A VAR MODEL OF SHOCKS TO THE VICTORIAN ECONOMY

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ABSTRACT A structural VAR model is used to identify the sources and effects of shocks on the Victorian economy. The two identifying restrictions in the model are that demand shocks are assumed to have no long-run effect on the level of output and unemployment, and that supply shocks are assumed to have no long-run effect on unemployment, but may have a long-run effect on output. Three types of shocks are identified: a terms of trade shock; a permanent 'supply' shock, of which output is the proxy variable; and a temporary 'demand' shock, of which unemployment is the proxy variable. The three-variable model is applied to the State level in Australia, using Victorian quarterly data on Gross State Product and unemployment rate, and the Australian terms of trade over the period 1984-1997. The econometric framework is designed to simultaneously identify the effects of these shocks on output, demand and supply. Terms of trade shocks were found to produce major fluctuations in the Victorian economy. Results from the model suggest that terms of trade shocks can account for 41 per cent of variation in the change in unemployment and 62 per cent of the variation in growth in real output.

1. INTRODUCTION

The pattern of economic growth in Victoria over the last two decades has been that annual output growth as measured by Gross State Product, (hereafter GSP), has varied greatly. It was zero in 1986, five per cent in 1987, -2.5 per cent in 1991 and four per cent in 1996 (ABS, 1997). It must be asked whether supply, demand or external terms of trade shocks have been the dominant source of these fluctuations in the Victorian economy. Victoria is a small, open economy, which takes the real interest rate and terms of trade as exogenously given by conditions existing in the rest of the world. Studies of other small, open economies have shown the terms of trade has a strong, though variable, influence on economic growth, and the influences of demand and supply shocks on macroeconomic variables have differed.

The sources of macroeconomic fluctuations have an important influence on the cyclical dynamics of the trade balance and the business cycle. Macroeconomic theorists (notably Blanchard, 1989) have suggested that strong demand growth leads to an increase in both output and prices in the short-run. Demand and terms of trade shocks can lead to variations in output in the same direction. However, demand and terms of trade shocks can have different effects on real exchange rates and consequently different effects on trade variables. Aggregate supply has been found to influence the determination of output and prices in both the long- and short-run. The effects of supply shocks on trade variables often differ substantially

from the effects of demand or terms of trade shocks, particularly in the long-run. Therefore, the relative importance of demand, supply and terms of trade shocks is likely to vary considerably over different time horizons and between countries.

In so far as governments and agencies are able to influence macroeconomic variables, knowledge of the relationships between these variables and the source of different economic shocks are important policy tools. The aim of this study is to ascertain the major sources and effects of shocks to the Victorian economy over the period 1984-1997. The shocks investigated are demand, supply and the terms of trade. The effects of these shocks on the unemployment rate and real output growth are measured.

To achieve this aim, a structural vector autoregression (SVAR) model has been constructed. The model is based on Blanchard and Quah (1989), (hereafter BQ), who constructed a bivariate vector autoregressive (VAR) model of the United States economy. They defined two types of shocks affecting unemployment and output: the first type of shock as having no permanent effect on either output or unemployment and the second type of shock as having no permanent effect on unemployment but which may have a permanent effect on output. Having defined the two types of shocks by these identification restrictions, BQ then suggested an economic interpretation of the first type of shock as a demand shock and the second type of shock as a supply shock. While BQ assumed a closed economy, others have extended the framework to open economies. Otto (1995) identified the impact of terms of trade shocks on the Australian economy. Prasad (1998) provided quantitative estimates of macroeconomic fluctuations on the dynamics of international trade, while Cashin and McDermott (1998) compared the contribution of terms of trade shocks to fluctuations in current account positions in five countries.

The extended BQ model is applied using Victorian quarterly data on GSP and the unemployment rate and the Australian terms of trade. The econometric framework is designed to simultaneously identify the effects of various types of structural shocks on output growth and the unemployment rate. [In undertaking this task, first a review of the literature on the impacts of structural shocks on small, open economies is presented.] [Firstly,] The key features of VARs and the empirical model used in this study are detailed, including a description of the data and its time series properties. Then, the results of the model estimation are presented and analysed and the paper concludes with a discussion of the results. It was found that terms of trade shocks are the dominant source of fluctuations in the Victorian economy.

2. SHOCKS TO SMALL, OPEN ECONOMIES

The Australian and Victorian economies are small, open economies, wherein the real interest rate and terms of trade are exogenously given. At the same time, many Australian macroeconomic variables, for example the price level and the exchange rate, could also be considered exogenous to Victoria. The implications of demand, supply and external terms of trade shocks for these variables at both the

national and state level will be similar where the national variables pertain to Victoria. However, Victoria can also be analysed in its own right as a small, open economy.

While it can be argued that Australia has been a small open economy since European settlement, Gruen and Shuetrim (1994) suggest that there are three key economic changes that have arisen from the increasing outward orientation of the Australian economy. They are firstly, the decrease in protection, secondly, the floating of the Australian dollar and thirdly, financial deregulation. The fall in protection has led to a strong rise in the trade share of Gross Domestic Product (GDP) since the early 1980s. Consequently, the exchange rate has an increasingly important influence on both domestic inflation and production activity. Another consequence is the diversification and expansion of Australia's export base. This study is over the time period post-1983 during which the floating exchange rate and the rising trade share of GDP have contributed to monetary policy acting increasingly through the external sector.[1] This occurs through altering the nominal exchange rate which influences the domestic prices of traded goods. The floating exchange rate also significantly changes the response of the macroeconomy to terms of trade shocks. The deregulation of financial markets, and technological advances therein, allow shocks to world asset markets to be translated quickly to Australia.

The impact of movements in the terms of trade is predominantly through effects on real income causing fluctuations in other macroeconomic variables. The terms of trade indexes reflect compositional changes and changes in the actual prices of exports and imports. Real income can be estimated by adjusting for terms of trade in the constant price GDP (or GSP) estimates. Supply shocks, such as those induced by drought in agriculturally-based economies, also lower an economy's real income. For Australia, the real-income effects of terms-of-trade changes can be significant. Long and Pitchford (1993) used Australian data to determine real-income adjustments to fluctuations in the terms of trade between 1972 and 1988. They estimated that the real-income effects of terms of trade adjustments were comparable in magnitude to Australia's GDP growth rates during this period.

The terms of trade also has a substantial effect on real exchange rates. Gruen and Wilkinson (1991) provide evidence of a stable, positive, long-run relationship in Australia between real exchange rates and the terms of trade. In a theoretical sense, it is normally assumed that an increase in a country's net holdings of foreign assets is assisted by an improvement in the terms of trade and leads to an appreciation of the domestic real exchange rate. Since the floating of the Australian dollar in late 1983, Australia's rising current account deficit has been associated with a depreciation of the Australian dollar.

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[1] In Victoria, the international trade (exports plus imports) share of GSP has risen from approximately 28 percent in 1992 to 37 per cent in 1997. The balance of international trade as a percentage of GSP has changed from negative four per cent to negative seven per cent in the same period (calculated from ABS, 1997).

The impact of an adverse terms of trade shock on the current account will in theory have three effects. Firstly, it will lower current income relative to future income, inducing a consumption-smoothing effect by reducing aggregate saving. Secondly, it will increase the current price of imports relative to the future price of imports, inducing a consumption-substitution effect. Lastly, it will increase the price of tradables relative to the price of non-tradables, thereby affecting the real exchange rate. The balance of these three effects will determine the overall effect on the current account. Cashin and McDermott (1998) found that the terms of trade are an important cause of variation in the current account position for Australia, New Zealand, Canada, the United Kingdom and the United States. As well, shocks to the terms of trade are persistent for all of the above countries except the United States.

3. THE VAR MODEL

In general, a VAR model can be described as a multi-equation model in which, in an *N*-variable VAR of order *p*, (VAR (*p*)), *N* different equations are estimated. In each equation, the relevant left-hand-side variable is regressed on *p* lags of itself and *p* lags of every other variable. A VAR model is suited to forecasting variables where each variable helps forecast other variables by allowing for cross-variable dynamics. The right hand side of the equation contains only predetermined variables and the error terms are assumed to be serially uncorrelated with constant variance.

The mathematical form of a VAR(*p*) is:

$$x_t = A_o + A_1 x_{t-1} + A_2 x_{t-2} + \ldots + A_p x_{t-p} + e_t \qquad (1)$$

where, x_t = an (n ×1) vector containing each of the n variables included in the VAR;

A_o = an (n ×1) vector of intercept terms;

A_i = (n × n) matrices of coefficients; and

and e_t = an (n ×1) vector of error terms.

The probability distribution of the error terms is specified, the usual specification being that they follow a joint normal distribution and that each has zero mean and constant variance.

Vector autoregression models have been used in forecasting and analysing Australian macrovariables (see Trevor and Thorp, 1985; Moreno, 1992; Smith and Murphy, 1994; Otto, 1995 and Dungey and Pagan, 1997). The proponents of vector autoregression modelling argue that simultaneous equations modelling places too many *a priori* restrictions on structural parameters and that VARs provide a flexible framework free from the constraint of macroeconomic theory. Sims (1980) argues that in principle all equations in a simultaneous system should have the same right-hand side variables in order to capture all possible forms of

interaction among variables. In practice, the size of VAR models is limited by the fact that each variable including lags appears in each equation, yet estimation requires sufficient degrees of freedom. There are some constraints therefore on the number of variables and the lengths of the lags used.

As well as the above constraints, restrictions can be placed upon the interactions and the dynamics to produce sensible responses and to resolve the problem of identification of a system of simultaneous equations. Linear exclusion restrictions are one common way of doing this. The role for economic theory in resolving the identification problem is therefore in providing information on the restrictions relevant to each equation, and also regarding cross-equation restrictions.

Vector autoregression is used for analysing the dynamic impact of different types of random disturbances on systems of variables. This can be referred to as 'policy analysis' where policy is interpreted narrowly to mean the addition of a known innovation shock to the model. There is the assumption that the behaviour of the system is not sensitive to the underlying economic origin or nature of the shock. The variance decomposition of a VAR gives information about the relative importance of the random innovations by showing how much of the *k*-step-ahead forecast error variance of one variable is explained by innovations to the other variables. The source of this forecast error is variation in the current and future values of the innovations. Impulse response functions can be used to illustrate the qualitative responses of the variables in the system to a one standard deviation shock to one of the innovations.

Model Specification and Estimation[2]

The VAR model in this study has the following structure;

$$z_t \equiv \begin{bmatrix} \Delta TT_t \\ \Delta RY_t \\ \Delta U_t \end{bmatrix} = B(L) \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \qquad (2)$$

where $B(L) = B_0 + B_1 L + \ldots$ is a 3x3 matrix of polynomials in the lag operator L;
Δ is the first difference operator;
TT is the terms of trade;
RY is real output and U is the unemployment rate.

The structural disturbances ε_{1t} to ε_{3t} correspond to a terms of trade shock, a supply shock and a demand shock uncorrelated. Implicit in equation (2) are some assumptions about the time series respectively. These innovations are assumed to

[2] The model specification follows that of Blanchard and Quah (1989) with the extension to a three variable model as in Otto (1995).

have a zero mean and to be contemporaneously properties of the three variables, in that all are assumed to be I(1) in levels and require first differencing to be stationary. To justify these assumptions, tests of the order of integration are undertaken, and presented in the data section.

Assuming B(L) is of order p, the model equations can then be written as:

$$\Delta TT_t = \sum_{i=1}^{p} \gamma_{tt,i} \Delta TT_{t-i} + \sum_{i=0}^{p} \gamma_{ty,i} \Delta RY_{t-i} + \sum_{i=0}^{p} \gamma_{tu,i} \Delta U_{t-i} + \varepsilon_{1t} \tag{3}$$

$$\Delta RY_t = \sum_{i=0}^{p} \gamma_{yt,i} \Delta TT_{t-i} + \sum_{i=1}^{p} \gamma_{yy,i} \Delta RY_{t-i} + \sum_{i=0}^{p} \gamma_{yu,i} \Delta U_{t-i} + \varepsilon_{2t} \tag{4}$$

$$\Delta U_t = \sum_{i=0}^{p} \gamma_{ut,i} \Delta TT_{t-i} + \sum_{i=0}^{p} \gamma_{uy,i} \Delta RY_{t-i} + \sum_{i=1}^{p} \gamma_{uu,i} \Delta U_{t-i} + \varepsilon_{3t} \tag{5}$$

where all variables are defined as above.

However, there are two identifying restrictions on the model. The first restriction arises from the assumption that the Australian terms of trade are exogenous to the Victorian economy. This restriction can be imposed by putting the parameters of the ΔRY and ΔU terms in equation (3) at zero. Equation (3) thereby becomes (3'):

$$\Delta TT_t = \sum_{i=1}^{p} \gamma_{tt,i} \Delta TT_{t-i} + \varepsilon_{1t} \tag{3'}$$

The second restriction arises from the definition of aggregate demand shocks as shocks which have no permanent effect on either real GSP or unemployment rate. This restriction can be imposed by restricting the sum of the coefficients on ΔU in equation (4) to equal zero.

That is,

$$\sum_{i=0}^{p} \gamma_{yu,i} = 0$$

The imposition of these coefficient restrictions leads to equation (4'):

$$\Delta RY_t = \sum_{i=0}^{p} \gamma_{yt,i} \Delta TT_{t-i} + \sum_{i=1}^{p} \gamma_{yy,i} \Delta RY_{t-i} + \sum_{i=0}^{p-1} \beta_{yu,i} \Delta U_{t-i} + \varepsilon_{2t} \quad (4')$$

where $\beta_{yu,0} = \gamma_{yu,0}$

and $\beta_{yu,1} = \gamma_{yu,0} + \gamma_{yu,1}$

$\beta_{yu,p} = -(\gamma_{yu,0} + \gamma_{yu,1} + \ldots + \gamma_{yu,p-1})$ where p is the lag interval.

With these restrictions, the SVAR model then becomes:

$$\Delta TT_t = \sum_{i=1}^{p} \gamma_{tt,i} \Delta TT_{t-i} + \varepsilon_{1t} \quad (3')$$

$$\Delta RY_t = \sum_{i=0}^{p} \gamma_{yt,i} \Delta TT_{t-i} + \sum_{i=1}^{p} \gamma_{yy,i} \Delta RY_{t-i} + \sum_{i=0}^{p-1} \beta_{yu,i} \Delta U_{t-i} + \varepsilon_{2t} \quad (4')$$

$$\Delta U_t = \sum_{i=0}^{p} \gamma_{ut,i} \Delta TT_{t-i} + \sum_{i=0}^{p} \gamma_{uy,i} \Delta RY_{t-i} + \sum_{i=1}^{p} \gamma_{uu,i} \Delta U_{t-i} + \varepsilon_{3t} \quad (5')$$

The above restrictions ensure that the structural disturbances, ε_{1t} to ε_{3t} are then mutually uncorrelated, and that, for example, ε_{3t} is the orthogonalised portion of the demand shock that does not change in response to movements in supply or the terms of trade. In the model equations (3') to (5'), the structural disturbances ε_{1t} to ε_{3t} then correspond to the underlying terms of trade, supply and demand shocks, respectively.

All statistical tests were undertaken, and the model equations were estimated, using a program in RATS Version 4.20. The error variance was calculated from the SVAR analysis, with eight lags of each variable in each of the three equations. The decomposition of the forecast error variance measures the percentage of the *k*-step ahead forecast error variance in each variable which is due to terms of trade, supply and demand shocks. The impulse response function describes the response of each variable to a one standard deviation shock in each innovation by tracing the effect on current and future values of the variable.

The Data

The data used in this study was quarterly, seasonally adjusted data collected over the period from the third quarter 1984 to the second quarter 1997. The Australian terms of trade (TT, base 1989/90=100) and Victorian unemployment rate (U) was obtained from the Australian Bureau of Statistics (ABS) on-line time series. The terms of trade index is defined as the ratio of the implicit price deflator for exports of goods and services over the implicit price deflator for imports of goods and services. Time series for Victorian Gross State Product, seasonally adjusted and in constant 1989/90 prices, was obtained from the ABS Australian National Accounts: State Accounts (Catalogue No 5242.0) and is as defined therein. For the SVAR model, the deseasonalised terms of trade and real output data were used.

Data on the Victorian terms of trade was only available for a limited period of 21 quarters between 1992 and 1997 (see ABS, 1997). The Australian terms of trade was substituted to ensure a reasonable number of observations. The correlation between the Victorian terms of trade and the Australian terms of trade over this period was 0.96. Victorian GSP increased from 1984 to 1997 with the exception of a decrease during 1990/91 (see Figure 1). The Victorian unemployment rate rose significantly during 1990/91, peaking above nine per cent in 1994 and decreasing to less than eight per cent in 1997. The Australian terms of trade index declined markedly during 1986, increased during 1988/89 before going through another trough in 1993 and rising again from 1994 onwards.

The SVAR model implies that real output, unemployment rate and terms of trade are non-stationary in levels, stationary in first differences and are not cointegrated.[3] The results from the Phillips-Perron (1988) unit root test, computed using the Bartlett kernel and with lag lengths determined by the data-dependent method of Andrews (1991), show that all three series were I(1) in levels and stationary in first differences (see Table 1).

Table 1. Summary Statistics and Unit Root Tests

Variable	Standard Deviation	Unit Root Tests	
		Levels	First Differences
Terms of Trade	0.0228	-1.779	-4.869*
Real Growth	0.0067	0.281	-2.845**
Unemployment	0.0280	-1.025	-3.608*

[3] There is some debate in the literature on the use of I(1) data in VAR systems. While it is not strictly true that a VAR requires I(0) data to produce stable results, the inclusion of I(1) data has been shown to bias coefficient estimates. For further discussion, see Hamilton (1994), Chapter 18.

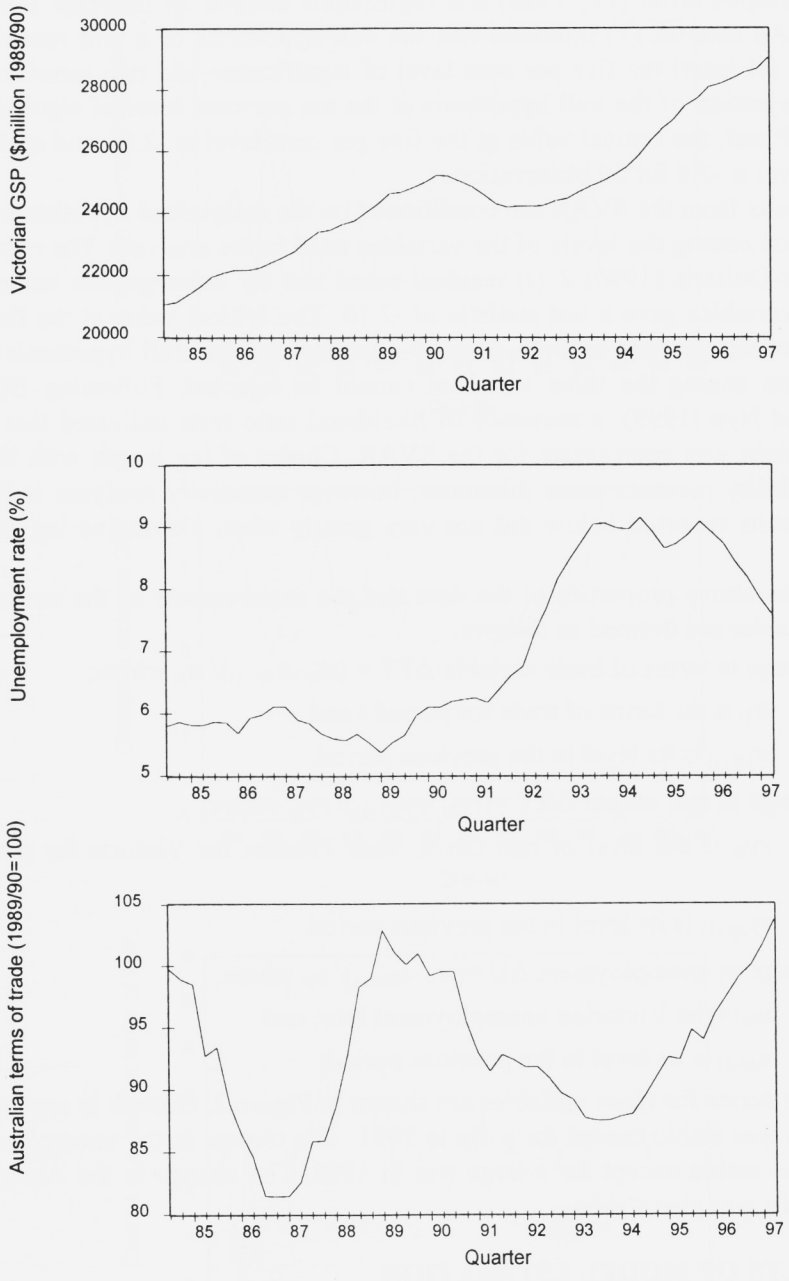

Figure 1. Victorian Gross State Product ($million, 1989/90 base), Victorian Unemployment Rate (%) and Australian Terms of Trade (1989/90=100), all Seasonally Adjusted, Quarterly 1984:3 - 1997:2.

The Phillips-Perron (PP, 1988) test regressions include an intercept term and four lags. An asterisk (*) indicates that the null hypothesis of a unit root can be rejected at (at least) the five per cent level of significance and two asterisks (**) indicates rejection of the null hypothesis at the ten per cent level of significance. (For the PP test, the critical value at the five per cent level is -2.93 and at the ten per cent level is -2.6 for 50 observations).

The results from the SVAR are conditioned on the maintained hypothesis of no cointegration among the levels of the variables used in the analysis. The results of the Phillips-Ouliaris (1990) Z (t) residual-based test for cointegration among the three I(1) variables gave a test statistic of -2.10. The critical value at the five per cent level of significance is -3.77, thereby implying that the null hypothesis of no cointegration among the three variables cannot be rejected. Following BQ and Keating and Nye (1999), a sequence of likelihood ratio tests indicated that a lag length of eight was appropriate for the SVAR. Choice of lag length with limited data availability presents some dilemmas, however sensitivity analyses indicated that the results reported below did not vary greatly when alternative lag lengths were used.

Given the above properties of the data and the requirements of the model, the SVAR variables are defined as follows.

The change in terms of trade variable $\Delta TT = (tt_{1t} - tt_{1(t-1)})/ tt_{1t}$ where;

tt_{1t} is the terms of trade for period t and

$tt_{1(t-1)}$ is its level in the previous period.

The change in real output $\Delta RY = (ry_{2t} - ry_{2(t-1)})/ ry_{2t}$ where;

ry_{2t} is the level of real Gross State Product for Victoria for period t and

$ry_{2(t-1)}$ is its level in the previous period.

The change in unemployment $\Delta U = (u_{3t} - u_{3(t-1)})/ u_{3t}$ where;

u_{3t} is the Victorian unemployment rate; and

$u_{3(t-1)}$ is its level in the previous period

The time series for these variables are shown in Figure 2. Growth in real output for Victoria was stable except for a dip in 1991. The change in the unemployment rate was also stable except for a large rise in 1992. The change in the Australian terms of trade was also stable.

4. RESULTS OF MODEL ESTIMATION

The decomposition of the forecast error variance from the SVAR model, which is presented in Table 2, indicates the relative importance of the three shocks in contributing to the variation in output and unemployment. The primary source of shocks to Victorian output from these results is the terms of trade. The decomposition shows that, in the short-run (five quarters), shocks to the terms of

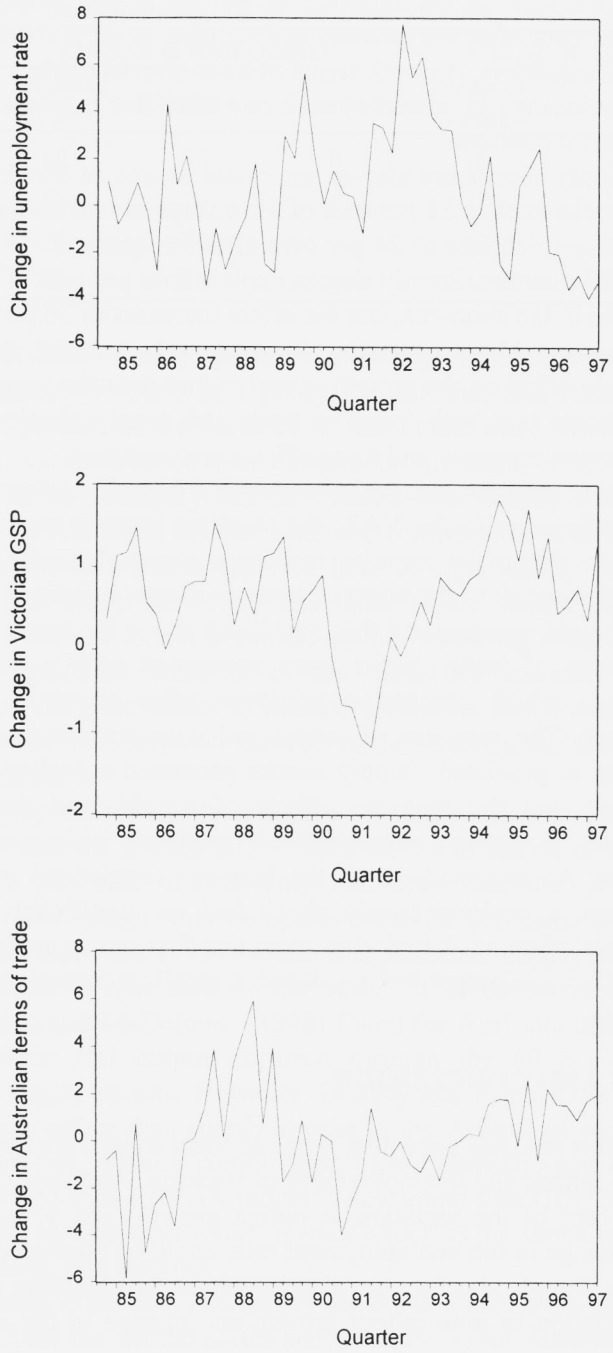

Figure 2. Change in Victorian Gross State Product, Change in Victorian Unemployment Rate, and Change in Australian Terms of Trade, in Percentages, Quarterly 1984:3 - 1997:2.

trade explain 68 per cent of the variation in growth in real output. This effect increases to 71 per cent after ten quarters and remains at 62 per cent in the long-run, that is, after 20 quarters. As well, terms of trade shocks explain 18 per cent of the variation in the change in unemployment rate after five quarters and this rises to 41 per cent after 20 quarters.

In addition, supply shocks are also an important source of shocks to Victorian output. Supply shocks explain 38 per cent of the change in real output growth after 5 quarters. This effect declines to 24 per cent after ten quarters but rises again to 32 per cent after 20 quarters. Supply shocks explain four per cent of the change in unemployment rate in the short-run, but the effect increases to 36 per cent after ten quarters and remains at 35 per cent after 20 quarters. In contrast, demand shocks appear to have little effect on the growth in real output over the long- or short-run. These results indicate that both terms of trade and supply shocks have a large effect on the Victorian economy and these effects are persistent.

The impulse response functions are presented in Figure 3. As the variables were entered as first differences in the VAR, the resulting impulse response functions were cumulated to obtain the impulse responses shown here for the levels of variables. A positive shock to the terms of trade produced increased output, which peaked at around eight quarters and then stabilised above the equilibrium level in the long-run. Terms of trade shocks were associated with a decrease in the unemployment rate which reached a minimum after about 12 quarters but remained persistent. The response of output and unemployment to demand and supply shocks was as predicted. Supply shocks generated a decline then a rise in the terms of trade, yet the long-run effects of supply (and demand) shocks asymptote to zero. A positive supply shock produced a long-run permanent increase in output. As expected, given the long-run restrictions imposed in the model construction, a positive supply shock had no significant effect on the unemployment rate after an initial rise over the first seven quarters. Demand shocks had no effect on output but produced a small and persistent rise in the unemployment rate.

5. DISCUSSION AND CONCLUSION

The results from this analysis show that terms of trade shocks are the major source of fluctuations in output and unemployment in Victoria. After twenty quarters, as much as 62 per cent of the variation in output growth, and 41 per cent of the variation in the change in the unemployment rate, could be attributed to a shock to the terms of trade. Supply shocks were also important, contributing approximately a third of the variation in both output growth and change in the unemployment rate.

The contribution of terms of trade shocks to the variance in output growth in Victoria can be contrasted with that estimated for Australia in Cashin and McDermott (1998). They found that, for the Australian economy over the period 1970-1997, terms of trade shocks explained about twenty per cent of the variation

Table 2. Decomposition of Forecast Error Variance (Percentage Changes)

Quarters	Growth in Real Output			Change in Unemployment		
	Terms of Trade	Supply	Demand	Terms of Trade	Supply	Demand
1	62	38	0	18	4	78
5	68	26	4	27	12	60
10	71	24	5	40	36	42
20	62	32	5	41	35	24

in real output after twenty quarters. Similarly, Otto (1995) found, using the Australian balance of trade as a proxy for demand, that terms of trade shocks explained ten percent of the variance in real output after twenty quarters and 44 per cent of the variance in the trade balance for Australia. While the effect of terms of trade shocks on unemployment in Victoria after twenty quarters is similar to Otto's result for Australia, (41 per cent) the contribution of terms of trade shocks to output growth in Victoria reported here is significantly higher after twenty quarters (62 per cent). However, this latter figure should be interpreted with caution as the current model is limited by not including a variable which would indicate the significant influence of the Australian economy on the Victorian economy. Extending the model to include a variable which would reveal the role of the Australian economy and thereby further decompose the economic shocks would be worthwhile.

Whilst supply shocks in Victoria have less effect on output growth than supply shocks reported in the literature for Australia, the influence of supply shocks was important (32 per cent after twenty quarters). Keeping in mind the above limitations of the model, this compares with 88 per cent determined by Otto (1995). Ahmed and Park (1994) found that domestic supply shocks in Australia explained around 80 per cent of the variation in output after 20 quarters. In addition, Cashin and McDermott (1998) found for Australia that the major source of fluctuation in real output occurred through the 69 per cent of variation explained by supply shocks. However, Dungey and Pagan (1997) found a greater role for demand rather than supply shocks in the Australian economy in both the long- and short-run, when a combination of ten domestic and overseas variables were incorporated into a SVAR model. They found that GDP did not necessarily rise in response to a positive terms of trade shock as the shock was ameliorated by a strong exchange rate response.

The responses to demand and supply shocks in Victoria are qualitatively similar to those of BQ for the United States and Otto (1995) for Australia. In Victoria, the unemployment rate rises in the short-run but exhibits a small and persistent decrease in the long-run in response to a positive supply shock. In comparison, Keating and Nye (1999) found that supply shocks cause the unemployment rate to rise for some countries and not others when they used the BQ model to analyse

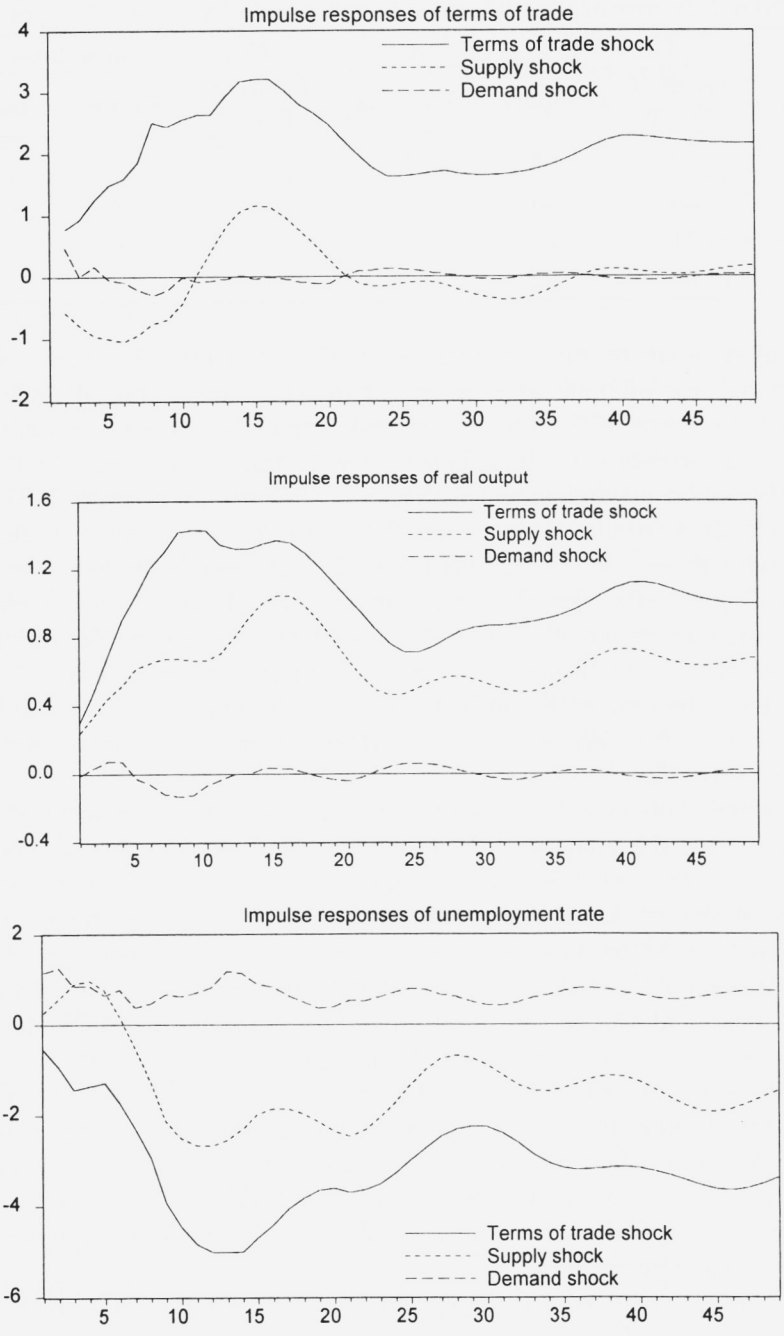

Figure 3. Impulse Response Functions of Terms of Trade, Real Output and Unemployment Rate to a One Standard Deviation Terms of Trade Shock, Supply Shock and Demand Shock (Cumulated).

demand and supply in the G7 countries. The unemployment rate rose temporarily following a positive supply shock for the United Kingdom, Italy and France. The unemployment rate in Germany had little response to a supply shock while the United States, Japan and Canada exhibited a fall in the unemployment rate. They concluded from this that each economy was subject to a variety of supply shocks but were more structurally sensitive to one type of shock; 'these different sensitivities across countries could be related to different structural parameter values and possibly to differences in the variability of shocks to labour supply and technology' (Keating and Nye, 1999, p275). They also point out, as did BQ, that the BQ model has the simplifying assumption of aggregate shocks and does not identify the underlying type of supply and demand shock. That is, if more than one type of supply shock is operating which affects output and unemployment in different ways, then the overall response of the economy may be difficult to interpret.

Nevertheless, the results suggest an important role for terms of trade shocks and supply shocks in Victoria relative to demand shocks. In relation to the terms of trade, Australia has a low trade share of GDP in comparison with other small, open economies. In addition, Australia is still reliant on commodity exports whilst its imports are predominantly manufactures and services (Gruen and Shuetrim, 1994). This trading situation also applies to Victoria, though the international trade share of GSP in Victoria is higher than that of Australia.[4] It is likely that volatility in the prices of commodity exports and the lack of diversity in the export base leads to volatility in the terms of trade and adds to the persistence of terms of trade shocks. The heavy reliance in Victoria on agricultural exports makes Victoria susceptible to terms of trade shocks caused by agricultural commodity price fluctuations, whilst facing essentially the same terms of trade and trading climate as Australia.

At the policy level, Victoria has a limited capacity to influence the macroeconomic variables which dictate its trading conditions as most fiscal, monetary and wage policy is made nationally. In turn, the Australian macroeconomy is largely circumscribed by the economic conditions in the rest of the world. If external terms of trade shocks are an important driving force behind Victoria's output fluctuations, as suggested here, then instruments at the state level to ameliorate these are limited. However, microeconomic reforms which improve the competitiveness of industry and increase diversification of the export base may act to reduce the effect on Victoria of shocks to the terms of trade. The long-run nature of terms of trade shocks suggest that short-run policy reactions are likely to be ineffective, whereas planning for output and employment changes from permanent changes in the terms of trade may be beneficial.

It is only possible to generalise about the nature of the supply fluctuations in Victoria from this analysis without further modelling. Supply fluctuations can

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[4] In Victoria, over the period 1992 to 1997, international trade share of GSP has increased from 28 to 37 per cent, but the export to import ratio has remained steady at around 2:3. (ABS, 1997).

generally be characterised into two types. The first type is usually short-term and pertains to agricultural-based economies, where adverse climatic conditions can generate a negative supply shock by reducing output and/or increasing the cost of production. It is possible that Victoria's reliance on export commodities such as wheat, wool and processed foods makes it vulnerable to supply shocks such as those caused by the severe droughts and low commodity prices occurring over the period of the study. It is also possible that the effects of agricultural supply shocks in Victoria are ameliorated by substituting trade in inputs and products from other States, as well as by secular improvements in agricultural productivity.

The second type of supply fluctuation relates to changes in the cost of production. This may be either a negative supply shock due to increased input costs or a positive supply change resulting from technology changes. Changes in telecommunications, information technology, transport and agricultural practices have an impact on aggregate supply in Victoria, as elsewhere. As well, there has been rapid structural change in the Victorian economy, particularly since the 1992 drought and recession. There has been re-allocation of resources from the public to the private sector and growth in the services sector of the economy relative to the primary and manufacturing sectors. It is difficult to say what effect these latter changes have had on Victorian GSP and unemployment.

Given the nature of supply fluctuations, the policy strategies for offsetting the effects of short term supply disturbances would also be short term, such as drought relief and income measures distributed through the welfare system. However, there is also scope for the adoption of agricultural practices which improve the resilience of the sector to adverse climatic conditions. In the longer term, efforts to realise the potential of technology and human resources to increase output, such as investment in education, research and development and improvements in infrastructure are required.

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