives. Most attention to restoring fiscal sustainability required the reduction in the level of Net Financial liabilities, in particular unfunded superannuation liabilities. It could be argued that this fiscal policy stance adopted in NSW provided a demonstration effect to other States which encouraged them to use greater caution in relying on debt finance. Overall the decade up to 2005 indicates the success of this policy of General Government debt constraint by States. However, this success led to the under-provision of infrastructure by States, although in the last 3 years debt finance has been increasingly used to finance infrastructure expansion, as has the use of PPP (Private Public Partnerships). The latter has been used for new government school expansion to the tune of $87M cumulatively in NSW up to 2006.
Translating the State own source revenue and borrowing magnitudes on a per head of population, Figure 1b shows the relevant per capita values for 2004/05 and 2006/07.

It seems that:

- NSW is currently attempting to fund its large backlog of infrastructure and asset renewal from new borrowings and to a lesser extent State taxes. This policy reversal is presently needed in comparison to other States. For instance, NSW taxes rose by 11.3% and net borrowing increased more than five-fold in the last three years.

- Victoria and South Australia appear to be consciously prudent in borrowing compared to the national average and other jurisdictional profiles. However, given their combined experience of State fiscal profligacy in the late 1980s and early 1990s this could be regarded as a policy reaction also, considering their present public infrastructure investment requirements. In the last three years, their tax increases per capita were 7% and 11% respectively.
Western Australia relies on their own source taxes to a much greater degree and places little emphasis on borrowing compared to the other jurisdictions. Indeed Western Australia has increased its taxes by 36% over the last three years and alone of the States is a net lender, not a net borrower.\footnote{The current mineral resource led boom flowing through into state government tax revenues may explain these preferences.}

Queensland historically has exhibited an aversion to borrowing and also has the lowest own source taxes per capita. However, recently the population growth induced deficiency in its public capital stock is a common place occurrence and has resulted in greater recourse to borrowing, particularly for the South East Queensland region growth corridor. For example, in the last 3 years Queensland has increased its own source taxes by 25% and its net borrowings six fold (from a small base).

Tasmania has traditionally been ultra cautious in utilising own source taxes
and borrowing and has the greatest reliance on Commonwealth Grants, advances and subsidies of all jurisdictions. Yet it has increased its taxes per capita by 20% and net borrowings by 3.7 times over the last three years.

Other noticeable aspects in Figure 1a are the marked and permanent increase in grant revenue in 2001 in all States, and the marked and permanent decrease in Own Revenue in 2000 in all States. As noted above, the Commonwealth Government in July 2000 began implementing the new General Purpose grant arrangements which were to be funded by the GST. Previously such GPP grants were sourced from Commonwealth Personal Income Tax Receipts. As part of this new arrangement a Memorandum of understanding was signed by all States to abolish some of their own taxes immediately and to phase out other agreed taxes in a staged process over time. Such one-off and well-documented incidents are not desired to be caught in the long or short-run relationships modelled by the VECM. As such, these values were considered as permanent shift outliers, and were adjusted accordingly prior to estimation. The adjustment process (i) took first-differences of the Grants and the Own Revenue variables in each state; (ii) smoothed out via interpolation the single outlier in these differenced series using a weighted average of the data values 2 periods each side of the outlier; (iii) the weights employed were (0.165, 0.33, 0.33, 0.165) for time points 2 periods back, 1 period back, 1 period ahead and 2 periods ahead, respectively. The smoothed differences were then transformed back to level-type data. A similar approach is recommended in Nielsen (2004).

2.2 Estimation approach

In order to obtain an insight into the dynamic fiscal policy adjustment for each of the six States in Australia, we estimate impulse-response functions. An impulse-response function (IRF) measures the effect of a shock to an endogenous (or weakly exogenous) variable on itself or on another endogenous (weakly exogenous) variable. An IRF is obtained by first estimating a VAR model and then recovering the response of a shock (innovation) to the system from its MA representation. For a formal (but brief) account of IRFs and VAR models see the analysis in the appendix. For more details, see Lütkepohl (1993) and Hamilton (1994).
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stationary time series — a condition that is not satisfied in our sample. To this end, we have estimated vector error correction models (VECMs) for each state individually.6

To begin with, consider the four fiscal variables involved; per capita Own Revenues, \( R \), Commonwealth Grants, \( Z \), Net Debt Receipts, \( NDR \), and Expenditure, \( G \). While \( R \), \( NDR \) and \( G \) can be thought of as being endogenous in the system in the sense that in general they are all influenced by each other, this is not the case for \( Z \). In particular, Commonwealth GPP grants are provided to allow the States to face differences between revenues and expenditure that arise for reasons beyond the state’s control, with the ultimate aim of enabling each state to provide — if it so chooses — services to their population at the national average standard. Hence, Commonwealth Grants are independent of a state’s individual policy in terms of tax revenues or expenditure. This is also documented in the 2004 review report of the Commonwealth Grants Commission on state revenue sharing relativities:7

“A State’s own policies or choices about the services it provides or the revenues it raises should not directly influence the level of grants it receives. We base our calculations on the standard policies in delivering services or raising revenue, so they are not directly affected by (or are neutral to) the specific policies of each State.” (page 5)

Hence, it is clear that while Commonwealth Grants may well have a long-run impact on the level of the deficit of each state, they are not influenced by Own Revenues, Net Debt Receipts or Expenditure in the short-run. Therefore, Grants are treated as weakly exogenous in the econometric model specification.8

There are other variables, usually ignored in the relevant literature, that may

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6An alternative approach would involve pooling the observations across states and estimating a single VECM using a panel framework. This approach is valid and fruitful provided that there is sufficient parameter homogeneity across the states, otherwise the estimated parameters (and thereby the impulse-response functions) will be subject to the so called ‘heterogeneity bias’ of the kind discussed by Pesaran and Smith (1995). The state-specific VECMs and impulse-response functions indicate some substantial differences in the estimated model parameters, indicating that pooling the data to perform a panel analysis would not be appropriate.


8Econometrically, this is implemented by imposing zero restrictions on the speed of adjustment coefficient(s) of the cointegrating vector(s) in \( Z \). This restriction was actually tested using a likelihood ratio test at the 5% level and it was not rejected in any of the states.
have a short-run impact on Own Revenues, Expenditure or Net Debt Receipts, although they are not considered to have an influence on the system in the long-run — namely, the interest rate, $ir$, (that could have an impact on $R$, and $NDR$) and the national unemployment rate, $ur$.

Thus, denoting the vector of endogenous variables by $y_t = (R_t, NDR_t, G_t)'$, the vector that includes both endogenous and the weakly exogenous variable by $w_t = (R_t, NDR_t, G_t, Z_t)'$, and the vector of strictly exogenous variables by $x_t = (ir_t, ur_t)'$, the vector error correction model may be written as:

$$
\Delta y_t = \mu + \Lambda_1 \Delta w_{t-1} + \ldots + \Lambda_p \Delta w_{t-p+1} + \Gamma_1 \Delta Z_t + \Gamma_1 \Delta x_t + \Pi w_{t-p} + \epsilon_t
$$

where $\Delta$ is the first-difference operator, $\mu$ is a $13 \times 1$ vector of intercepts and $\Pi = \alpha \beta'$, where $\alpha$ represents the speed of adjustment parameters to disequilibrium and $\beta$ is a matrix of long-run coefficients. The $\Lambda$'s are $3 \times 4$ matrices of fixed parameters, with $\Gamma_0$ and $\Gamma_1$ being $3 \times 1$ and $3 \times 2$ matrices of fixed coefficients, respectively. $\epsilon_t$ is a $13 \times 1$ vector of normally distributed disturbances. Suitable lags of $\Delta x_t$ may also be included.

The use of model (1) is feasible provided that the variables involved are integrated of the same order (usually integrated of order one) and there is some cointegrating relationship, which may not necessarily be unique, that binds these variables. Similarly to Buettner and Wildasin (2006), in this paper we have assumed a single cointegrating relationship among the endogenous variables involved. However, our approach deviates substantially in that we have not imposed a cointegrating vector of the form $(1, 1, -1, 1)$ — rather, we have tested whether these restrictions hold using a likelihood ratio test and we estimated IRFs using the preferred model specification. This approach ensures that the analysis is data-coherent without violating the ‘intertemporal budget constraint’, which is necessary to ensure the sustainability of external debts and current account deficits for a given state over long horizons of time.

In summary, our methodology may be outlined as follows:

1. We tested for stationarity in the individual time series across States using

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9In other words, the matrix $\Pi$ has rank 1 such that both $\alpha$ and $\beta$ are $3 \times 1$ vectors.

10Notice that in a recent paper, Bohn (2006) argues that restrictions in the cointegration vector, or even the existence of cointegration itself, are not really necessary for the intertemporal budget constraint to hold.
augmented Dickey-Fuller tests. The null hypothesis of a single unit root could not be rejected for any of the series across States — however, the null of two unit roots was comfortably rejected.

2. We estimated vector error correction models for each state of the form given in (1) by imposing a single cointegrating vector.

3. Prior to testing whether the cointegrating restriction \((1, 1, -1, 1)\) is supported by the data, we first subjected our model to a series of diagnostic tests, mainly for lag specification, serial correlation and normality of the disturbances and then we tested/imposed the restriction of weak exogeneity on the Grants equation. This approach is embraced by Greenslade et al. (2002), who argue that imposing exogeneity restrictions prior to testing for overidentifying restrictions on the long-run cointegrating vectors increases the power of these tests considerably.

4. Having estimated a model that is both congruent and coherent, we recovered consistent estimates of the VAR model using the method outlined in equation (15) in the appendix.

5. In turn, these estimates allowed us to recover estimates of the impulse-response functions, using the method put forward by Pesaran and Shin (1998).

The results of our analysis are discussed in the following section.

3 Estimation results

Before we analyse the results of our final models in terms of the impulse-response functions, it is useful to discuss briefly our findings with respect to \(\alpha\), the \(4 \times 1\) vector of the speed of adjustment parameters to disequilibrium, and \(\beta\), the \(1 \times 4\) vector of long-run coefficients. Firstly, the zero-restriction on the speed of adjustment parameter for the equation of \(Z_t\) was not rejected by the data in any of the six States — thus, providing supporting evidence that \(Z_t\) is indeed only weakly exogenous.\(^{11}\) In terms of the remaining elements of \(\alpha\), the largest value (in all six States) was taken by the adjustment coefficient of \(G_t\), ranging between 0.22

\(^{11}\)The speed of adjustment parameter for the equation of \(Z_t\) is given by \(\alpha\), in (16) of appendix B.
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for Vic. and 0.68 for WA. This indicates that it is the General Expenditure variable, \( G_t \), that adjusts more rapidly to fiscal disequilibria in order to satisfy the intertemporal budget constraint. This is intuitive because state and local governments exercise more control over their expenditure than the other fiscal variables.

In terms of the cointegrating vector, \( \beta \), the test results showed that the restriction \((1, 1, -1, 1)\) was rejected by the data at the 5% level of significance in all six States and this may be attributed to the long-run coefficient of \( Z_t \). In particular, the final estimated cointegrating vectors appear in the following table:

<table>
<thead>
<tr>
<th></th>
<th>NSW</th>
<th>VIC.</th>
<th>QLD</th>
<th>WA</th>
<th>SA</th>
<th>TAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \hat{\beta} )</td>
<td>1 1 -1</td>
<td>.521</td>
<td>1 1 -1</td>
<td>.681</td>
<td>1 1 -1</td>
<td>.493</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- - -</td>
<td></td>
<td>(1.110)*</td>
<td>- - -</td>
<td>(.094)*</td>
</tr>
<tr>
<td>( LR_{(1)} )</td>
<td>[.134]</td>
<td>[.096]</td>
<td></td>
<td>[.179]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \hat{\beta} )</td>
<td>1 1 -1</td>
<td>.452</td>
<td>1 1 -1</td>
<td>.714</td>
<td>1 1 -1</td>
<td>.614</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- - -</td>
<td></td>
<td>(0.58)*</td>
<td>- - -</td>
<td>(0.71)*</td>
</tr>
<tr>
<td>( LR_{(1)} )</td>
<td>[.769]</td>
<td>[.448]</td>
<td></td>
<td>[.394]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses. ‘*’ indicates statistical significance at the 1% level. \( LR_{(1)} \) denotes the p-value of the Likelihood Ratio test for the binding restriction \((1, 1, -1, 1, \beta)\) imposed on the cointegrating vector and the zero restriction on the speed of adjustment parameter for \( Z_t \).

Taking into account the standard errors of the estimates, it is obvious that the long-run coefficient of \( Z_t \) is significantly less than one, which leads to the rejection of the \((1, 1, -1, 1)\) restriction on the cointegrating vector in all States. On the other hand, relaxing the unity restriction on the coefficient of \( Z_t \) in particular, has led to failing to reject the remaining binding restrictions at the 5% level, as shown by the p-value of the LR test with three degrees of freedom. This implies that imposing this restriction on the coefficient of \( Z_t \) is neither trivial nor data-coherent. The estimated \((1, 1, -1, \beta)\) cointegrating vector, where \( 0 < \beta < 1 \), shows that the endogenous fiscal variables, \( R_t \), \( NDR_t \), and \( G_t \), are less responsive to changes in the weakly exogenous \( Z_t \) than to changes in themselves in the long-run. This result makes intuitive sense in economic terms because government Grants are determined by factors that lie beyond the control of each state and therefore they are less
predictable. Failure to satisfy the unity restriction on the long-run coefficient of $Z$ is consistent with the intertemporal budget constraint requirements.

Figures 2a - 4c show the impulse-response functions (IRF) estimated from the Vector Error Correction Models in each state. These illustrate the partial lagged response of each of the variables to a unit standard deviation shock from itself, and separately from each of the other variables, including Grants. These responses are marginal in nature and are the independent partial effect, once the effects of the other variables and any contemporaneous correlation have been accounted for.

Firstly, as we can see from figures 2a - 2c, almost all variables display a strong positive and seemingly permanent response to a unit shock in their own series. Innovations in Own Revenue taxes invoke a strong positive and permanent response in this variable in all States. The same effect is observed for Net Debt Receipts and Expenditure, with the exception of Net Debt Receipts in Queensland (Qld), which has a transitory positive response that seems to die out after 3 periods, then possibly even becomes negative after 4 and 5 periods, before dying out again; and Expenditure in WA, which exhibits a short-run positive response that dies out to negligible amounts after 5 years.

More interesting are the responses of the three variables to each other, and to Grants. Firstly, the IRF for Expenditure to an increase in Own Revenue, shown in Figure 3a, is consistent across the States: higher tax revenue leads to permanent increases in Expenditure. In NSW, VIC., WA, and SA the positive response takes between 3 and 6 periods to reach its highest level then maintains this value moving forward. This makes sense in that (some) current expenditure may be funded by previously gained tax revenue. Tasmania’s response is still positive and permanent, after two or three years but slightly reduces after that.
Figure 2a: Impulse response functions of $tR$ to an innovation in $tR$.

Figure 2b: Impulse response functions of $tNDR$ to an innovation in $tNDR$. 
Figure 2c: Impulse response functions of $tG$ to an innovation in $tG$.

The responses of Net Debt Receipts to an increased Own Revenue, in Figure 3b, are also reasonably consistent. NSW, Qld, WA and Vic. exhibit a moderate positive and permanent response to increased tax revenue, that rises initially for 3-5 periods then remains fairly constant in future periods. This indicates that tax revenue is not used to pay off debts — rather, it might possibly be used for investment purposes that increase interest receipts or for some other purpose that would increase Net Debt Receipts. SA has an initial negative response to tax revenue that becomes positive and flat after 3 or 4 periods. It seems that initially tax revenue is used to increase debt payments, but the lagged positive response could indicate that funds are used for loan purposes that lead to longer term increases in Net Debt Receipts. Finally, Tasmania has a declining negative and permanent response. This could indicate that in Tasmania tax revenue is primarily used to pay off debts.
The response of Own Revenue to a unit standard deviation increase in
Expenditure again has the States divided into two groups (see Figure 3c). NSW and Qld display immediate permanent responses, while SA and Vic. Have responses that build to a permanent maximum level after a lead in period of 2 years (SA) and 8 years (Vic.). As expected, tax revenue is clearly used to offset Expenditure with a positive permanent response in these States. On the other hand, Tas. and WA display an initial positive response that almost dies out to be close to 0 after 4 years.

The States’ responses of Net Debt Receipts to positive changes in Expenditure seem quite inconsistent, see Figure 3d, with perhaps 3 separate responses on display. Vic. and Tas. display increasingly negative permanent responses here. The IRF of Victoria is consistent with the state’s pattern of heavy borrowing inducing a blow out in interest payments. On the other hand, the IRF for Tasmania may be driven by the state’s strong commitment for paying-off debts at times of increasing General Expenditure. NSW, Qld and WA have very small positive responses, while SA has a strong permanent positive response of Net Debt Receipts to rising Expenditure. These States seem to have a different policy in response to increasing Expenditure, in that subsequently debt payments seem to decrease. This makes sense if expenditure and net debt payments are competing for the same pot of money:
payments reduce as expenditure rises.

![Impulse response functions](image)

Some remaining responses are those of Own Revenues and Expenditure to innovations in Net Debt Receipts, i.e. figures 3e and 3f respectively. Responses are again not consistent across States here. In SA, Tas. and WA tax revenues display a permanent negative response to increasing Net Debt Receipts, after a few periods. These States tend to reduce taxation as Net Debt Receipts increases, perhaps in response to having to make less debt payments or receiving higher interest receipts. Vic. displays close to a zero long term tax effect, but only after a strong positive response in the first four or five periods. It seems that Vic. tends to increase taxes initially as Net Debt Receipts rise, only subsequently reducing them five or so periods after Net Debt Receipts have increased. NSW and Qld, on the other hand, display a small positive and long term tax increase in response to rising Net Debt Receipts, possibly reflecting their stronger tax regimes compared to other States.
Figure 3: Impulse response functions of $R_t$ to an innovation in $NDR_t$.

Regarding Expenditure, all States except Tas. show a strong permanent positive increase in response to rising Net Debt Receipts. NSW, Qld and WA, all display strong, permanent and positive responses in Expenditure, while Vic. displays an immediate effect that dies out in the 2nd year before reaching its highest permanent level after 7 years. This may indicate that lower debt payments or higher interest receipts are freeing up money that is subsequently used for expenditure in these 4 States, with the effect immediate in NSW, Qld and WA and taking some periods in Vic. to ‘kick in’. Clearly Queensland’s lower level of debt service has a more observable impact in improving their fiscal flexibility, compared to other States. Tas. has an initial negative response in Expenditure that becomes only very small but positive from the 2nd year.
Finally, Figures 4a - 4c consider the responses of the endogenous variables to increases in Commonwealth Grant funds. WA displays a permanent decrease in Own Revenues, reaching a minimum level after 3 years, while Qld seems unaffected after a slight 1 year decrease. These responses seem logical for these resource rich States with minimal debt problems in this time period. On the other hand, SA, Vic., NSW and Tas. all display a permanent increase in tax revenue in response to increasing Grant funds.

Some of these results could be explained by theory. For instance, Commonwealth Grants are a mixture of Specific Purpose (SPP) and General Purpose (GPP) payments. Grants incidence theory indicates that SPPs are more stimulative of State revenue raising effort than GPPs (see Gramlich, 1977, and Blackburn, 1979). Ceteris paribus, States with a higher share of total grants being of an SPP form, should exhibit a higher degree of stimulation of their own source revenue.

This is clearly the case in New South Wales and Vic. which have the highest ratios of SPPs to total grants (between 45% and 50%). However, SA and Tas. go against this a priori expectation as they have a low SPP share historically (30% to...
40%) yet exhibit a stimulation of their own source revenues after grant innovations. Queensland with a mid-range share of SPPs (38% to 49%) has a flat non-stimulation of own source revenues. Also Western Australia which has a high SPP share profile (40%-58%) shows a non-stimulatory effect on own source revenues. Indeed it appears to allow for substantial tax relief. Viewed from the perspective of the GPP shares (now funded by the GST), the three States, Tas., WA and Qld receive a much greater per capita GPP through the equalisation methods as determined by the Commonwealth Grants Commission. This allows WA and Qld, and in theory Tas. to reduce Own Revenues compared to Vic. and NSW.

Responses of Expenditure to Grants (Figure 4b are all strong, positive and permanent, as expected. The largest stimulatory impact of Grants innovation on Expenditure is evident in SA and Tas., slightly less so in NSW and Vic. and least in WA. Qld reveals a volatile Expenditure response path compared to other States, indicating a unique set of fiscal circumstances compared to other States.
The responses of Net Debt Receipts to an innovation in grant funds seem more variable than other response patterns. Firstly, Tas. and NSW (to a lesser extent) are the only States that do not increase their debt payments in response to innovations in Grants. In fact, they appear to use grant funds in a manner that increases Net Debt Receipts, for example, on investment or loan purposes. In contrast, alone of the States, Victoria’s debt payments seem to permanently increase at times of extra grant funding. One possible explanation is that Victoria uses such grants to partially pay for large infrastructure projects that require significant additional State borrowings. SA appears to use grant inflows to increase debt payments, which payments are gradually reduced over time. These IRFs indicate the tightness of the two States’ overall fragile fiscal circumstances. WA has a negligible response to grant money, which indicates the state’s low propensity for borrowing, preferring instead to use its tax sources to fund its infrastructure requirements as opposed to using grants for debt payments. Qld seems to use grant inflows to initially reduce debt, a behaviour underlying its traditional reluctance to borrow and a desire to repay its debts very quickly.

Figure 4b: Impulse response functions of $G_t$ to an innovation in $Z_t$.
It is also interesting to see the effect of the strictly exogenous variables (State unemployment rates and national interest rates) on each of the endogenous variables. Table 4 reports the regression results for the partial coefficients of the exogenous variables. The ‘*’ superscript indicates statistical significance at the 5% level. As we can see, many of the States’ fiscal variables seem somewhat robust to changes in unemployment and interest rates. However, there are some points to note. Firstly, all States seem to marginally decrease tax revenue in response to interest rate rises: even though the effects are mostly insignificant, except in NSW, they are all negative, perhaps because a rise in the rate of interest has a dampening influence on the general demand in the economy, as well as a specific adverse impact on the level of house prices and home loan affordability. This implies a fall in the value of community income and wealth and thereby in tax revenues, ceteris paribus. The unemployment rate has a significant negative impact on Net Debt Receipts in Victoria alone of the States. This presumably is a reflection of a more prudent approach to borrowing for infrastructure in Victoria since the mid to late 90’s during the period in office of Premier Jeff Kennett.
Table 4: Regression Results for Exogenous Coefficients

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<th>QLD</th>
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<td>(13.1)*</td>
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<td>(10.6)*</td>
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<table>
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<th>SA</th>
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</table>

Notes: Standard errors in parentheses. ‘*’ indicates statistical significance at the 5% level.

4 Conclusion

This paper examined State and local government fiscal policy adjustment and inter-temporal shock adjustment models in the Australian federation of States. Vector Error Correction Models were estimated using aggregated state and local GFS data from 1961-2005. The main findings included clear differences in fiscal policy in debt servicing and taxation changes in response to increases in grant revenues (this result was GST corrected) with only the resource rich States Queensland and WA seemingly able to reduce taxes after grant increases. SA, Qld and Victoria seem to employ grant revenue to increase debt payments while NSW and Tasmania seem to use it for investment or loan purposes. Tax regimes are also different with NSW, Victoria and Qld increasing their taxes at times of rising debt receipts, while all other States reduce taxation. Finally, debt servicing in times of increasing expenditure displays marked differences, with Tasmania and Victoria also
increasing debt payments during times of increased expenditure, while NSW, Qld and SA seem to decrease debt payments to cover rising expenditure. Similarities in fiscal policy across States were apparent in Expenditure when: (i) Own Revenues; (ii) Net Debt Receipts; and (iii) Grants were increasing. Overall, the States were mostly marginally unaffected by interest or unemployment rate changes over the period examined, except Tasmania where rising interest rates tended to increase Net Debt Receipts; Victoria, which displayed the opposite effect; and NSW where rising interest rates preceded reductions in Own Revenues. Finally, rising unemployment in Victoria seemed to precede reductions in Net Debt Receipts. While Australia has one of the tightest levels of fiscal control at the highest level of its Federal government structure, our results illustrate that the States limited fiscal elbow room has not stopped them developing contrasting fiscal policies or stopped specific state issues affecting fiscal adjustments at a local level.

Appendix

A. Stylised facts on State/local government indicators of fiscal sustainability in australia

This section outlines in more detail the degree of vertical fiscal imbalance in the Australian Federation. In particular, as figure A1 shows, the Commonwealth collects about 80% of total public sector tax revenue (including the Goods and Services Tax, GST) yet is responsible for only 54% of total own purpose spending.

In addition, grants from the Commonwealth Government make up almost half State Government Expenditure (see figure A2). This is in stark contrast to the situation in Canada where the share of Provincial expenditure sourced from Federal grants is only 18%. This indicates that in Canada provinces have the financial capacity to fund a much higher proportion of their expenditure from their own revenue sources. This results in Australian State governments depending to a much greater extent on financial grants from the Federal government, relative to Canada. Overall in Australia this decentralised spending is financed roughly equally by Commonwealth Grants and State taxes.

12The figures are sourced from Warren (2006).
B. Estimating impulse-response functions from a VECM

Consider the following VAR model:

$$w_t = c + \Phi_1 w_{t-1} + \Phi_2 w_{t-2} + \cdots + \Phi_p w_{t-p} + \epsilon_t$$

(2)

where $w_t = (R_t, NDR_t, G_t, Z_t)'$ is a $(K = 4) \times 1$ vector of random variables, $c$ is a $K \times 1$ vector of fixed intercepts, $\Phi_j$ is a $K \times K$ matrix of fixed parameters and
\( \epsilon_t = (\epsilon_{u,1}, \epsilon_{u,2}, \epsilon_{u,3}, \epsilon_{u,4})' \) is a vector of serially uncorrelated/contemporaneously correlated disturbances, such that

\[
E(\epsilon_t) = 0 \\
E(\epsilon_t, \epsilon_{t'}) = 0 \quad \text{for} \ t \neq s \\
E(\epsilon_t, \epsilon_{t'}) = \Sigma
\]

Assuming that the stability condition holds (see, for example, Hamilton (1994), p. 259), the above model has the following vector MA(\( \infty \)) representation:

\[
w_t = \mu + \epsilon_t\Psi_{s,1} + \Psi_{s,2} + \Psi_{s,3} + \ldots
\]

where \( \mu = \Theta(L) \epsilon_t \) is the \( K \times 1 \) time-invariant mean of \( w_t \) and

\[
\Psi_s = \begin{cases} 
I_K & \text{for } s = 0 \\
\sum_{\tau=0}^s \Psi_{s,\tau} \Theta & \text{for } s = 1, 2, \ldots
\end{cases}
\]

with \( I_K \) being an identity matrix of order \( K \).

The \( \Psi_s \) matrices are the impulse-response functions. In particular, the row \( j \), column \( k \) element of \( \Psi_s \) identifies the effect of a one unit (in time) rise in the \( k \)th variable’s innovation at time \( t \), \( \epsilon_{k,t} \), on the \( j \)th element of \( w_t \) after \( s \) periods, holding all other innovations at all periods constant. Thus, a plot of the \( j \)th row \( k \)th column element of \( \Psi_s \),

\[
\frac{\partial w_{j,t}}{\partial \epsilon_{k,t}} = \Psi_{s,s}
\]

as a function of \( s \) gives rise to the impulse-response plot.

However, the existence of contemporaneous correlations among the innovations, as reflected by \( \Sigma \) in (3), implies that we cannot assume that all other innovations are held constant for a given change in \( \epsilon_{k,t} \); a shock in the \( k \)th variable is most likely to be accompanied by shocks to the other variables that will

\( ^{13} \)Notice that in this sort of analysis the strictly exogenous and deterministic variables are treated as fixed and can therefore be dropped from the system. In other words, the part of the conditional mean of the endogenous variables attributable to these variables is eliminated.
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in turn influence the $k$th variable — meaning that the effects of the shocks cannot be given a causal interpretation. To circumvent this problem, the traditional approach, suggested by Sims (1980), is to decompose $\Sigma$ as $\Sigma = PP'$, such that premultiplying $\varepsilon_t$ by $P^{-1}$ leads to disturbances, $\varepsilon_t^* = P^{-1}\varepsilon_t$, that are orthogonal to each other:

$$E[\varepsilon_t^* \varepsilon_t^*'] = E[P^{-1}\varepsilon_t P^{-1} \varepsilon_t'] = P^{-1}E[\varepsilon_t \varepsilon_t'] P^{-1} = P^{-1}\Sigma P^{-1} = P^{-1}(PP')P^{-1} = I_k$$

(7)

In this way, (4) can now be written as

$$w_s = \mu + \sum_{i=0}^{\infty} \Psi_i PP^* \varepsilon_{i-s} = \mu + \sum_{i=0}^{\infty} (\Psi_i P)(P^* \varepsilon_{i-s})$$

(8)

where $\Xi = \Psi P$ and $\varepsilon_{i-s}^* = P^{-1}\varepsilon_{i-s}$. The orthogonalised impulse-response function is now given by $\Xi_s$ and the plot of the $j$th row, $k$th column element of $\Xi_s$,

$$\frac{\partial W_{j,s}}{\partial \varepsilon_{k,s}^*} = \Xi_{j,k}$$

(9)

as a function of $s$ will satisfy the assumption that all other innovations are held constant for a given change in the innovation of the $k$th variable.

A problem with this approach is that it is not invariant to the ordering of the variables in the VAR model, which implies that the shape of the impulse-response functions may be sensitive to the way the variables are ordered. To overcome this shortcoming, Pesaran and Shin (1998) proposed an alternative method, which does not depend on the VAR ordering and does not require orthogonalization of the innovations — rather, it integrates out the effects of other shocks by setting

$$\Xi'_s = [\xi'_s, \xi''_s, \ldots, \xi'''_s]$$

(10)

with the $k$th column of $\Xi'_s$ being equal to

$$\xi'_{k,s} = \frac{1}{\sqrt{\sigma_{kk}}} \Psi_s \quad \Sigma' \varepsilon_t$$

(11)
where $\sigma_{kk}$ is the $k$th diagonal element of $\Sigma$ and $e_k$ is an $m \times 1$ ‘selection vector’ that takes the value of one in its $k$th element and the value of zero otherwise. Each of the $\xi^s_{kk}$ measures essentially the effect of a one standard error shock to the $k$th variable at time $t$ on expected values of $w_s$ after $s$ periods.

If $w_t$ comprises non-stationary series, the stability condition of the VAR model is not satisfied. Hence, inferences on the estimated VAR coefficients, $\Phi_s$, are invalid and the impulse-response functions are not valid either. Provided that the variables in the model are cointegrated, the VAR model in (2) can be written in VECM form as follows:

$$\Delta w_t = \mu + \Pi \Delta w_{t-1} + \Lambda_1 \Delta w_{t-2} + \cdots + \Lambda_{p-1} \Delta w_{t-p+1} + e_t$$

where

$$\Pi = \sum_{s=1}^{s} \Phi_s - I_k$$

and

$$\Lambda_s = -\sum_{j=1}^{s} \Phi_j$$

Therefore, (12) allows one to obtain unbiased and consistent estimates of $\Pi$ and $\Lambda_s$. Since the impulse-response functions actually require estimates of the $\Phi_s$, these can be recovered by solving (13) and (14) in terms of the $\Phi_s$ such that

$$\Phi_1 = \Pi + \Lambda_1 + I_k$$
$$\Phi_s = \Lambda_s - \Lambda_{s-1} \quad \text{for} \quad s = 2, \ldots, p-1$$
$$\Phi_p = -\Lambda_{p-1}$$

In turn, the estimates of the $\Phi_s$ matrices allow one to obtain estimates of the $\Psi_s$ in (15), $\Xi_{xx}$ in (8) and $\Xi'_x$ and thus the orthogonalised impulse-response functions can be computed. Notice that the estimates of the $\Phi_s$ and ultimately of the impulse-response functions will depend on the form and the rank of $\Pi$.

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14See, for example, Johansen (1995).
15Given that $\Sigma$ is unknown in practice, $P$ needs to be estimated, and therefore it will not be unique; Sims (1980) suggests using the Cholesky decomposition of $\Sigma$, where $\hat{\Sigma}$ can be the empirical covariance matrix of the disturbances from the VECM model, i.e. $\hat{\Sigma} = \hat{\varepsilon}'(T-1)\hat{\varepsilon}$
where $\Pi = \alpha \beta'$. Model (12) can also be modified to allow $Z_t$ to be weakly exogenous, as opposed to being endogenous. In particular, assuming for simplicity that the VAR model in (2) has two lags only and that there is a single cointegrating vector, (12) can be written as

$$
\begin{bmatrix}
\Delta R_t \\
\Delta NDR_t \\
\Delta G_t \\
\Delta Z_t
\end{bmatrix} =
\begin{bmatrix}
\mu_1 \\
\mu_2 \\
\mu_3 \\
\mu_4
\end{bmatrix} +
\begin{bmatrix}
\Lambda_{11} & \Lambda_{12} & \Lambda_{13} & \Lambda_{14} \\
\Lambda_{21} & \Lambda_{22} & \Lambda_{23} & \Lambda_{24} \\
\Lambda_{31} & \Lambda_{32} & \Lambda_{33} & \Lambda_{34} \\
\Lambda_{41} & \Lambda_{42} & \Lambda_{43} & \Lambda_{44}
\end{bmatrix}
\begin{bmatrix}
\Delta R_{t-1} \\
\Delta NDR_{t-1} \\
\Delta G_{t-1} \\
\Delta Z_{t-1}
\end{bmatrix} +
\begin{bmatrix}
\varepsilon_{t-1} \\
\phi_{t-1} \\
G_{t-1} \\
Z_{t-1}
\end{bmatrix}
$$

(15)

Weak exogeneity on $Z_t$ implies that $\alpha = 0$, in which case (16) can be decomposed into the conditional model given in (1) and the marginal model for $Z_t$, which is omitted to save some space. The restriction $\alpha = 0$ will have an impact on the impulse-response functions of $R_t$, $NDR_t$, and $G_t$, following a shock to either of these variables or a shock to $Z_t$ (but the impulse-response functions will still exist in all cases); for instance, using (13), (14) and (15) it is straightforward to show that

$$
\frac{\partial R_{t+1}}{\partial \varepsilon_{t_i}} = \Psi_{i_{t+1}} = 0, \quad \frac{\partial R_{t+1}}{\partial Z_{t_i}} = \Psi_{i_{t+1}} = \alpha \beta_i + \Lambda_{i_{t}}
$$

$$
\frac{\partial R_{t+1}}{\partial Z_{t_i}} = \Psi_{i_{t+1}} = \sum_{i=1}^n \left( \alpha \beta_i + \Lambda_{i_{t}} + \left\lfloor \frac{i}{4} \right\rfloor \right) - \Lambda_{i_{t}}
$$

(17)

where $\varepsilon_{t_i}$ is the shock to $Z_t$ and $\lfloor \eta \rfloor$ is the floor value, defined as the largest integer less than or equal to $\eta$.

It is useful to notice that contrary to the impulse-response functions of a stationary VAR model, which are mean-reverting in the sense that the effect of a shock in an innovation of any of the elements in $w_t$ will eventually die out, this is not the case for the impulse-response functions computed from a cointegrating

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VECM. The reason is that the elements in $w_t$ are not stationary (usually they are I(1)) and thereby the effect of a given shock on the level of $w_t$ will persist forever. For the same reason, standard errors for the point estimates of the impulse-response functions are not valid, although some progress could be made using bootstrapping methods.

**References**


