How Big Was the Effect of Budget Consolidation on the Australian Economy in the 1990s?*

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Abstract

This paper evaluates the effects of budget consolidation on the Australian economy in the 1990s by using a modified version of TRYM. By identifying the effects on long-term interest rates of the expected reduction in budget deficits in the 1996/97 financial year, the paper simulates the model for would-be impacts on the economy, had interest rates not fallen due to no budget consolidation. It is found that the program of budget consolidation did have a sizable impact on the economy, raising GDP by up to three quarters of a percentage point and reducing unemployment by 0.3 percentage points in two to three years.

Key words: budget deficits, interest rates, macroeconometric model, policy simulation, fiscal policy

JEL classification: H62, E62, C32, C52

1 Introduction

The effect of fiscal policy on an economy is a controversial and long-standing issue. It is at the heart of the policy debate surrounding sharp decreases in government deficits in developed economies in the 1990s, expected future budget shortfalls associated with the ageing of their populations, and the dramatic deterioration in the US fiscal outlook since 2001. This paper re-evaluates the effects of budget consolidation—turning government budget from deficit to surplus—on the Australian economy in the 1990s to shed light on this debate. A modified version of the structural macroeconometric model of the Australian economy, TRYM, will be used to assess the effects quantitatively.

The reversal of fiscal policy setting in Australia in the 1990s reflects concern about the long-term implications of a relatively low level of national saving and the imbalance existing between national saving and investment. In his Report to the Treasurer on national saving, FitzGerald (1993) argued that the strategy for raising national saving should focus primarily on the public saving component, a view also reflected in numerous fiscal policy statements during the course of the decade. In its 1996 Budget Statements the newly elected government endorsed a medium term fiscal strategy with 'the objective of maintaining an underlying balance on average over the course of the economic cycle' (Commonwealth Treasury, 1996a, p.1-9) along with other measures of 'Budget Honesty'. Since then, the bipartisan nature of the general strategy to raise public saving has moved the orientation of fiscal policy towards long-term issues.

FitzGerald's Report coincided with the peak in the public sector deficit and there has been considerable success in shifting the fiscal position in the following years. The general government sector cash deficit as a per cent of GDP on a consolidated basis has fallen from 4.0 per cent in 1992/93 to 1.0 per cent in 1996/97. The fiscal position of the general government sector has been turned around to surplus since then and the surplus reached 2.1 per cent of GDP in 1999/2000.[1] As Gruen and Stevens (2000, p.67) pointed out, achieving continued medium-term fiscal balance and maintaining fiscal restraint and discipline represent an appropriately prudent course of action to maintain the confidence

[1] See Commonwealth Treasury (2003, Appendix C) for historical data for Australian government fiscal aggregates across the general government sector.

of foreign investors over the two decades of high current account deficits.

In a policy forum evaluating the impact on the economy of the first two tightening budgets of the Howard government, Olekalns (1998), from his survey of the literature, argues that the fiscal tightening would have a minor impact on the level of aggregate demand because of the offsetting effect on expenditure of induced changes in the exchange rate and induced changes in wealth, in addition to the effects of possible offsetting changes in monetary policy. Olekalns, however, also points out that the cutbacks to government expenditure, particularly in public capital, could impose some dangers in the medium to longer term. Using a version of TRYM, MON–TRYM, Dixon, Malakellis, McDonald and Meagher (1996; 1997) assess the possible macroeconomic effects of the expenditure cuts as announced in the 1996/97 and 1997/98 Budgets. They find that even though the budget cuts were worth about 1.5 per cent of GDP, by the eighth quarter after its introduction, real GDP would only be 0.5 per cent below the base line forecasts.

This paper will use a modified version of TRYM to compare actual history with counterfactual simulations of budget consolidation in the 1990s. Both the cuts in government expenditure and responses of financial markets, the later of which has significant implications for business investment, will be taken into account in the counterfactual simulations. The organisation of the paper is as follows. Section 2 briefly describes the possible macroeconomic effects of budget consolidation. This is followed in Section 3 by a discussion of responses of financial markets to fiscal restraint and discipline. The fourth section reports the results of counterfactual simulations, and the last section concludes. Modifications to the TRYM model are discussed in an appendix.

2 Macroeconomic effects of budget consolidation

To gain insight into the economic effects of budget surpluses or deficits in the long-term, it is useful to start with some concepts. National saving (S) is the sum of private saving and public saving. National saving and net foreign capital inflow (NFI) are used to finance domestic investment (I), which is the net accumulation of assets in the economy. That accumulation of assets will increase the capital stock, which in turn

will raise national income in the future. The following identity between saving and investment reflects the two sides in the market for loanable funds:

$$\Delta S + \Delta NFI = \Delta I \tag{1}$$

This identity highlights two key aspects of budget consolidation when the fiscal position improves or even turns from deficit to surplus, holding other factors constant. One is that a decrease in the budget deficit (i.e., an increase in public saving) increases national saving, unless it is fully offset by a decrease in private saving. The other is that an increase in national saving must correspond to an increase in national investment and in future national income, unless it is fully offset by a decrease in net foreign capital inflow.

A key issue here is the response of private saving to a change in public saving. In the view of the Ricardian equivalence hypothesis advanced by Barro (1974), as government saving rises private saving falls by the same amount and therefore there is no change in national saving and no further adjustments in national investment. While it offers a theoretical benchmark for analysis and a deeper understanding about the effects of government deficits on the economy, Ricardian equivalence does not describe the world.[2] The view held by most economists and almost all policymakers is that private saving will fall by less than the full amount that public saving rises, and therefore national saving rises, and further adjustments are needed to bring saving and investment back into balance. This is the 'conventional analysis' of budget deficits or surpluses described in Elmendorf and Mankiw (1999).

In addition, net capital inflows would also be affected by the changes in national saving. In a closed economy, the entire adjustment to the increase in national saving occurs through domestic investment ($\Delta S = \Delta I$). In an open economy with imperfect capital mobility, the rise in national saving and the resulting fall in interest rates induces some combination of an increase in domestic investment and a change in net capital inflows. The final effect on net capital inflows is ambiguous. On the one hand, a falling domestic interest rate relative to world interest rates would discourage foreign investors

[2]See Elmendorf and Mankiw (1999) for a survey on Ricardian equivalence.

and encourage domestic residents to invest overseas. On the other hand, An improved prospect of the domestic economy due to the increase in national saving would attract more foreign investment. Moreover, policy credibility associated with reducing budget deficits would also increase capital inflows as it reduces expected inflation and the risk premium of investing in the domestic economy.

This conventional view suggests a good case for eliminating budget deficits, as put by Feldstein (1995). Firstly, eliminating budget deficits would crowd in capital formation as in the accounting identity (1), thus increase real output in the medium to longer term. Secondly, a decrease in budget deficits would also lead to a reduction in government debt and associated interest payments, which would benefit the economy because paying less interests on that debt means in the future lower taxes and decreased associated distortions of economic activity. In addition to increased capital accumulation and reduced interest payments, fiscal discipline of having to balance the budget would also bring about responsible decision making in government spending, in which costs have to be justified by benefits. Feldstein argues that this alone would be a strong case for a balanced budget.

There is, however, a counter argument that runs as follows. Suggested by the literature, public investment, particularly in infrastructure, is complementary to private investment and it would not be undertaken by the private sector because of market failures.[3] If (this may be a big if) a deficit reduction requires a reduction in public investment, then the productivity of, and the incentives for and rewards from, private sector investment are reduced.

Australian evidence suggests that budget consolidation in the 1990s did lead to an increase in national saving. The balance in national saving, represented by the current account position, has risen after the release of FitzGerald's Report in 1993. The 10-year average of Australian current account deficit is -4.4 per cent of GDP from the December quarter 1993, which narrowed from an average of -4.6 per cent in the 10 years before October 1993 (ABS Cat No.5302.0).

One important transmission channel from saving to investment is through interest

[3]See, for example, Aschauer (1989) for the US, and Otto and Voss (1994; 1996) for the Australian evidence.

rates. Interest rates depend on expectations of fiscal policy and other variables and the response of financial markets to a change in the government's fiscal position would affect investment decisions of private agents. The next section turns to discuss the response of financial markets to budget consolidation and this response will then be used in the modified TRYM model to obtain the effects on the economy.

3 Long-term interest rates and budget consolidation

In an open economy with imperfect capital mobility, an increase in national saving implies an excess of loanable funds to finance investments given existing interest rates. That imbalance puts downward pressure on interest rates as creditors compete for the limited pool of borrowing demands. The fall in interest rates serves to stimulate domestic investment ($\Delta I > 0$). The increase in national saving and the resulting fall in interest rates induces some combination of an increase in domestic investment and a decrease in net capital inflows. These changes would ensure that the changes in both sides of the saving investment identity (1) are equal.

Normally long-term interest rates respond to expected changes in the government fiscal position. The rationale for this response is as follows. If the government announces a decision to reduce its budget deficit, the future path of government spending would be affected, and it has no immediate effect on demand. If this reduction in the budget deficit is deemed creditable, markets would expect future short rates to be lower as the central bank reacts to offset the effects of future fiscal policy on aggregate demand. The expectations theory of the term structure suggests that long rates are entirely governed by the expected future path of short-term interest rates. As a result, long-term interest rates would fall.[4]

Blinder and Yellen (2001) argue that the 1993 budget agreement by the Clinton Administration in the United States, which made a significant deficit reduction, 'galvanised the bond market' and the yield on 10-year US Treasury bonds fell from 6.6 per cent in early 1993 to 5.6 per cent by the end of 1993. This seems also to be the case in

[4]See Muhleisen and Towe (2004) for a survey of the relationship between budget deficits and real interest rates.

Table 1: Correlation between 10-year Treasury bond yields and fiscal aggregates

General government sector		As per cent of GDP	
	Financial year	Net lending	Cash surplus
Yields on nominal bonds	1970/71-2002/03	-0.50**	-0.27
	1986/87-2002/03	-0.33	0.06
Yields on indexed bonds	1986/87-2002/03	-0.63**	-0.44*

Bond yields are yearly averages and fiscal aggregates are financial year numbers.

** and *: significance at 5 per cent and 10 per cent levels, respectively.

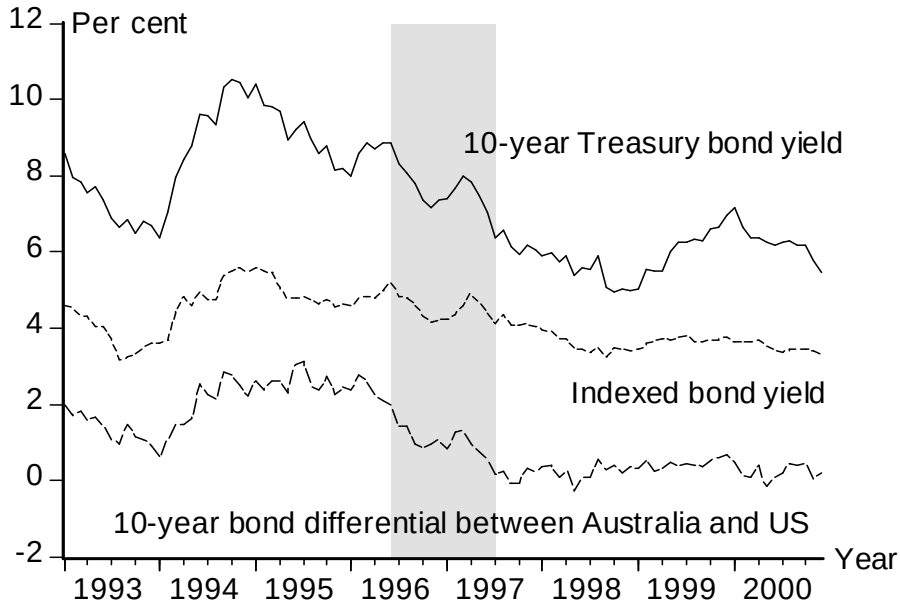
Source of data: RBA and Treasury.

Australia. A major macroeconomic initiative of the Howard Government in 1996 was to tighten fiscal policy, promising spending cuts of $8 billion over the next two years. The immediate response of the financial market to its election (on 4 March 1996) was a 20 basis point fall in the yield on 10-year Commonwealth Treasury bonds, the benchmark of the long-term interest rates. As one commentator pointed out on the *Australian Financial Review* on 5 March 1996, 'on the fiscal side, there will be more of a tendency to cut spending and provide a budget surplus which is positive for the bond market.' In the three days immediately before and after the Howard Government announced its first Budget on 20 August 1996, the 10-year Treasury bond yields fell by 27 basis points.

The Commonwealth Treasury issues both nominal and inflation-indexed 10-year bonds and the yields on them can be combined to provide policymakers with information on real interest rates and inflation expectations. The important information for policymakers is not the absolute levels of either the real interest rate or inflation expectations; rather, it is how they change in response to policy actions and changes in economic conditions. Table 1 reports the correlation coefficients between annual fiscal aggregates of the Australian general government sector and the yearly average yields on nominal and indexed 10-year Treasury bonds. One observation is that long-term interest rates move in the opposite direction to the government fiscal position: when the fiscal position improves, the long-term interest rates, particularly the real rates, decline. In the period 1986/87–2002/03 when inflation expectations changed substantially, the nominal yields had a very weak correlation with the fiscal position, but the real yields still had a strong correlation with the government budget.

Because the nominal interest rate on 10-year Treasury bonds is the sum of the real

Figure 1: Nominal and indexed 10-year bond yields: 1993–2000



interest rate, expected future inflation, and the inflation risk premium, the difference between the rates on nominal and indexed bonds is the sum of the expected rate of inflation and the inflation risk premium. In addition, Australia is a small open economy and as a result, movements in world interest rates also affect the interest rates in Australia. To gauge how much of a fall in the long-term interest rate can be attributed to the (expected) change in the government fiscal position, we have to look at both the yields on the nominal and indexed 10-year Treasury bonds and the spread between the Australia and US 10-year Treasury bond yields (a benchmark for world long-term interest rates). Figure 1 plots these three time series for the period 1993–2000.

Starting from a peak of 10.5 per cent in October 1994, the nominal 10-year bond yield began a substantial fall until reaching a low of about 5 per cent in late 1998. There are many factors contributing to such a big fall in nominal interest rates, and a creditable program of budget consolidation is certainly an important one. This five year period can be divided into three subperiods: before mid-1996, between mid-1996 and mid-1997, and after mid-1997.

In the first subperiod, the nominal 10-year bond yield fell by 1.7 percentage points,

but the indexed bond yield fell only slightly from 5.4 per cent to 5.2 per cent, and the 10-year bond differential between Australia and the US remained at about 2.5 percentage points. Therefore, the fall in the nominal rate in this subperiod can be attributed mainly to a fall in inflation expectations and movements in the international financial markets.

From mid-1996 to mid-1997, the nominal bond yield fell by about 2.5 percentage points, but more significantly, the indexed bond yield fell by more than 1 percentage point and the bond differential between Australia and the US narrowed to almost zero. This subperiod is highlighted in Figure 1. The sharp narrowing of the spread occurred because of Australia's better inflation performance relative to the US, and differences in the cyclical position of the Australian and US economies over this subperiod. Undoubtedly, the progress in reducing budget deficits and the expected stance of fiscal policy had also helped narrow the bond differentials.[5] As the Reserve Bank of Australia pointed out in its semi-annual statement on monetary policy in November 1997, 'the program of budget consolidation has put Australia in a much better position to withstand market pressures on bond yields.'

After mid-1997, the nominal and indexed bond yields continued to fall, by 1.4 and 0.7 percentage points respectively, but the bond differential between Australia and the US remained steady. This suggests that to a large degree, it was the movements in international financial markets driving the changes in Australian long-term interest rates between mid-1997 and the end of 1998. Table 2 lists the changes in the nominal and indexed 10-year bond yields and the differential between Australian 10-year bonds and corresponding US yields.[6]

It can be argued that from mid-1996 to mid-1997, after knowing the first budget of the new government and what would be in the second budget, market participants were convinced that the reduction in budget deficits would be creditable. This could have to some extent brought about a bond market rally, which had helped deliver a

[5]See Elmendorf (1996) for US evidence of a strong positive relationship between expected budget deficits and real interest rates.

[6]The argument of 'a rush to the bottom' could partly explain the change in the stance of fiscal policy across developed economies in the 1990s when fiscal discipline was a trend. Any country with the commitment to a balanced budget would be awarded by financial markets with higher credit ratings and lower premiums of domestic yields over world yields. The reduction of budget deficits among industrial countries, particularly in the US, helped lowered world real interest rates in the 1990s. See Muhleisen and Towe (2004).

Table 2: Movements in the 10-year bond yields and the bond differentials between Australia and US: percentage points

Percentage points	October 94– June 96	June 96–July 97	July 97–Dec 98
Nominal bond yield	1.7	2.5	1.4
Indexed bond yield	0.3	1.0	0.7
Bond differential	0.2	1.8	-0.2

Changes are monthly figures. Source of data: RBA and Federal Reserve.

one percentage point fall in the real long-term interest rate and an almost 2 percentage point fall in the premium for Australian yields over the US yields. The fall in long-term interest rates, partly attributed to the program of budget consolidation, also probably gave the economy a big lift. The next section tries to quantify the macroeconomic effects of this lift by simulating a modified version of the TRYM model.

4 Counterfactual simulations

long-term interest rates are important to investment decisions by affecting the user costs of capital and this is certainly the case in structural macroeconometric models, such as TRYM. The details of the TRYM model are described in Commonwealth Treasury (1996b; 1996c). For the policy analysis purposes of this paper, the June 2000 release of TRYM has been modified with the aim of better capturing empirical facts of the Australian economy of the 1990s and to dampen the magnitude of cycles generated by the original TRYM model. The modifications to TRYM are described in an appendix.

In short, there are three major modifications. One production function was estimated for both the public trading enterprises and private business sectors. A monetary policy rule similar to the Taylor's rule with interest rate smoothing was estimated to capture the behaviour of the Reserve Bank. In simulation the Fair-Taylor (1983) extended path procedure for rational expectations models is used, which iterates on future paths of the expectation variables until achieving convergence. The modified model is able to track history and to converge to a long run equilibrium growth path defined in the model. The model is also comparable to a simple VAR model in terms of explanatory and forecasting performance.

From the previous section, a reasonable assumption, that a fall of 0.5 percentage

Table 3: Estimated effects of budget consolidation in the 1990s: deviation from baseline

Deviation from baseline	1997Q2	1998Q2	1999Q2	2000Q2
Scenario (a): higher long-term interest rate for one year				
GDP[a]	-0.20	-0.38	-0.19	-0.08
Unemployment rate[b]	0.04	0.13	0.11	0.05
Business investment[a]	-0.63	-1.07	-0.67	-0.30
90 day bill rate[b]	-0.08	-0.61	-1.03	-0.54
Net public sector borrowing[c]	0.07	0.05	0.07	-0.02
Current account deficit[c]	-0.02	-0.20	-0.09	-0.08
Scenario (b): higher long-term interest rate over the period				
GDP[a]	-0.20	-0.56	-0.66	-0.56
Unemployment rate[b]	0.04	0.16	0.25	0.24
Business investment[a]	-0.62	-1.66	-2.20	-2.27
90 day bill rate[b]	-0.04	-0.31	-0.66	-0.77
Net public sector borrowing[c]	0.09	0.20	0.34	0.36
Current account deficit[c]	-0.02	-0.21	-0.27	-0.30
Scenario (c): higher long-term interest rate and government expenditure				
GDP[a]	0.22	-0.31	-0.70	-0.78
Unemployment rate[b]	-0.15	0.01	0.18	0.26
Business investment[a]	0.25	-0.93	-1.95	-2.45
90 day bill rate[b]	0.26	0.38	-0.05	-0.48
Net public sector borrowing[c]	0.75	0.84	1.02	1.14
Current account deficit[c]	0.55	0.27	0.10	0.07

Source: authors' simulations.

[a]per cent. [b]percentage points. [c]percentage points of nominal GDP.

points in the 10-year bond yields is attributed to budget consolidation, is used to assess the possible effects of the change in fiscal policy. This section looks at three simulation scenarios in the period from the September quarter 1996 to the June quarter 2000.

Scenario (a) is a delayed budget consolidation, that the long-term interest rate was 0.5 percentage points above the actual level from the September quarter 1996 to the June quarter 1997. Scenario (b) is a higher long-term interest rate, 0.5 percentage points above the actual level in the simulation period, due to no budget consolidation. Scenario (c) assumes that due to no budget consolidation, the long-term interest rate was 0.5 percentage points higher and government expenditure was $1 billion per quarter above the actual levels in the simulation period.

Table 3 reports the deviations from the baseline for five variables: real GDP, real business investment, the unemployment rate, net public sector borrowing and current account deficit, under these three simulation scenarios. Had the budget consolidation

been delayed for one year, and as a result the long-term interest rate was 0.5 percentage points higher than the actual level in the 1996/97 financial year, business investment would have been lower, which would have led to real GDP 0.38 percentage points below the baseline in mid-1998. The unemployment rate would have been higher by 0.13 percentage points in mid-1998. The monetary authority would have responded to falling domestic demand and lowered official interest rates by up to 1 percentage point in mid-1999. Net public sector borrowing, as a ratio of nominal GDP, would have increased marginally while the current account deficit would have improved a little in mid-1998. The delay in budget consolidation, however, would have had almost no long lasting effects on the economy by mid-2000 with real GDP and the unemployment rate almost returning to the baseline levels. In the modified TRYM model, the baseline economy was almost at an equilibrium in 2000 as unemployment was close to the estimated NAIRU. It is not surprising that the economy would return in a few years to the equilibrium after a temporary shock in long-term interest rates.

If there were no budget consolidation and as a result the long-term interest rate had been 0.5 percentage points higher throughout the simulation period, then the effects on business investment, GDP and unemployment are estimated to have been much bigger and to be sustained over the 1997-2000 period. According to the model, higher long-term interest rates would have led to a significant fall in business investment, by up to 2.3 per cent below the baseline level in mid-2000. Real GDP would have been 0.6 per cent lower and the unemployment rate 0.25 percentage points higher than the baseline levels in 1999 and 2000. As the economy weakening, the public sector would have suffered an increase in expenditure and a fall in revenue, and it would have borrowed more, up to 0.4 percentage points (as a ratio of nominal GDP) higher in 1999 and 2000, even as the simulation exercise assumes no change in government expenditure. The current account, however, would have improved since imports would have fallen significantly due to weak domestic demand.

Scenario simulation (c) evaluates the effects of both higher long-term interest rates and higher government spending. As shown in the table, the expansionary effects of not reducing the budget deficit were small. In the first year of an increase of $4 billion

in government spending, real GDP would have been boosted by only 0.2 per cent and unemployment reduced by 0.15 percentage points. The costs of running the budget deficit quickly exceeded the benefits. Had the program of budget consolidation been not implemented (implying higher long-term interest rates and government spending), real GDP would have been 0.78 per cent lower and unemployment would have been 0.26 percentage points higher than the baseline by mid-2000. With higher government expenditure, the public sector would have borrowed more, up to 1.1 percentage points higher, than the baseline case (or about 0.7 percentage points higher than that in the scenario (b)). The current account would have also worsened, particularly in the first year (1997), though recovered in the following years when imports declining significantly due to weaker domestic demand.

In all these scenarios, the Reserve Bank of Australia is assumed to follow a policy rule similar to the Taylor's rule with interest rate smoothing. With the economy weakening and prices falling, the monetary authority would have responded by lowering official interest rates. Without such a stimulatory policy reaction function in the simulations, the effects on real GDP and unemployment would have been bigger than those shown in the table.

5 Conclusion

In the early 1990s, Australia started to emphasise the role of fiscal policy on national saving in the medium to longer term. The need to improve the fiscal balance to make a contribution to raising insufficient national saving was argued forcefully in the June 1993 FitzGerald report. In its first budget in May 1996, the new government committed itself to a medium-term fiscal strategy to maintain an underlying budget balance on average over the course of the economic cycle. The financial markets seem to have been convinced that this strategy would be maintained and in turn delivered a significant fall in long-term interest rates, which has had a sizable impact on the Australian economy in the late 1990s.

It is identified that long-term interest rates in Australia have had a close relationship with fiscal aggregates of the general government sector. By analysing the movements

of 10-year nominal and indexed bond yields and the spread of Australian 10-year bond yields to corresponding US yields in the period from late 1994 to late 1998, the paper drew a conclusion that the program of budget consolidation announced by the Federal government contributed to the significant fall in Australian long-term interest rates. By assuming that budget consolidation resulted in a fall of 0.5 percentage points in long-term interest rates, this paper utilises a modified version of the TRYM model to evaluate the effects of budget consolidation.

A delay in budget consolidation, and the associated effect of the long-term interest rate being assumed to be 0.5 percentage points higher than the actual values from mid-1996 to mid-1997, would have had a small and transitory adverse impact on the economy with real GDP lower and unemployment a little higher than the actual levels. The economy, however, would have returned to the baseline by mid-2000. If the budget consolidation did contribute to the permanent reduction in the long-term interest rate, the economy received a significant and sustained boost from the rally in the bond market. The boost is estimated to be up to three quarters of a percentage point of real GDP and a 0.3 percentage point reduction in the unemployment rate. The impact on the economy of the cuts of government spending is estimated to be small and transitory.

As shown in this study and others, the sharp decreases in government deficits in developed economies in the 1990s have contributed to economic growth in the 1990s and beyond. Expected future budget shortfalls associated with the ageing of their populations and the dramatic deterioration in the US fiscal outlook since 2001 are therefore likely to have adverse implications for the world and Australian economies in the medium to longer term.

A Appendix: Modifications to TRYM[7]

The TRYM model is a small scale macroeconometric model of the Australian economy for 'macroeconomic forecasting, policy analysis and sensitivity analysis'.[8] It has 122 equations, and among them 26 equations are estimated using data from the period since the late 1960s. TRYM is described as 'broadly new Keynesian in its dynamic structure but with an equilibrating long run' (Downes and Bernie, 1999, P.i).

A.1 TRYM

The TRYM model has a long run neoclassical balanced growth path with error correction adjustments in the short run. In the long run, the real economy grows at a constant rate equal to the underlying growth of labour productivity represented as Harrod neutral technical change, plus population growth. All prices in the long run will grow at the rate of inflation, which is itself exogenous. In the short run, however, there exists price stickiness. Product prices are assumed to adjust slowly towards their equilibrium levels which are derived from a production function. A homogeneity constraint is imposed so that changes in prices eventually will be fully reflected in changes in nominal wages.

There are three decision units: private business, household, and public; and three markets: goods (domestic and international), labour and financial. The basic labour market framework in TRYM bears many similarities with the system outlined in Layard, Nickell and Jackman (1991, Chapter 8).[9] Labour demand by the private sector comes from a profit maximising neoclassical model, with substitutability of labour and capital in production. A Beveridge curve relates unemployment to vacancies and represents matching efficiency in the labour market. A long run exogenous NAIRU means that labour demand ultimately depends on labour supply in equilibrium. A short run Phillips curve, or wage offer curve, adjusts wage rates in response to unemployment deviations from the NAIRU. Real wages have no effects on labour supply, but employment does have an encouraged worker effect in both the short and long run.

[7] This section is drawn from Song, Freebairn and Harding (2001).

[8] The details of the TRYM model are described in Commonwealth Treasury (1996b; 1996c). The documentation and related papers about TRYM can be found at the Treasury web site (www.treasury.gov.au) and the TRYM data set can be obtained from the ABS web site (www.abs.gov.au).

[9] The detailed discussions of the labour market in TRYM can be found in Downes and Bernie (1999).

The financial markets are said to be 'quasi-rational', that is, 'agents in the financial markets are assumed to have a mixture of forward looking and adaptive behaviour.' Rather than solving these expectations to be consistent with the dynamic path taken by the model, the values of the expectation variables are obtained from a corresponding steady state simulation, and they act as forward looking expectations in solving short run dynamics of endogenous variables.

The default fiscal and monetary policy reaction functions are not forward looking in TRYM. The labour income tax rate and the short-term interest rate react to economic conditions in current and previous periods. This implies that following a shock, the model adjusts slowly towards a new equilibrium. The short run partial adjustment in prices and wages and non-forward-looking policy reactions make model adjustments to shocks sluggish and they help to generate cyclical responses to changes in policies or other exogenous shocks.

A.2 Modifications

For the policy analysis purposes of this paper, the June 2000 release of TRYM has been modified with the aim of better capturing empirical facts of the Australian economy and to dampen the magnitude of cycles generated by the original TRYM model, which last about 14 years under the default fiscal and monetary policy reaction functions.[10]

The strategy in TRYM of separating government trading enterprises from private firms seems to have distorted the estimation results of the private sector production function, and in large part because privatisation artificially moved capital stocks from the public sector to the private sector in the 1990s. It was also found that the default monetary reaction function derived from a money demand function is the main reason for long cycles in TRYM simulations. In addition, the model was not solved consistently and the forward looking variables were not consistent with the dynamic model solutions. Therefore, three major modifications were introduced to improve model performance.

First, government trading enterprises are combined into the private business sector

[10]The June 2000 release of the TRYM model, representing the TRYM model in recent years, is different in some aspects from its initial release in 1996. The most recent releases of TRYM in 2003 are almost identical to the 2000 release. The reason to use the 2000 release is that the model has not been affected by the introduction of the GST.

Table 4: Monetary policy rule estimates (1985–2000)

Coefficient	Partial adjustment (ρ)	Inflation (β_1)	Output gap (β_2)	J-test
Estimate	0.39 (0.02)	1.09 (0.02)	0.14 (0.03)	0.227

Note: standard errors are in parentheses.

and only one production function for both public and private firms is estimated. As a result, the production function and other related equations are re-specified and re-estimated. As to monetary policy reaction, a simple policy rule allowing interest rate smoothing and exogenous shocks similar to the rule in Clarida, Gali and Gertler (2000) has been estimated for the Australian economy:

$$\begin{aligned} i_t &= (1-\rho)i_t^* + \rho(L)i_{t-1} \qquad (2) \\ i_t^* &= rr^* + \beta_1(\pi_t - \pi^*) + \beta_2(y_t - y_t^*) \end{aligned}$$

where $\rho(L) = \rho_1 + \rho_2 L^1 + ... + \rho_n L^{n-1}$ and where $\rho \equiv \rho(1)$. i^* is the desired level of the short run interest rate, and the actual interest rate (i) moves towards its desired level via a partial adjustment mechanism. rr^* is the long-run equilibrium real interest rate and is assumed to be equal to 2.5 per cent, the average real rate in the period 1960–2003.[11] The target inflation rate π^* is assumed to be 3 per cent. y^* is potential output derived from the re-estimated production function of the private sector in the TRYM model.

This monetary policy rule is implicitly forward looking, as decision makers do not know the outcomes of inflation and economic activity for the current quarter and in the Australian case they have to wait until at least the next quarter.[12] Equation (2) was then estimated for the sample period 1985Q1–2000Q2 by using the Generalised Method of Moments (GMM), with an optimal weighting matrix that accounts for possible serial correlation in errors.[13] The GMM estimates and the p-value associated with a test of the model's overidentifying restrictions (Hansen's J-test) are in Table 4.

[11] This period (1960–2003) has a common start and end inflation rate of about 3 per cent.

[12] An explicit one period ahead forward looking version of Equation (2) was also estimated and the estimates are similar to those in the text. Simulations based on this forward looking policy rule produce a similar path of endogenous variables with cycles one to two quarters shorter than those based on Equation (2).

[13] The instrument set includes lags of the cash rate, inflation, and the output gap, as well as the same number of lags of the terms of trade, M2 growth, and the 'spread' between the long-term bond rate and the 90 day bill rate.

The estimates of the βs have the expected sign and are significant. The coefficient associated with inflation (β_1) is significantly greater than one, indicating that monetary policy pursued by the Reserve Bank tended to be stabilising and was not accommodative of shocks to the economy. The estimate of the smoothing parameter (ρ) is high, suggesting considerable interest rate inertia.

In simulations, the modified model is solved by using the Fair-Taylor (1983) extended path procedure for rational expectations models, which iterates on future paths of the expectation variables until achieving convergence. The host model does not apply any iterative procedures.[14]

A.3 Properties of the Modified Model

Long run growth path and NAIRU

The underlying growth rate of private sector labour productivity is 1.81 per cent per annum and the elasticity of substitution between labour and capital is 0.69, which is slightly smaller than 0.79 in the host model but is bigger than 0.45 reported in Lewis and MacDonald (2002). The NAIRU is estimated to be 5.94 per cent with a standard error of 0.65. The point estimate is a little higher than the average unemployment rate of 5.5 per cent over the period 1960–2003, which has a common start and end inflation of about 3 per cent. A permanent reduction in the level of the NAIRU of 1 percentage point would lead to a temporary reduction in nominal wage growth of about 0.2 of a percentage point per quarter, other things being equal. In other words, if the unemployment rate was 1 percentage point higher than the level of the NAIRU, this would result in wage deflation of about 0.8 percentage points per year. This is, however, a temporary effect as nominal wage growth would return to the level of price inflation once the unemployment rate had fallen to the new NAIRU. In the long run, the unemployment rate equals the NAIRU.

Although the estimated NAIRU from the modified TRYM is comparable to those from other studies, the literature favours varying NAIRU estimates over time. After

[14]There are also some other minor modifications, such as for uncovered interest rate parity. Interest rate parity is assumed to hold in ten years in the host model, while the modified model assumes interest rate parity in a quarter.

estimating a Phillips curve for Australia with a constant NAIRU, Gruen, Pagan and Thompson (1999) report a NAIRU of 6.58 per cent with a standard error of 0.81. They argue, however, a constant NAIRU is not an attractive idea as Australian unemployment rose sharply in the mid 1970s and has never returned to its pre-1973 level. As a result, a time-varying NAIRU model was estimated which treats the NAIRU as a unit-root process. By the end of the sample (1997) their estimate of the NAIRU is about 5.5 per cent. Laubach (2001) uses several specifications of state-space models to obtain estimates of the NAIRU for major economies, including Australia, and reports the most precise estimates of the NAIRU for Australia: 6.3 per cent in the beginning of 1980, 8.0 per cent in early 1990 and 7.9 per cent at the end of 1998. The standard error is about 1.5.

There are other models such as the multiple equilibria model (e.g. Lye, McDonald and Sibly, 2001) with different values of the NAIRU in a time period. Hagger and Groenewold (2003) take another critical perspective on use of the NAIRU for policy, and instead they propose in addition to the NAIRU use of a measure for frictional unemployment plus a measure of unemployment for which macroeconomic policies have countered aggregate demand shocks.

Dynamic properties

Given the assumptions for exogenous variables, the model can produce a steady state growth path. With a shock, the model will deviate from the steady state path. Depending on whether the shock is permanent or temporary, the model will either converge to a new steady state or return to the existing steady state gradually, respectively. The dynamic path after the shock reveals that a cycle in real economic activity (from peak to peak) is about 6 years long and the modified model is able to converge to a steady state path in two to three cycles. The length of a cycle is similar to the average duration of classical business cycles in Australia from 1951-1997.[15]

Some other macroeconometric models of the Australian economy exhibit similar

[15] According to Boehm and Summers (1999), the average duration of a classical cycle is 77 months from peak to peak and 80 months from trough to trough, while the average duration of a growth cycle is 53 and 54 quarters, respectively.

cyclical patterns. Though not imposing a balanced growth path, the structural VAR model proposed by Dungey and Pagan (2000) allows a variety of growth rates by working with data that have been detrended via a regression on a constant and a deterministic trend. Hence their model can be thought of as describing the dynamics around a steady state that has to be set by the user. In their model simulations, the duration of a cycle in GDP is about 4 to 5 years, which coincides with the average duration of the growth cycles of the Australian economy. The small structural model in Beechey, Bharucha, Cagliarini, Gruen and Thompson (2000) projects rapid adjustments after shocks. For example, after a permanent increase of 1 percentage point in the real cash rate, the bulk of the contractionary effect in GDP is completed within three years, with no oscillations in GDP. The path of the unit labour cost after temporary shocks, however, does have oscillations around the new steady state, and these oscillations take several years to dissipate.

Past history for Australia, and for all modern economies, is characterised by cyclical economic behaviour. Many explanations and models have been published. Clearly there has to be debate about whether the key causal mechanisms in TRYM of cyclical behaviour, namely sluggish adjustment of prices and quantities to shocks, elements of backward looking expectations by households, firms and government, and stock-flow interactions, are the most appropriate causes of Australian cyclical behaviour.

Model explanatory and forecasting comparison

The modified TRYM model can be compared with other useful benchmark models, such as VAR models. A ten variable VAR model is used, which has two foreign variables: the log of world GDP, the world short term interest rates, and eight domestic variables: the log of real GDP, the log of the GDP deflator, the 90 day bill rate, the log of the trade weighted exchange rate, the unemployment rate, the log of employment, the log of real private investment and the log of private consumption. The choice of the variables is similar to those in Dungey and Pagan (2000) and Summers (2001). Each of the ten variables is taken to be a function of a constant, its first four lagged values, and the

first four lagged values of each of the other variables.[16] There are thus 9 coefficients to estimate for each of the ten equations.[17] The data used in estimating the VAR model are from the TRYM data set and the sample period is from January 1971 to June 2000, the same as in estimating the modified TRYM model.

Explanatory powers of the two models are compared in sample (1998 and 1999) and out of sample (8 quarters immediately after the estimation period), by stochastically simulating the models. Stochastic simulation requires an assumption about the distribution of error terms in the models. It is assumed that error terms are randomly drawn from estimated errors for in sample simulations, while out of sample simulations draw error terms from the multivariate normal distribution with the covariance matrix obtained from the estimated errors.

One simply draws values for error terms for each period of the simulation. Each repetition is one dynamic simulation over the period of interest (an eight quarter period in the paper). Each repetition yields eight predicted values, one per quarter, for each endogenous variable, and 1000 repetitions were made for each model. From these 1000 repetitions one also obtains an estimate of the expected value of the forecast of a variable in a certain period. The difference between this estimate and the actual value of the variable in that period is the mean forecast error, and then one can calculate summary measures of forecasting performance, such as mean absolute errors (MAE) and root mean squared errors (RMSE). Table 5 reports these measures for selected variables produced by the two models for both in sample and out of sample simulations.

The results in the table show that within the sample period, the modified TRYM model is better than the VAR model for unemployment and the 90 day bill rate, though it is worse than the VAR model for GDP and the GDP deflator. The summary measures for out of sample simulations clearly show that the VAR is noticeably better than the TRYM model but the differences, particularly in unemployment, are not big. It should be pointed out that some big shocks to the Australian economy occurred in the out of

[16] With a time trend included in the VAR, most of the summary measures would be worse.

[17] It is possible to decrease the number of unrestricted coefficients to estimate in the VAR model by imposing Bayesian priors on the coefficients. The stochastic simulation results from this Bayesian VAR model are similar to the VAR model, though slightly better than the VAR model. The following only reports the simulation results from the VAR model.

Table 5: Model comparison: TRYM and VAR

	GDP		GDP deflator		Unemployment		90 day bill rate	
	VAR	TRYM	VAR	TRYM	VAR	TRYM	VAR	TRYM
In sample	(1998Q1–1999Q4)							
MAE	0.47	0.64	1.19	1.58	0.24	0.21	0.75	0.49
RMSE	0.59	0.82	1.31	1.89	0.31	0.26	0.89	0.61
Out of sample	(2000Q3–2002Q2)							
MAE	1.85	3.17	0.87	1.89	0.85	1.14	0.75	1.17
RMSE	2.26	3.59	1.11	2.05	0.99	1.29	1.16	1.50

Note: MAE and RMSE are calculated from the difference between the expected value of each variable from 1000 stochastic simulations and its actual value for the period. For unemployment and the 90 day bill rate, the errors are in percentage points. For real GDP and the GDP deflator, the errors are expressed as a percent of the actual value (in percentage points).

sample simulation period (2000Q3–2002Q2), such as the introduction of the GST and the terrorist attacks in September 2001. One would expect that a structural model such as TRYM would have difficulties in forecasting an economy with unexpected large shocks. VAR models are more capable in doing such a task. The results in the table also show that the GDP deflator results are the weakest for the modified TRYM model and this is an area for future work.

A.4 Evaluation of TRYM as a Policy Model

A macroeconometric model, such as TRYM, has a number of advantages and disadvantages for policy analysis relative to, say, a qualitative and informal model analysis, partial equilibrium models and time series models.

The TRYM model captures most of the important direct and indirect, or feed forward and feedback, linkages in the economy. For example, changes in wages affect business hiring and investment decisions, they affect household incomes and consumption expenditures, they affect pricing decisions, and the model captures interrelationships between prices and quantities. In TRYM, monetary and fiscal policy settings can be made exogenous or set as endogenous policy reaction functions. These and other general equilibrium interactions are left out of partial equilibrium models, often they are implicit or ignored in qualitative analyses, and they are treated in a highly aggregated way in time series models.

Macroeconometric models, like any formal model, require the investigator to make

explicit assumptions about functions and parameters. This has the advantages of focussing the analyst's mind, of providing a way of explaining the underlying logic and transmission processes from policy change to simulated policy responses, and for focusing the debate on key areas of uncertainty and their effects.

The general analytical structure of TRYM, however, imposes *a priori* a number of important constraints which in turn partly predetermine the simulated effects of different policy options. TRYM has a long run neoclassical equilibrium closure. Pre-specified growth rates for labour augmenting technical change and workforce growth, and an essentially exogenous NAIRU, together with the requirements of model consistency and identities, determine the long run equilibrium growth rate of GDP and its components. In the long run monetary policy has no real effects, and the monetary policy rule determines inflation and nominal wage growth rates. The long run structure of TRYM, and assuming a convergent system, means that all policy alternatives have no long run real effects.

However, in the short and medium term, a period which exceeds ten years, TRYM simulations of aggregate prices and quantities can and do deviate from the long run equilibrium growth path. Short run dynamics, usually formulated as error correction models and estimated using historical time series data, arise from sticky wages and prices, from adjustment costs and lags, and from private sector expectations and government policy reaction functions which are in part driven by backward looking adjustments rather than entirely by rational long run model consistent outcomes. Because of these short run dynamics, macroeconomic expansion policies, wage interventions, and productivity changes will have short and medium term real effects in TRYM simulations.

Short run dynamics in TRYM simulations show a clear pattern of cycles and oscillations towards the long run equilibrium path. These cycles and oscillations are partly driven by slow stock adjustments, which result in under- and over-shooting of endogenous flow variables. Backward looking policy responses, and private sector expectations, are other important model structural characteristics contributing to the cyclical pattern. This cyclical pattern is also evident in some time series models, such as Dungey and Pagan (2000).

The model assumptions and estimated parameters for short run adjustments in TRYM represent a mixture of *a priori* specification and data estimation. As has been argued, they affect the simulated effects of policy options, and there can be legitimate debate as to their appropriateness as a simplified model of the Australian macroeconomy. A comparison of the explanatory and forecasting properties of the modified TRYM model with those of a ten variable VAR mode, both using the same date series, found comparable mean square errors for within sample explanatory power and a little worse than the VAR for the out of sample forecasting.

Results of TRYM simulations of fiscal and monetary policy stimuli are conditioned by lagged adjustments built into the model and by crowding out effects. The combination of backward looking expectations (though forward looking in financial markets) and sluggish responses of real quantities and some prices can generate cyclical responses and phases of undershooting and overshooting of responses to changes in policy and other exogenous variables. Crowding out effects arising from changes in government borrowing requirements affect interest rates, which in turn have impacts on business investment and international capital inflows, with the latter effecting changes in the exchange rate and then net exports. Increases in domestic absorption push up domestic prices which in turn change real labour costs and international competitiveness.

Interesting and important characteristics of TRYM are its inclusion of policy reaction functions for fiscal and monetary policy. In practice, Treasury modellers have experimented with alternative policy reaction functions, and the Taylor-type monetary policy rule with interest rate smoothing used in this paper is only a particular example chosen from a number of possible functions.

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