Wage Determination and the Labour Market in the Treasury Macroeconomic (TRYM) Model

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ABSTRACT

The labour market is a key area which determines how the macroeconomy responds to various shocks and policy changes. Yet it is also an area of great uncertainty and opinions differ on how to treat particular equations. It is quite clear from the work on segmented labour markets that behaviour at the aggregate level can sometimes have very complex roots. TRYM works at a high level of aggregation and is designed to explore the links between the labour market and other macro markets in a concise and coherent way. To do so requires some simplifying assumptions. (Hence TRYM cannot be used to explore questions of detail in the labour market area. For example, there are no relative wage effects in TRYM and no distinction between demographic or occupational groups.) However, TRYM does have significant advantages over simple partial analyses of the labour market to answer broad macro questions. For example, a simple partial analysis of the labour market might conclude that wage changes will only have a relatively minor effect on employment in the short to medium term, and that very large changes in the real wage would be required to eliminate unemployment at any particular time. Full model analysis on the other hand indicates that the employment response is relatively large and that only relatively small changes in real wages are required to reduce unemployment. This follows from the financial market reaction to reduced inflationary pressures coming from the labour market. As the economy has become more open over time, the interest rate and exchange rate effects on activity have become more important in transmitting any given wage shock to unemployment. The model also has the advantage of being able to explore the link between labour market imbalances and imbalances in other areas of the economy.

This paper re-examines the specification of the behavioural equations in TRYM particularly the wage equation, and takes the opportunity to represent some TRYM results on the effects of a change in the NAIRU. This paper is based on work in progress and is presented to obtain feedback on the work done before final specifications are incorporated into the model.

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INTRODUCTION

The deterioration in the performance of many OECD economies in 1970s and 1980s created new challenges for macroeconometric modelling. Macroeconomic models of this time proved unable to deal with supply shocks prevalent in the 1970s (eg) the two oil shocks. As a consequence, there was widespread recognition of the need to focus on the supply side of models. The test for model builders was to develop a framework that could explain short-run fluctuations, whether driven by demand or supply shocks, while ensuring that the model provided a long run solution that was internally consistent, both empirically and theoretically[1].

One of the most important aspects of the renewed focus on the supply side has been the re-examination of the labour market behaviour spurred on by the rise in and persistence of high levels of unemployment in most OECD economies. During the last ten to fifteen years a number of new theories have been developed to provide insights into how the labour market behaves and why persistence in unemployment might develop. Despite this work, labour market behaviour, particularly wage behaviour, remains a major source of uncertainty on the supply side of macro models. It is also a key area in determining short term responses, for example, of inflation to changes in demand and hence to policy trade-offs and results.[2]

The TRYM model was designed as a simulation model, based on aggregate data that takes account of the major interactions and linkages in the macroeconomy. TRYM therefore has an aggregated, simplified interpretation of the Australian labour market. This consists of three behavioural equations. These are: a wage setting equation (an expectations augmented Phillips curve), a labour demand equation, and a labour force participation equation (labour supply). In the TRYM model, households or workers make decisions on labour force participation and wage demands (independent from their consumption/savings choice), while firms make decisions about labour demand (employment levels), prices and investment. Investment, prices and employment are estimated jointly to ensure consistency with profit maximisation in the long run given estimated production technology.

The re-examination of the labour market specification presented at the June 1993 TRYM Conference was motivated by the desire to more fully integrate the specification of the various labour market equations and to improve their explanatory power. In particular it was to (by equation):

- *Wages:* examine the possibility of simultaneity in the wage and price relationship incorporated in the model[3]; and to explore the possibility that changes in the search effectiveness of the unemployed as evidenced by the changes in the unemployment/vacancy (UV) relationship had led to changes in the link between unemployment and wages. (A number of recent studies both in Australia and overseas have excluded long term unemployment from the unemployment measure used in modelling wages on the basis that the long term unemployed exert little leverage on the wage bargaining process - ie are not search effective.)

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[1] Notable examples included, work by Holley and Smith (1985) on the LBS model of the UK economy and Helliwell *et al* (1982) for the MACE model of the Canadian economy. In the Australian context, the AMPS model of the Australian economy (Murphy *et al*., 1985) is example of a model where particular attention was paid in the design stage to the nature of the model's long-run equilibrium.

[2] For example, Downes (1995) shows that the main uncertainty in deriving optimal policy responses is in deriving the non inflationary path for the economy which in turn is highly dependant on assumptions about wage behaviour.

[3] This was highlighted in applications of control framework developed for the TRYM (see Louis, 1995).

- *Labour Demand:* incorporate information about the demand for labour contained in unfilled vacancies data. Unfilled job vacancies represent the difference between the demand for labour and actual employment. Fluctuations in vacancies may mean changes in the demand for labour do not translate directly into changes in employment. Incorporation of the vacancies data should therefore help to estimate the true impact of factors which affect the demand for labour. In particular, it should help tie down the effect of wages.

- *Labour Supply:* re-examine the specification of the equation, in particular to explore the effect of demographics on the participation rate and to re-examine the role of after-tax real wages on labour supply decisions.

Given the source of potential changes to the wage and labour demand equations, the specification of the labour market has been extended to include an equation to endogenise unfilled vacancies. This equation captures the outward movement in the unemployment/vacancy relationship or Beveridge curve which occurred in the 1970s.

The paper is arranged in the following manner. Sections 2, 3 and 4 examine the wage, labour demand and labour supply equations respectively. Each section has a short introduction which briefly reviews the theoretical and empirical literature. Section 5 presents a full TRYM model simulation of the impact of a lower NAIRU, and how wage restraint flows through the economy. Section 6 draws some conclusions from this analysis.

WAGE DETERMINATION, THE NAIRU AND THE BEVERIDGE CURVE

2.1 Introduction

Wages have played a dominant role in shaping the course of the Australian economy over the past two decades. Yet, there remains little consensus on the determinants of wages.

Initially, attention focussed on the statistical relationship between nominal wage inflation and unemployment - the Phillips curve. The Phillips curve was thought to have provided policy makers with a trade-off between increases in unemployment and reductions in inflation. By the 1970s, however, the question was whether a long-run trade-off existed. The broad consensus in Australian literature is that Australia does not have a long run trade-off between inflation and unemployment. The subsequent re-examination of labour market behaviour introduced the concept of an equilibrium rate of unemployment. That is, there exists a natural rate of unemployment, independent of the inflation rate, at which any steady-state rate of inflation is possible but below which inflation will persistently accelerate.

High real wages in the face of continuing high unemployment from the second half of the 1970s onwards led to the development of alternative theories of unemployment and wage formation. The research into the reasons for the increase in unemployment can be divided into two broad streams:

- Wage setting explanations - such as the efficiency wage theory (and variants thereof), the insider or membership theory, and wage bargaining models tied to increases in union power or the reservation wage.[4] These theories suggest reasons why the labour market equilibrium may not be the market clearing equilibrium (the point where unfilled vacancies equal unemployment on the Beveridge curve).

- Search effectiveness theories. There are a number of factors that might lead to reductions in the effectiveness of the unemployed in filling available jobs and hence explain the rise in unemployment. Increases in long term unemployment may lead to deterioration of skill levels or morale problems which reduce search intensity. Structural change (particularly in the face of relative wage rigidities) can increase the mismatch between the skills of the unemployed and available jobs. Increases in welfare benefits can reduce the incentive to seek employment. In all cases unfilled vacancies should rise for a given unemployment rate. The unemployed would be less search effective and the unemployment rate would be higher at the point where the market clears.

Some of these theories embodied the idea that the equilibrium unemployment rate depends on the history of the actual unemployment rate and takes a long time to return to equilibrium. This phenomenon is usually labelled ‘hysteresis’. On the wages setting side, the insider-outsider or membership theory of Gregory (1985), Blanchard and Summers (1986) and Lindbeck and Snower (1986) provides a reason why unemployment may be path dependant. The essential idea here is that the number of insiders will fall during a recession. As only insiders participate in the wage bargaining process (the welfare of the unemployed does not enter the equation), insiders will bid up wages as the economy comes out of recession and before unemployment falls back to its original levels. Unemployment will tend to ratchet up after each recession. (Necessary adjustments to the capital stock can amplify this process - see Bean (1989). In its extreme form, the insider theory leads to the conclusion that there is no equilibrium rate of unemployment even in the long term.)

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[4] See, for example, Stiglitz and Shapiro “Equilibrium Unemployment as a Worker Discipline Device”, Yellen “Efficiency Wage Models of Unemployment” and Blanchard and Summers “Hysteresis in Unemployment” collected in Mankiw and Romer (1991).

Similarly, there are hysteresis explanations from the search effectiveness point of view. Higher unemployment leads to higher levels of long term unemployment. Higher long term unemployment leads to deterioration in skill levels and possible morale problems which reduce search intensity. The loss of human capital and reduction in search effectiveness associated with long periods of unemployment will lessen the potential competition from the unemployed leading to higher wage pressures at a given rate of unemployment. Thus, the equilibrium rate of unemployment increases.

However, these theories are not mutually exclusive. It seems likely that the behaviour of unemployment is due to a range of factors both on the wage bargaining side and the search effectiveness side.

Wage Bargaining

The theories on the wage bargaining side are particularly diverse. Originally these tended to be a little ad hoc. However, more recent developments have used micro foundations to explain wage determination. The focus of this research has been centred around four possible mechanisms for wage determination (summarised in Layard and Nickell, 1985). The first group of models allow real wages to be determined by supply and demand (ie) by impersonal forces. The second group of models involve firms setting wages, many of which are summarised in Johnson and Layard (1984). Efficiency wage models are one type of such models. These models have the property that an increase in the wage paid generates a benefit to the firm, which partially offsets the direct cost. For example, increasing wages relative to external wages raises employees' work effort[5].

The third and forth groups of models are union and bargaining models. The bargaining type of model forms the basis of the influential analysis by Layard and Nickell (1986). They argue that all four mechanisms may be used in various sectors of the economy, so it is important that a wage equation be sufficiently general to encompass all these forms of behaviour. The most general form of the wage equation is generated by the last of the above mechanisms, and so is the one concentrated on in their work. Layard and Nickell develop a three equation model for determining wages, prices and employment, emphasising the role of 'push' variables, including tax wedges, real import prices and mismatch between unemployment and vacancies. For given values of such variables there is a unique level of unemployment, the NAIRU, which leads bargainers to settle for a real wage which is consistent with that which firms are willing to accept in their pricing behaviour.

2.2 Empirical Literature

The specification of the wage equation has important implications for the overall properties of econometric models. The wage equation in most macroeconomic models is an important link in the resolution of the overall association between changes in unemployment and inflation. Consequently, a vast empirical literature has evolved trying to effectively model the wage determination process. The following sections discuss the findings of empirical work on wage equations that have been useful for our analysis.

Labour Market Pressures

A major concern with wage equations for the Australian economy has been the adequate modelling of labour market pressures. A common feature of wage equations has been the inclusion of a term related to the level of unemployment. The unemployment rate is included by invoking the Phillips curve, efficiency wage models or bargaining models of wages. The higher the level of the unemployment rate, the weaker will be the bargaining position of employees and the lower the level of wage increases.

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[5] See, Stiglitz and Shapiro "Equilibrium Unemployment as a Worker Discipline Device" collected in Mankiw and Romer (1991).

The Phillips curve has been the dominant approach to modelling wage determination in Australian empirical literature. This is largely due to the fact that it immediately reveals the long-run equilibrium rate of unemployment on a fixed growth path and hence pins down the equilibrium level of labour utilisation in the economy without recourse to any other behavioural equation.

The hysteresis effect has also been investigated through the wage equation by looking for the effects of the rate of change of the unemployment rate as well as the unemployment level. Simes and Richardson (1987) adopt this methodology in examining whether a stable expectations-augmented Phillips curve existed in Australia. They use a modified expectations-augmented Phillips curve specification which incorporates variables related to both the level and the change in unemployment for labour market pressure. Their results suggested that wages were influenced by the level of unemployment, as well as, the reaction of those in secure employment to changing labour market conditions, in their case the level of overtime (related to change in the unemployment rate).

However, the adoption of the expectations-augmented Phillips curve approach has been questioned by some commentators. Grubb (1986) provided evidence against the expectations-augmented Phillips curve restriction for all OECD countries, whereas Hughes (1985) observes that "perhaps this formulation of wage theory has been imported too readily into Australia". Gregory and Smith (1983) argue that those in secure employment are sensitive to changes in, rather than levels of, labour market conditions. While Watts and Mitchell (1990) employ a wage equation using the change in capacity utilisation as its labour market pressure variable and conclude that "there is not a steady state or natural rate of unemployment". Accordingly, they argue against the "conventional Phillips curve relating inflation and unemployment."

Layard and Nickell Framework

Wallis (1992) examines the econometric implementation of wage equations developed within the Layard-Nickell framework for Australia. He notes that it is of interest to an Australian audience that Nickell (1988) adds income policy to the list of wage-pressure effects that might be investigated in the Layard-Nickell framework. However, he adds that Nickell then observes that "appropriate data may not be available and the relationship between the available data and the true wage pressure variables is likely to be weak. As a consequence, the wage equation lacks robustness because trends and dummies have to be used to cope with these problems."

Wallis also raises the question of how appropriate the Layard-Nickell bargaining model is in an Australian context. He argues that "as for the wage determination process itself, neither the empirical results nor institutional knowledge support the basic bargaining model....". He continues that "Australian negotiations have clearly gone beyond the wage, to include such matters as taxation and investment incentives during the life of the Prices and Incomes Accord, and unions encroach on the firm's 'right to manage' whenever large scale redundancies are planned. Equally clearly negotiations have involved another party, namely government.....Theoretical bargaining models are not yet sufficiently developed that they can provide good guidance to empirical research in this context...".

2.3 Approach in TRYM

It is reasonably clear from observing the history of wage setting in Australia that institutional factors have played a large role which makes modelling wage behaviour a difficult exercise. It is also clear from the brief discussion above that it is difficult to distinguish between alternative theories of wage behaviour from the aggregate data. As Nickell (1988) and Bean (1990) point out, aggregate wage behaviour is likely to reflect a mix of factors, some of which may be more important in some sectors than others. Given the need for parsimony in modelling the labour market in TRYM, it is not possible to introduce the detailed disaggregated data required to distinguish between the different theories

(although the inclusion of the change in unemployment term is suggestive of insider-outsider effects being present in the data to some extent).

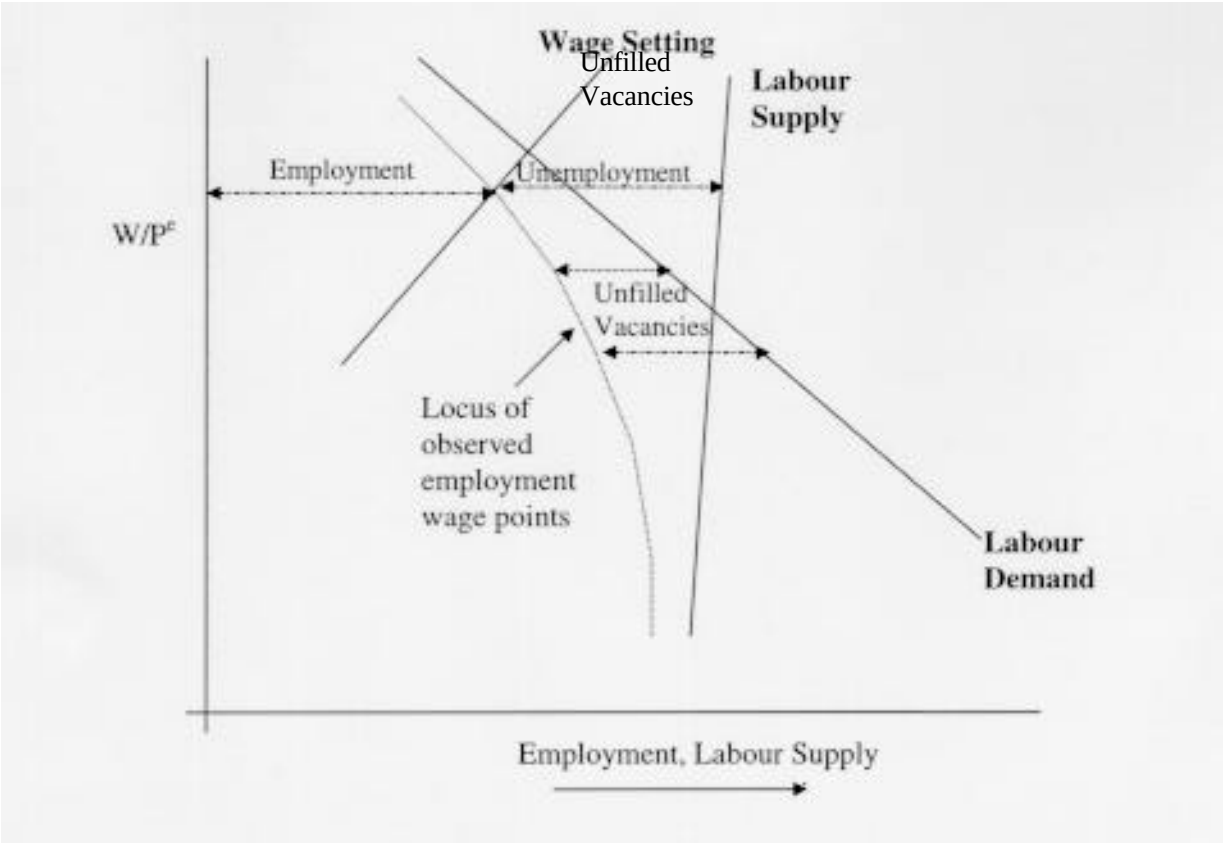
However, it does appear to be possible to distinguish between search effectiveness and wage setting explanations of the increase in unemployment at a very broad level by the use of unfilled vacancy data. Any decrease in the search effectiveness of the unemployed (for whatever reason) should lead to an increase in unfilled vacancies for a given level of unemployment. The unemployment/vacancies relationship thus represents a powerful summary indicator of the state of the labour market, and there has been something of a resurgence in interest in this relationship over recent years. Some have attempted to examine the Beveridge curve in combination with the Phillip's curve to identify the sources of unemployment shocks. Blanchard (1988) for example, does this for the US, UK and Germany and concludes that labour market efficiency and mismatch problems (ie a reduction in search effectiveness) explain most of the rise in unemployment in the US and the UK but not in Germany. Attempts to replicate the Blanchard approach for Australia appear to indicate that only a part of the increase in unemployment can be explained by search effectiveness factors. This is consistent with earlier work by Trivedi and Baker (1985) and Matthews (1991).

Given the interest in search effectiveness factors (such as the increase in long term unemployment), a Beveridge curve is estimated to introduce a simple summary measure of search effectiveness into the wage equation. The introduction of vacancies data also has the advantage of helping to identify the labour demand equation. However, no attempt is made to comprehensively model the unemployment vacancy relationship. For example, it has become popular following the work of Jackman, Layard and Pissarides (1983) at the LSE and Blanchard and Diamond (1989) at MIT to use labour market flows data to estimate an equilibrium unemployment/vacancy relationship. The lack of gross flows data in TRYM and other relevant factors (such as immigration occupational or industry mismatch data, unemployment duration or other factors that researchers have found to be relevant to the relationship) meant that it is not possible to identify the cause of shifts within the context of the variables used in TRYM. A fairly simple formulation is therefore adopted for modelling purposes and the results of this should be interpreted with caution.

2.4 Overall Structure

The overall structure of the labour market adopted below can therefore be represented by the diagram below:

Figure 1: Stylised Representation of the Labour Market in TRYM



The model's labour market consists of an upward sloping labour supply curve (relatively invariant to the real wage (W/P^e); a downward sloping labour demand curve and an upward sloping wage setting curve (expectations adjusted Phillip's curve) which is vertical in the long run. The difference between labour demand and observed employment and wage outcomes is given by unfilled vacancies. The depiction above owes a lot to Hansen (1970) but with the addition of a wage setting schedule separate from labour supply.[6]

The wage setting schedule is a function of unemployment adjusted for search effectiveness (ie will shift with changes in the unemployment/unfilled vacancy relationship). This is achieved by introducing a variable (RNUSTAR)[7] which captures movements in search effectiveness as evidenced by movements

[6] Given that in TRYM, firms set prices while workers bargain over the nominal wage, a price setting curve a la Layard Nickell and Jackman (1991) could be added to Figure 1. This would be virtually horizontal in the medium to long term. That is, workers can only bid up the real wage in the short term in TRYM. In the medium to long term wages are largely determined by technology. Thus, analysis using TRYM leads to similar conclusions as that derived from the Layard Nickell and Jackman imperfect competition wage bargaining framework. See Section 5 below.

[7] The equilibrium unemployment variable (RNUSTAR) was calculated by inverting the long-run part of the Beveridge curve (see Section 2.5) and setting the vacancy rate equal to the unemployment rate. The inverted equation was then solved for the unemployment to give the equilibrium unemployment rate.

in the Beveridge curve (see Section 2.5) into the wage equation. This in combination with two wage setting parameters (WS an WS_0) determine the level of the NAIRU in the model.

In this framework, any increase in unfilled vacancies for a given level of employment (ie reduction in the search effectiveness of the unemployed) will lead to an increase in the NAIRU and shift the wage setting curve in Figure 1 to the left. That is, the Phillips curve will shift with the search effectiveness adjustment to unemployment. However, the wage setting curve can also shift independent of any shift in search effectiveness due to wage bargaining or insider-outsider factors discussed above. The wage setting parameter thus captures the effect on the NAIRU of other factors associated with the wage bargaining process. For example, it may reflect insider / outsider factors in combination with institutional features of the wage bargaining system.

This gives the following NAIRU term:

$$NAIRU = (RNUSTAR + WS) \times (1 - QS741) + (RNUSTAR + WSo) \times QS741$$

The TRYM wage equation also allows for a structural break in the NAIRU in the first quarter of 1974 to help explain the strong wages boom in 1974. The increase in the NAIRU is larger than would be suggested by the shift in the Beveridge curve. Moreover, estimates not incorporating this shift tend to lead to implausibly strong wage price dynamics and weaken the link between wages growth and the level of the unemployment rate.

The wages boom of 1974 has been a problem for researchers and particularly macroeconomic modellers for many years. In the NIF10 model, wages were not fully endogenous, and the events of 1974 where captured by indices for National Wage Case and Metal Trades award decisions. Simes and Horn (1988) in the NIFF model also utilised dummy variables to account for the timing of Arbitration and Conciliation decisions (although allowed the magnitude of wage decisions to reflect market forces), yet still reported difficulties in explaining wages in 1974. Simes and Horn (1988) also note that including 1974 data in their specification weakens the link between wages and the level of unemployment.

The current TRYM estimate of 7.0 per cent for the NAIRU is consistent with findings of other studies by Simes and Horn (1988) and Murphy (1992) of 6.5 and 7.1 per cent respectively. That said, the TRYM estimate has a large degree of imprecision. A ninety five per cent confidence interval would place the true value of the NAIRU somewhere between 8.6 to 5.3 per cent.

Chart 1 shows the TRYM estimates of the search effectiveness variable (RNUSTAR) since the 1970s (see Section 2.5). This shows that reductions in search effectiveness have increased the unemployment rate by around half of a percentage point over the past twenty five years (although this estimate should be interpreted with caution). This compares with estimates of the NAIRU which have risen by around 2.6 percentage points. Hence, it seems likely that other factors associated with the wage setting process are also at work. This view is consistent with the findings of Trivedi and Baker (1985) who argue that the NAIRU has risen in Australia because of wage bargaining factors rather than search effectiveness factors. The distinction between the Beveridge curve and the wage setting curve is also outlined in the Ocean's Employment Outlook (1993) and in many other recent analyses of the labour market including Layard, Nickell and Jackman (1991).

2.5 The Unemployment/Vacancy (U/V) Relationship or Beveridge Curve

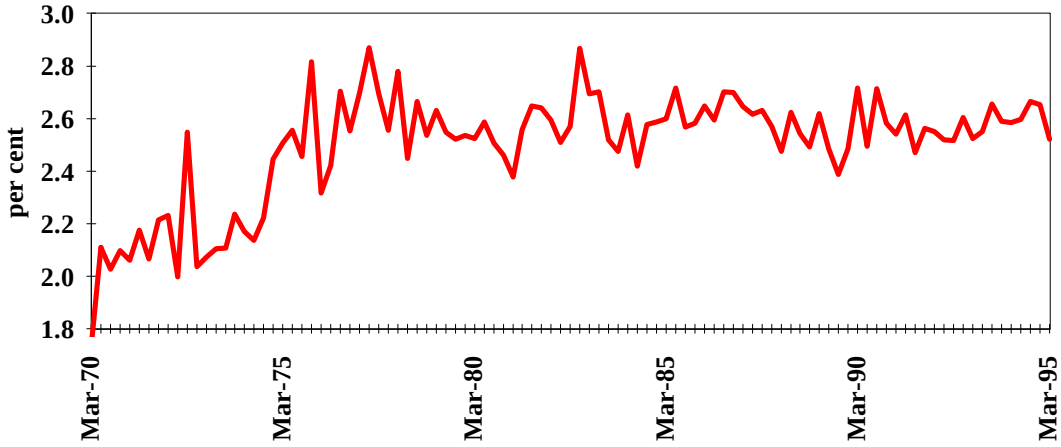
Traditionally, unemployment has been decomposed into frictional, structural and cyclical components. The gradual rise in the unemployment rate, in association with the increase in long term unemployment (LT), is suggestive that frictional and/or structural unemployment has increased over time. That is, due

to factors such as skills atrophy, diminishing job search skills, low morale and false signals that long unemployment duration may send to employers, the unemployment rate may not be exerting the same influence on wages that has occurred in the past. In other words, there may have been an outward movement in the unemployment/vacancy (U/V) relationship or Beveridge Curve.

Hansen (1970) provided the most widely used justification for the existence of the inverse relationship between the unemployment rate and the vacancy rate. According to Hansen, the convex shape of the Beveridge curve is caused by the effect that excess supply or excess demand for labour has on the matching of the unemployed to vacancies. He assumes that there are always, in a given short period, some employers who do not succeed in finding sufficient labour for satisfying their demands completely, even though total supply exceeds total demand. Furthermore, there will always be some members of the labour force who do not succeed in getting a job even though there is more than a sufficient number of jobs to employ the total supply. In terms of ordinary demand and supply theory, this means that actual employment is never on the supply or demand curves.

The TRYM approach to estimating the Beveridge curve for Australia is based around a dynamic error correction specification, including a logistical growth curve, to help capture the structural shift in the Beveridge curve thought to have occurred in the early 1970s. The logistical dummy allows the data to determine the size and timing of any structural break in the relationship. Chart 1 shows the search effectiveness adjustment derived from the equation (including unexplained movements). The relationship indicates a significant outward movement in 1974 (reduction in search effectiveness). Tests for a structural break in the 1980s early 1990s were unsuccessful.

Chart 1: Search Effectiveness Adjustment to Unemployment (RNUSTAR)



A similar result was found by Farrer and Pease (1993) of the RBA in a much more detailed empirical study of the Australian unemployment vacancy relationship.[8] They ran two models. The first was a simple model similar to the above equation. The second attempted to distinguish between cyclical changes and equilibrium movements in the unemployment vacancy relationship using the methodology set out in Layard Nickell and Jackman (1991) and employing ABS gross flows data to identify flows to and from unemployment. In neither case did they find any large outward movement in the relationship in the 1980s and early 1990s. With the simple model (which they ran with both the linked ABS vacancy series and an alternative series based on CES vacancies data) they found no outward shift in the 1980s, but a significant outward shift in the mid seventies. In the second model, they found an outward

[8]Other empirical studies of the Australian relationship such as Trivedi and Baker (1985), Hughes (1987) and Matthews (1991) have been virtually unanimous in finding a significant structural break in the mid seventies but no significant outward movement in the 1980s. The empirical studies all use the linked vacancy series.

shift in the equilibrium relationship around 1983-84 of about half a percentage point, but this was unwound in the late 1980s early 1990s (as long term unemployment fell).

The estimated Beveridge Curve equation is:

$$\Delta \ln(RNU) = -a_1 \times \Delta \ln\left(\frac{NVA}{NLF}\right) + a_2 \times \Delta LGF + a_3 \times \left\{\ln\left(RNU(-1)\right) - \left[c_0 + LGF(-1) + c_1 \times \ln\left(\frac{NVA(-1)}{NLF(-1)}\right)\right]\right\}$$

Logistical Growth Function: $LGF = b_1 / \left[1 + \exp\left(QTIME + b_2\right) / b_3\right]$

Results

Sample: 1967(3):1995(1)

Parameter	**Interpretation**	**Estimate**	**t-Statistic**
a_1	change in vacancy rate	0.219	5.79
a_2	change in LGF	2.600	2.21
a_3	error correction	0.136	4.18
c_0	constant	1.331	11.80
c_1	vacancy rate	0.812	7.09
b_1	LGF	0.356	2.28
b_2		15.270	318.33
b_3		0.195	5.50

Diagnostic Statistics:

R^2 = 0.66	
SE = 4.0%	
DW = 1.81	
Box-Pierce Q (1-8th order auto correlation)	6.00
Jarque-Bera test for Normality	3.88
Chow test for Parameter Stability	0.28
Ramsey's Reset test	2.75
Breusch-Pagan Heteroscedasticity tests:	
Trend	3.91**
Y-Hat	0.30
Joint	4.00**

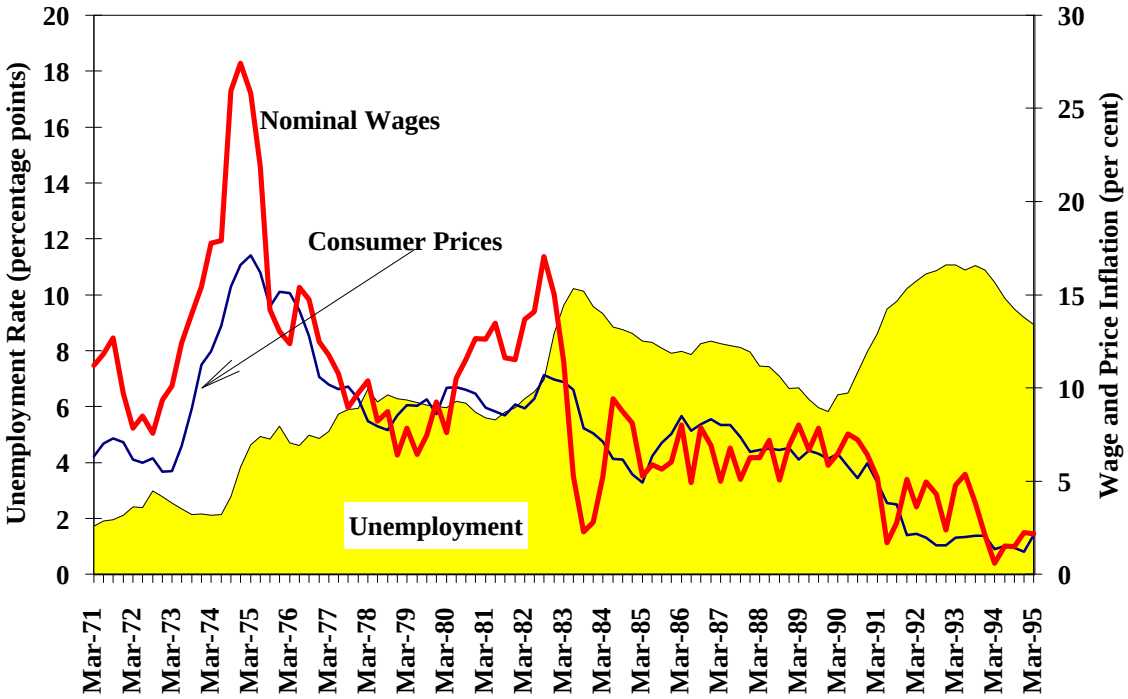
* indicates the test has failed at the 5% confidence level.

** inspection of the equation residuals revealed greater volatility in the period prior to 1980. The failure of the test at the 5% confidence level may therefore be data related. The vacancy data used was the ABS spliced vacancy series. The structural break occurs in the early 1980s.

2.6 Wage Equation

Chart 2 below depicts the evolution of the unemployment rate, and wage and price inflation in Australia over the past thirty years. One of the dominant trends over the past two decades has been the tendency for the average unemployment rate to rise. The unemployment rate has tended to ratchet up over time, with relatively sudden increases that are only slowly unwound. The tendency for the unemployment to remain at high levels, for long periods, raises some questions about the nature of the NAIRU and in particular, the sensitivity of wages to unemployment.

Chart 2: Wage and Price Inflation and Unemployment



The TRYM approach to modelling Australian wage behaviour, in common with other Australian models, starts with an expectations augmented Phillips curve. Under this approach, wage inflation (adjusted for productivity growth) is conditioned on expected consumer price inflation (proxied by lags of past inflation) and the degree of excess demand in the labour market (measured by the deviation in the level of the unemployment rate from some NAIRU level[9]). At the heart of this model is the assumption that those people outside employment (the unemployed or "outsiders") will place downward on wages in periods of excess supply, and this will restore equilibrium in the labour market.

The TRYM wage equation augments the basic Phillips curve with modifications to allow for the wage behaviour of those inside employment or "insiders". Outsiders may be viewed as imperfect substitutes for insiders for a variety of reasons, including labour market rigidities or regulations, imperfect information, on-the-job training or significant transaction costs involved in hiring/firing decisions. In this world, insiders may find their jobs relatively more secure, and therefore, be less sensitive to the level of the unemployment rate in determining wage claims. Simes and Horn (1988) used detrended overtime per worker[10] to capture this internal labour market pressure. In TRYM, this effect is modelled by a

[9]This unemployment/NAIRU level term enters the wage equation in a non-linear fashion as in the Phillips curve analysis.

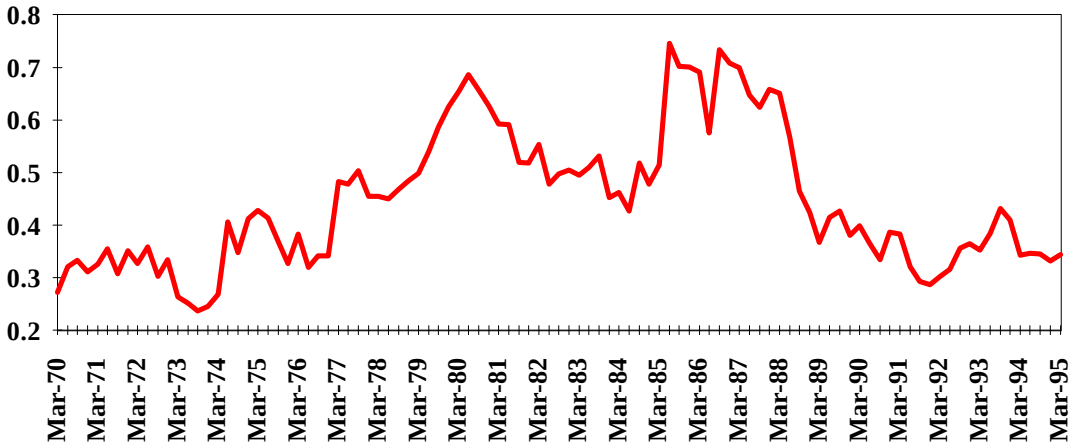
[10]In different versions, Simes and Horn (1988) used both a detrended as well as a truncated asymmetric measure where only *increases* in overtime per worker feed into wage pressure.

change in the unemployment rate term (•RNU), where the increasing risk of unemployment influences insiders' wage claims.

The TRYM wage equation also attempts to capture the influence of changes in taxation and relative import prices on wages. These factors drive a wedge between the employers' real wage costs (nominal wages plus payroll taxes deflated by producer prices) and the employees' real consumption wage (nominal wages less direct taxes deflated by consumer prices). For example, an increase in relative import prices would tend to reduce the employees' real consumption wage. If this was resisted, real wage costs would increase. The incidence of these factors is ultimately determined by workers and firms in the wage setting process. However, in the TRYM model workers are assumed to make decisions on wage demands, while firms make decisions about prices. Therefore, the wedge variable has been included in an attempt to capture more effectively the wage setting process. The omission of the wedge variable may lead to different incidence implications. For example, the omission of a relative import price effects implies that any changes in relative import prices would be bourne entirely by employers which may not be the case in reality. Nickell (1988) argues "it is essential to include the elements of the wedge in a wage equation for not doing so is tantamount to imposing some arbitrary degree of real wage restraint (or lack of it) on the model".

The TRYM wedge variable (WDG) combines the TRYM measures of indirect tax rates on consumption, business investment and dwelling investment, tax rates on payrolls and fringe benefits and relative import prices (capturing terms of trade shocks) - see Chart 3 below. This methodology is consistent with that adopted by Wallis (1992). Wallis argues that each element of the wedge should have the same effect on the final outcome, in principle. This proposition was tested using the TRYM wage equation. The results supported the case that the individual components of the wedge variable have the same incidence. The TRYM approach does however, differ slightly from that used by Wallis in that direct labour taxes have not been included in the wedge variable. This is due to the fact that wages in TRYM are modelled on a pre-tax rather than after-tax basis. However, the influence of changes in direct labour taxes on wages was tested separately, but was not found to be significant.

Chart 3: The Level of the Wedge Variable



The TRYM wage equation also includes a dummy variable (QCC) that attempts to capture the effect of various institutional arrangements such as wage indexation (between 1975 and 1981), the Wages Pause (introduced in 1982) and various Prices and Income Accord agreements (since 1983). This dummy attempts to measure the degree of centralisation in various wage regimes, set to 0.8 in highly centralised periods and 0.2 in relatively decentralised periods. The values broadly represent the proportion of movements in the average minimum wage rate attributable to the national wage case decisions. Since 1987, with the movement towards productivity based enterprise bargaining, QCC has been assumed to be slowly declining. The interest with this dummy is the effect that the degree of centralisation in wage

fixation may have had on sources of wage pressure. Allowance has also been made for the Metal Trades wage decision in the third quarter of 1974.

This gives the following estimated equation:

$$\begin{aligned}\Delta\ln\left(\frac{RWT}{NH}\right) = {} & \frac{\text{l}}{4} + (1 - a_1 - a_2 - a_3) \times \Delta\ln(PCON(-1)) \\ & + a_1 \times \Delta\ln(PCON(-2)) \\ & + a_2 \times \Delta\ln(PCON(-3)) \\ & + a_3 \times \Delta\ln(PCON(-4)) \\ & - a_4 \times \Delta RNU(-1) \\ & - a_5 \times (QCC - QCC(-4)) \\ & + a_6 \times \frac{NAIRU - RNU}{RNU} \\ & - (a_7 \times Q911) \times \Delta\ln(WDG(-5)) \\ & + a_8 \times Q743\end{aligned}$$

Results

Sample: 1970(3):1995(1)

Parameter	**Interpretation**	**Estimate**	**t-Statistic**
a_1	change in prices	0.043	0.21**
a_2	change in prices	0.137	0.70**
a_3	change in prices	0.191	1.09**
a_4	change in unemployment	0.008	2.77
a_5	change in centralisation	0.018	3.15
a_6	deviation from NAIRU	0.011	3.02
NAIRU	after 1974	7.0	5.24***
	before 1974	4.4	2.23***
a_7	change in tax wedge	0.080	2.53
a_8	dummy variable	0.067	5.19

** indicates parameters were found to be jointly significant at the 5% confidence level.
*** t-statistics refer to the estimates of WS and WSo.

Diagnostic Statistics:

$R^2 = 0.68$	
SE = 1.1%	
DW = 2.20	
Box-Pierce Q (1-8th order auto correlation)	12.08
Jarque-Bera test for Normality	1.84
Chow test for Parameter Stability	0.83
Ramsey's Reset test	0.86
Breusch-Pagan Heteroscedasticity tests:	
Trend	0.24
Y-Hat	0.39
Joint	1.73

* indicates the test has failed at the 5% confidence level.

Economic Interpretation

All estimates have plausible economic interpretations and are significant. The NAIRU is estimated to have been around 7.0 per cent after 1974, which is about the average level during this period. The estimated results imply that:

- if the actual level of unemployment is ten per cent, for example, wages growth will be 0.3 per cent per quarter less than if the unemployment rate was equal to the NAIRU;
- an increase in prices of 1 per cent will increase wages by 1 per cent after four quarters, with a 0.63 per cent increase after 1 quarter;
- a 1 per cent increase in the tax wedge term will reduce wages of about 0.08 per cent after five quarters (for the period after 1990);
- an increase in the actual unemployment rate of 1 per cent will lead to a fall in wages of 0.08 per cent after 1 quarter; and
- wages respond to changes in the institutional environment in the wage determination system over the previous year. A shift to a more decentralised wages system will exert upward pressure on wages for a year.

2.7 Properties of the TRYM Wage Equation

In TRYM, there is no long run hysteresis in the unemployment rate. That is, the constant NAIRU assumption implies that wages will adjust, influencing labour demand and supply, to ensure the unemployment rate returns to the NAIRU in the long run. Both Murphy and NIFF models also utilise a constant long run NAIRU. The earlier NIF10S model (the simulation version of the NIF10 forecasting model) related wages to changes in the unemployment rate, but did not have a stable long run unemployment rate. The adoption of a fixed NAIRU is adopted for computational and theoretical convenience so that there is a unique long run equilibrium in the model, rather than from any view that the NAIRU cannot change over time. Clearly, the NAIRU has changed in the past, however TRYM does not contain the detailed data on the labour market that would be required to endogenise the NAIRU.

While TRYM does not have unemployment hysteresis in the long run, there is a form of short run unemployment hysteresis by insiders (captured by a term for the change in the unemployment rate). The estimated wage equation suggests that even if the unemployment rate is above the estimated NAIRU, large falls in the unemployment rate can create higher wage pressures. There is therefore, an implicit short run non accelerating inflation path (NIP) for unemployment, that is, a dynamic path for the unemployment rate, which does not cause an acceleration in wage inflation in the TRYM model[11]. This mechanism captures in the wage equation, the apparent persistence of high unemployment rates without market clearing wage adjustment, evident in historical data.

There is also reasonable amount of wage-price dynamics in the TRYM model. The wage equation is based on backward looking expectations. This is important, in that, movements in the NAIRU (particularly in the presence of short run hysteresis), may generate significant variations in inflation.

The homogeneity constraint placed on prices in the TRYM wage equation, implies that it can be interpreted as a real wage equation. Therefore, a reduction in the NAIRU can be interpreted as real wage restraint. A gap between the unemployment rate and the NAIRU causes real wage growth to slow (until the gap is removed). In the long run, however, real wages grow in line with productivity growth.

The current specification for wage equation differs from the 1993 Conference version in a number of aspects: firstly, it partly endogenises the NAIRU (as well as, tightening the estimate) by introducing a simple summary measure of search effectiveness; secondly, it incorporate the effects of taxes and relative import prices on wages by way of the wedge variable; and thirdly, the lagged structure of changes in prices was lengthened to increase wage-price inertia in the model.

[11]Conceptually, this path could be constructed by inverting the wage equation and solving for the unemployment path that does not cause an acceleration in wage inflation. Unfortunately, the TRYM wage equation strictly speaking cannot be inverted as it contains a lagged change in unemployment term.

LABOUR DEMAND

3.1 Introduction

In TRYM, employment demand is modelled as a function of the first order conditions for profit maximisation in the long run, but with fluctuations in the demand for output playing a large role in the short run.[12] Brooker (1993) provides a short theoretical justification for this approach. In general, firms are assumed to demand labour in accordance with profit maximising behaviour. However, the exact nature of the profit-maximisation process depends on the length of the planning horizon involved. Brooker outlines three common cases: the short-run, the medium-run and the long-run. In the short run, firms maximise profits subject to aggregate demand, the capital stock and the real wage (the principle involved in the derivation of the short-run equilibrium employment in AEM). Short-run desired employment results from profit maximisation in the face of goods market disequilibrium. In the medium run, firms are free to adjust their levels of output to equate their marginal cost of production with price, while taking the capital stock and real wage as given (provides basis for the equilibrium private business sector labour demand equation in TRYM). In the long-run case, the size of the labour force and the NAIRU determine the level of employment.

While in the long run labour demand is usually estimated from the inversion of a production function, there is debate about the short-run adjustment process. One issue that arises in this context is that of labour hoarding. There has been considerable evidence of labour hoarding in the US literature (eg) Fay and Medoff (1985) and Fair (1985).

In Australian literature, Upcher and Taplin (1990) argue that labour hoarding by firms in the face of fluctuations in demand can be argued on sound theoretical grounds. They argue that a firm's first response to a temporary fall in output might be to cut back on the amount of overtime worked leaving numbers employed little changed. They also argue that hoarding will not be a long-run phenomenon, but instead will vary over the business cycle depending on expected fluctuations in output and the costs of hiring and firing. To this end, Upcher and Taplin extend the CES production function to include short-run behaviour, often attributed to labour hoarding. This was done by the use of an error correction model which includes changes in output and real wages.

Simes (1988) also pays close attention to the issue of labour hoarding. Simes uses labour costs and the change in output as proxies for hoarding in his labour demand function. He argues that casual empiricism for the Australian economy would appear to support the proposition that labour costs affect the incentives to hoard labour - labour was shed rapidly following the surge in wage costs in 1974-75 and in 1982-83.

3.2 The Private Business Sector

Chart 4 depicts growth in real wages, business sector output and employment. The chart suggests a strong correlation between employment growth and both output and real wage growth. In regard to real wages, strong growth in 1974 and 1982 appears to have played an important, leading role in the employment downturns in the 1974/75 and 1982/83 recessions. Similarly, the significant fall in real wages during the Wage Pause in 1982, as well as the sustained real wage restraint during the Accord period, appears to have supported strong employment growth.

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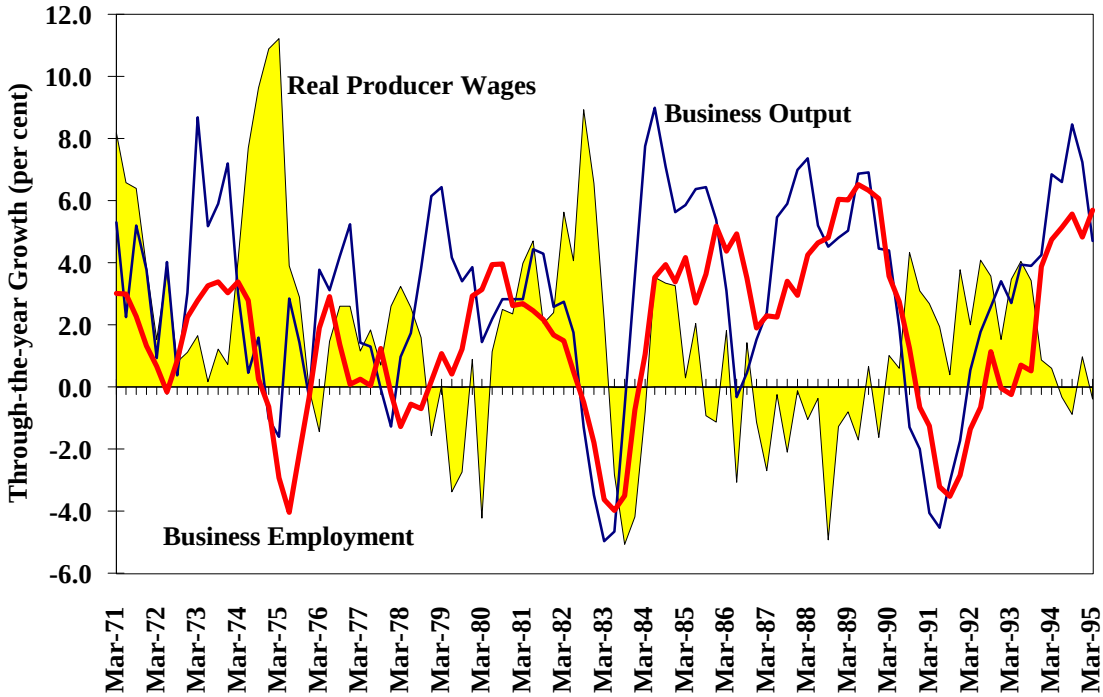
[12] Hamermesh (1986) provides a useful outline of the theory behind the demand for labour in the long run. The theoretical discussion is divided into two parts: demand for labour in a two-factor case; and demand for labour in a multi-factor case.

Chart 4: Real Producer Wages, Output and Employment



In TRYM, the demand for labour decision is made by firms, jointly with their investment and pricing decisions. In the long run, the optimal level of output produced by the private business sector is assumed to be consistent with profit maximising behaviour subject to a given technology. However, firms may be in disequilibrium in the short run as they adjust towards their desired position.

The production technology is not directly observable and must be inferred from the behaviour of employment, investment and the prices observed in the business sector. These decisions are captured in the TRYM model by behavioural equations for investment, the demand for labour and the price of non-commodities.

Care has been taken to ensure that these three equations are drawn together in a consistent and unified framework. In particular, the long run functional forms of the three equations are derived assuming a representative firm exists for the private business sector. This firm is assumed to produce output in the long run using a constant elasticity of substitution (CES) production function, exhibiting constant returns to scale, with capital (K) and labour (L) as the only inputs into production. Imports are treated as final goods when specifying the production technology. If output is denoted by Y, and • and • are the parameters on labour and capital respectively, the production function is defined as follows:

$$Y = \left[a L^{\rho} + b K^{\rho} \right]^{\left(\frac{1}{\rho}\right)}$$

$$\text{where } \rho = \frac{(\sigma - 1)}{\sigma}, \text{ and } \sigma \text{ is the factor elasticity of substitution}$$

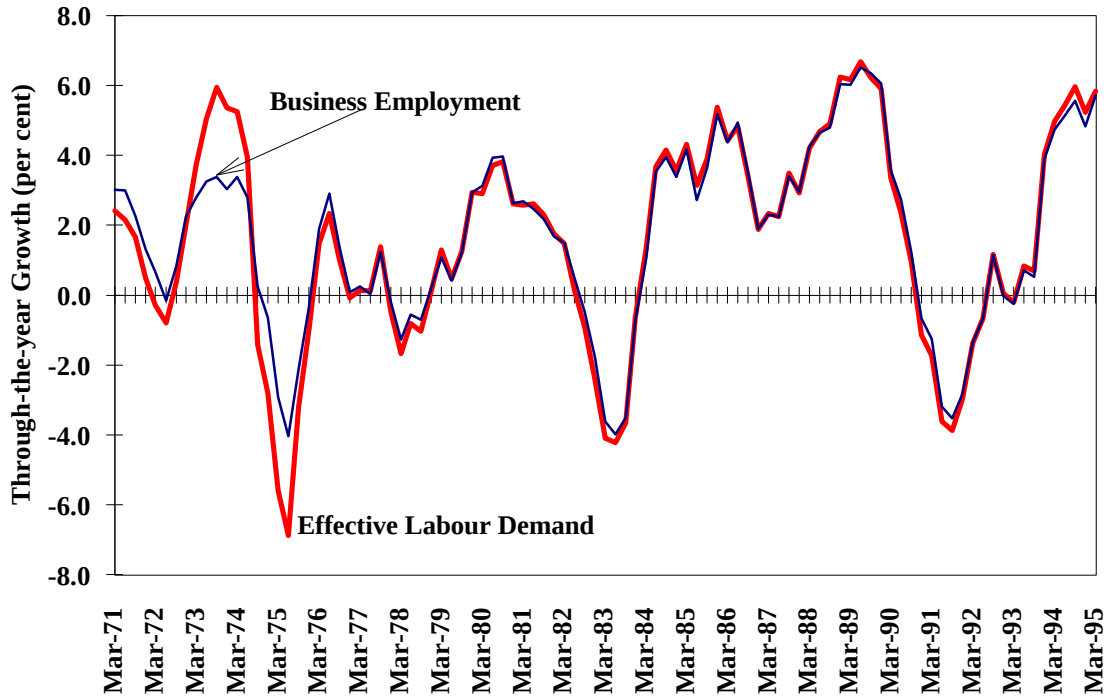
3.3 Labour Demand Equation

The current approach to modelling the labour demand equation differs from the 1993 Conference version by making the distinction between the quantity of labour input demanded by firms (effective

labour demand) and business employment. Unfilled vacancies capture the difference between these two concepts.

Chart 5 shows that the nature of the relationship between effective labour demand (NEBEFF) and business employment (NEB) growth has changed over the past three decades. In the 1960s and early 1970s, the labour market was closer to equilibrium than in the 1980s and 1990s as defined by the unemployment/vacancy relationship (see Section 2.5). It was an economy where as the 1945 White Paper put it "there was a tendency towards a shortage of men instead of a shortage of jobs". As a consequence, fluctuations in effective labour demand had less of an effect on employment due to significant changes in vacancies. Whereas, with much higher unemployment (lower unfilled vacancies) in the late 1970s and 1980s, there was a more direct translation of fluctuations in effective labour demand into employment. Given the change in the relationship between labour demand and employment, this approach adopted may capture more effectively the effects of various factors (eg real wages) on the demand for labour.

Chart 5: Growth in Employment and Effective Labour Demand



The first order condition for profit maximisation requires that the marginal product of labour ($\partial Y/\partial L$) is equal to the real wage (W/P), and this is assumed to hold in the long run. Given the CES production function specified in TRYM, this implies that in the long run:

$$\frac{W}{P} = a\left(\frac{L}{Y}\right)^{(r-1)}$$

Rearranging to obtain the equilibrium level of labour demand as a function of output and real wages gives:

$$\ln(L) = \ln(Y) + \sigma \ln(\alpha) - \sigma \ln\left(\frac{W}{P}\right)$$

Firms can alter their labour input by either changing the number of people they demand or by altering the number of hours worked by existing employees. The labour demand equation is therefore specified using average hours worked (NH) in addition to the number of people demanded (NEBEFF).
This approach helps to capture, for example, the effect of the trend decline in average hours worked over the 1970s and 1980s, which seems to be related in part to a general shift towards part time work.
Technical progress is assumed to be labour augmenting, so the marginal product of labour is adjusted for the rate of Harrod neutral technical progress (or the underlying growth in private sector productivity, •) to determine the equilibrium relationship for labour demand.

The real wage faced by producers is given by the hourly nominal wage (RWH) adjusted for payroll and fringe benefits taxes (RTPRB) and deflated by the price of business sector output (PGB). This gives the following long run relationship for labour demand by the private business sector:

$$\ln(NEBEFF) = \ln(GBA) - \ln(NH) + \sigma \ln(\alpha) - \sigma\left[\ln\left(\frac{RWH \times RTPRB}{PGB}\right) - \lambda \times QTIME\right] - \lambda \times QTIME$$

The (producer) real wage, ln(RWH x RTPRB/PGB), adjusted for underlying productivity (•) can be interpreted as a measure of real hourly wages adjusted for efficiency. As labour efficiency improves, with unchanged real wages, the real wage per unit of production declines. The above equilibrium relationship defines the labour demand of profit maximising firms, given real wages and the level of private business output (GBA). The equation implies that if real wages grow in line with underlying productivity, employment, on an average hours worked basis, will grow in line with output less underlying productivity growth.

This relationship will not necessarily hold in the short run. Changes in the output to capital ratio, GBA/KB, which is closely related to some measures of capacity utilisation, are likely to have a positive direct impact on labour demand in the short run. Changes in real wages and changes in average hours worked were also found to impact on employment in the short run. An error correction specification has been used to incorporate the dynamic and long run responses.

The estimated equation is adjusted for population growth to ensure that steady state bias is not introduced into the model. Average adult population growth (NPAP) over two years is used to smooth out short term fluctuations in population growth.

$$\begin{aligned}\Delta \ln(NEBEFF) = {} & \frac{\Delta_8 \ln(NPAP)}{8} - a_0 \times \sigma \times \left[\Delta \ln\left(\frac{RWH \times RTPRB}{PGB}\right) - \frac{\lambda}{4}\right] \\ & - (1 - a_1) \times \Delta \ln(NH) \\ & + a_2 \times \Delta \ln\left(\frac{GBA}{KB(-1)}\right) \\ & - a_3 \times \left[\begin{array}{l} \ln\left(\frac{NEBEFF(-1)}{GBA(-1)}\right) + \ln(NH) - \sigma \ln(\alpha) + \\ \sigma \times \left[\ln\left(\frac{RWH(-1) \times RTPRB(-1)}{PGB(-1)}\right) - \lambda \times QTIME(-1)\right] + \lambda \times QTIME(-1) \end{array}\right]\end{aligned}$$

Results: (from joint estimation of business employment, investment and price of non-commodities equations)

Sample: 1971(1):1995(1)

Parameter	Interpretation	Estimate	t-Statistic
a_0	real wages	0.131	2.63
a_1	hours worked	0.521	2.36
•	elasticity of substitution	0.843	21.97
•	labour productivity	0.008	7.11
a_2	output to capital ratio	0.186	3.77
a_3	error correction	0.244	9.87

Diagnostic Statistics: (based on single equation estimates)

$R^2 = 0.55$	
SE = 0.69%	
DW = 1.66	
Box-Pierce Q (1-8th order auto correlation)	13.70
Jarque-Bera test for Normality	0.24
Chow test for Parameter Stability	3.25
Ramsey's Reset test	1.77
Breusch-Pagan Heteroscedasticity tests:	
Trend	0.00
Y-Hat	5.34**
Joint	5.73**

* indicates the test has failed at the 5% confidence level.

** on inspection of the residuals, the failure of the test at the 5% confidence level was thought be attributable to one residual, the third quarter of 1974. However, this period coincided with important developments in the labour market. Consequently, no allowance has been made for this data point.

Economic Interpretation

All estimates have plausible economic interpretations and are significant. The adjustment toward equilibrium is fairly quick, with around 24 per cent of any difference between actual and desired labour demand eliminated each quarter. Other elasticities in this equation imply that an increase of one per cent in:

- the output to capital ratio (ie if output were to rise 1.0 per cent faster than the level of the capital stock) leads to initial increase of 0.19 per cent in the level of labour demanded, which builds to 1 per cent in the long-run (in accordance with the constant returns to scale assumption);
- real wages would decrease the level of labour demanded by 0.11 per cent initially, building to 0.84 per cent in the long-run; and
- average hours worked would decrease the level of labour demanded (in terms of the number of people required) by about 0.48 per cent.

LABOUR SUPPLY

4.1 Introduction

Simple microeconomic theory suggests that the individual household's desired supply of labour (measured in hours) or work leisure choice, is a matter of households attempting to maximise utility trading off the utility generated by leisure against the utility obtained by earning labour income and consuming goods. Fundamental to this choice is the slope of the budget constraint, that is, the real wage rate. This raises the crucial question of what will be the effect on labour supply of an increase in the real wage - see Levacic and Rebmann (1989). A rise in the real wage increases the opportunity cost of leisure. The substitution effect of this relative price change is to reduce leisure time and increase work time. But an increased real wage rate raises the real income for a given work time. This income effect raises the demand for leisure. Thus, an increase in the real wage will increase the supply of labour hours per worker only if the substitution effect outweighs the income effect.

In aggregate, the labour participation rate has undergone noticeable cyclical variations (see Chart 6 in Section 4.3). One standard argument for this variation is the so called encouraged worker effect. As labour market conditions deteriorate, many unemployed workers cease searching for employment and fall out of the labour force. However, these workers may return to the labour force as employment prospects improve. The counter-argument to this is the additional worker effect, which specifies that erstwhile non-working members of the family (non-primary workers) will be driven into the labour force by the unemployment of an income earner to make up for the cash loss. Despite this counter-argument, it is clearly evident that the encouraged worker effect predominates in Australian economic behaviour.

4.2 Empirical Literature

When faced with modelling labour supply economists in the past have found it necessary to proceed on the basis of certain assumptions regarding labour supply. In growth literature, it was generally assumed that population growth was exogenous and that the supply of labour from any fixed population was an inelastic function of the real wage rate. While in literature dealing with the short-run, it was assumed that the labour supply was infinitely elastic at some rigid real wage. Lucas and Rapping (1969) constructed a model of the labour market which reconciled these apparently divergent views of labour supply using annual aggregate US data. Their results were found to be consistent with labour supply being wage inelastic in the long-run and wage elastic in the short-run.

Traditionally, the encouraged worker effect has been modelled using the employment ratio (the ratio of employment to the working population) as an indicator of the state of the labour market. The AEM participation rate equation (see Brooker, 1993) captures the encouraged worker effect both in its dynamics and long run specification. The specification is presented in terms of the deviations of the actual participation rate from an exogenous underlying trend.

4.3 Labour Supply Equation

Chart 6: Participation Rate and Employment Ratio

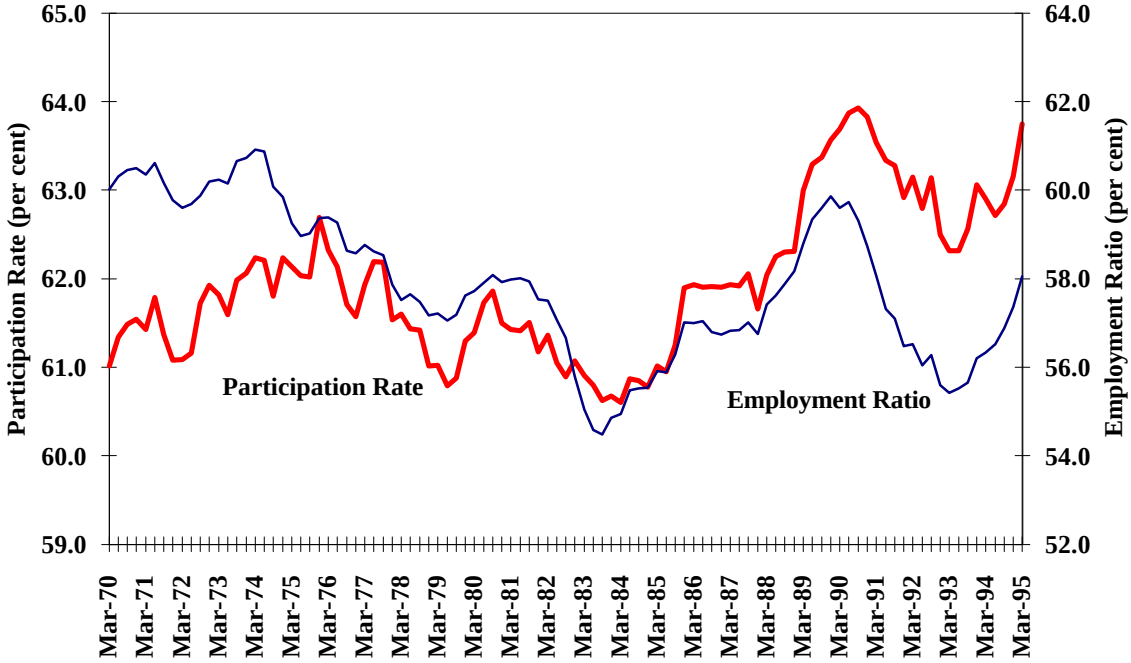
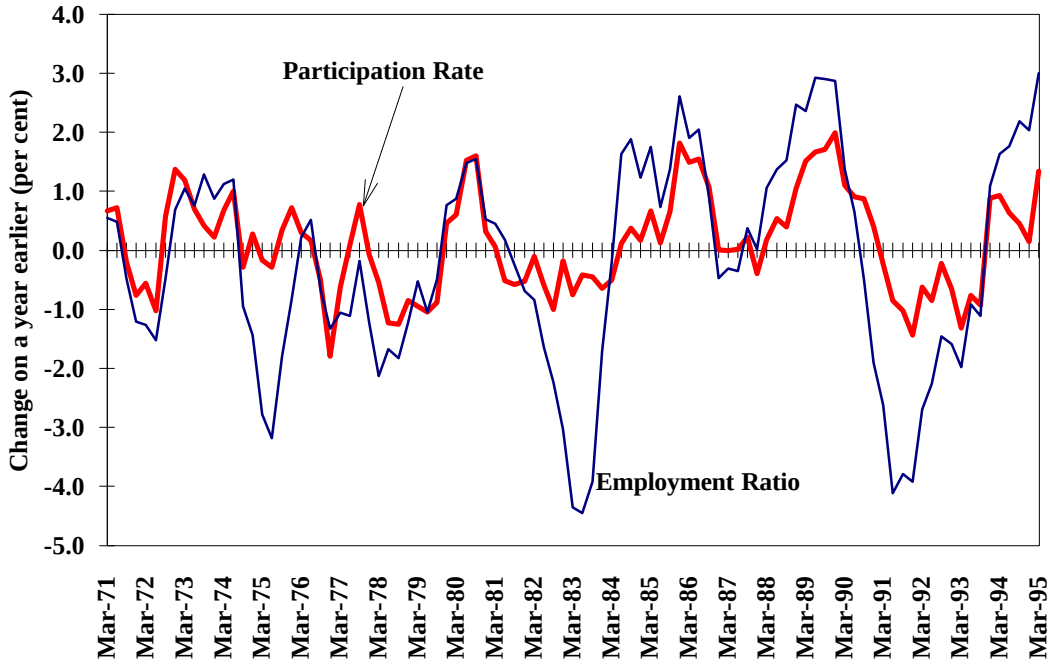


Chart 6 depicts the level of the participation rate and employment ratio since the late 1970s. There have been trends evident in the aggregate participation rate data over this period, particularly the slow decline between 1976 and 1983, and the strong increase in participation between 1983 and 1990. One economic factor that tends to have a strong correlation with the participation rate is the employment ratio. The employment ratio has a close correlation with the participation rate both in levels and in changes (Chart 7) suggesting an encouraged worker effect may be important in the data.

Chart 7: Change in Participation Rate and Employment Ratio



In TRYM, labour supply is modelled by an aggregate participation rate equation. The aggregate approach has been adopted because of its advantages in terms of simplicity of interpretation and making the model easier to maintain. Moreover, it allows the various equations in TRYM to be linked in a transparent and manageable way. However, it has the disadvantage of not identifying changes at a more disaggregated level which may lead to structural changes in the aggregate relationship. For example, it is clear that female participation is far more responsive to changes in employment than male participation. Thus changes in industry or occupational demand that changed the relative demand for female dominated occupations relative to males could lead to a change in the link between employment growth and participation at the aggregate level. However, this is difficult to capture in the context of TRYM, as there is no industry or occupational detail with which to endogenise demand for female employment relative to males.

The TRYM aggregate labour force participation equation includes a time trend for the 1980's onwards for similar reasons. The time trend attempts to capture the influence of trends at a disaggregated level (by gender or age), and demographic trends. The strong rise in labour force participation in the 1980s to some extent, reflected a strong increase in female participation (male participation declined), which may be associated with increasing part-time work and growth of the services sector of the economy. Similarly, a host of demographic factors, such as the movement of the baby boomer generation through the age distribution, may have influenced the participation rate of various age groups and generated secular movements in the aggregate participation rate.

The TRYM approach to modelling labour supply has been developed on an hours worked basis. However, this choice of specification for labour supply raises the problem of identification. The ABS measure of hours worked reflects both demand and supply of labour services. Therefore, to ensure that the labour supply equation is identified, the demand influences have been removed from the measured hours worked series. This was accomplished by fitting a trend - called the desired level of hours worked (NHLR) - through the average hours worked (NH) series published by the ABS. A logistical growth function that reflects the sharp decline in trend average hours worked since 1973 has been fitted to NH.

As a result, TRYM's labour supply, examined using the participation rate on an hours worked basis as the dependent variable, is modelled as a function of the level of employment on an hours worked basis (reflecting the so-called encouraged worker effect) and a deterministic time trend in the long-run. While in the short run, changes in the participation rate are also assumed to depend on:

- changes in the contemporaneous and lagged employment ratios, $\Delta\ln(NET/NPAP)$, thereby capturing the short run impact on labour supply of the encouraged worker effect; and

- the after-tax (consumer) real wage - nominal wages (RWT) are deflated using the private consumption deflator (PCON), and adjusted for the rate of tax on labour income (RTN).

The current specification for labour supply equation differs from the 1993 Conference version through its handling of the effects of after-tax real wages. In the Conference version, real wages were incorporated in the long run specification, but not in the short run dynamics.

An error correction specification was used to incorporate the dynamic and long run responses. The estimated equation is as follows:

$$\Delta \ln\left(\frac{NLF \times NHLR}{NPAP}\right) = a_0 \times \left[\Delta \ln\left(\frac{(1 - RTN(-3)) \times RWT(-3)}{PCON(-3)}\right) - \frac{1}{4}\right] + a_1 \times \Delta \ln\left(\frac{NET}{NPAP}\right) - a_2 \times \Delta \ln\left(\frac{NET(-2)}{NPAP(-2)}\right) - a_3 \times \left\{\begin{array}{l} \ln\left(\frac{NLF(-1) \times NHLR(-1)}{NPAP(-1)}\right) + c_0 \\ - c_1 \times \ln\left(\frac{NET(-1) \times NHLR(-1)}{NPAP(-1)}\right) \\ - c_2 \times Q80(-1) \times (QTIMF(-1) + 10.125) \end{array}\right\}$$

Results

Sample 1974(1):1995(1)

Parameter	Interpretation	Estimate	t-Statistic
a_0	after-tax real wages	0.049	2.59
a_1	employment to population ratio	0.514	9.61
a_2	employment to population ratio	0.148	2.51
a_3	error correction	0.256	5.04
c_0	long run constant	0.187	9.34
c_1	employment to population	0.554	15.05
c_2	time trend	0.003	9.81

Diagnostic Statistics:

R^2 = 0.65	
SE = 0.27%	
DW = 2.00	
Box-Pierce Q (1-8th order auto correlation)	12.23
Jarque-Bera test for Normality	2.58
Chow test for Parameter Stability	0.89
Ramsey's Reset test	1.00
Breusch-Pagan Heteroscedasticity tests:	
Trend	1.81
Y-Hat	1.90
Joint	3.18

* indicates the test has failed at the 5% confidence level.

Economic Interpretation

All estimates have plausible economic interpretations and are significant. The adjustment toward equilibrium is fairly quick, with any difference between the actual and desired participation rates being closed by about 0.26 per cent per quarter. The dynamics of the equation also imply that:

- a 10 per cent rise in real after-tax wages will increase the participation rate by 0.5 per cent in the short-run;
- every 1 per cent increase in the employment to population ratio will result in about a 0.36 per cent increase in the participation rate after 2 quarters; and
- the coefficients on the time trend indicates that during the 1980s the participation rate grew 0.3 per cent per quarter faster than would have been expected given the employment ratio and real after-tax wages.

A TRYM MODEL SIMULATION OF THE EFFECTS OF A LOWER NAIRU

This section examines the macroeconomic impact of an exogenous fall in the NAIRU by simulating the TRYM model. A comparison is made between two alternative paths for the economy (baseline and shock), where the only difference is the assumption about the NAIRU. Not surprisingly, there are significant benefits from reducing the NAIRU (wage pressure) and unemployment. What is surprising is that individual wage earners (the insiders in the wage bargaining process) are better off as a result of the reduction in the NAIRU (which can be characterised as an increase in wage restraint). The intuition behind this result, which at first brush might appear implausible, is very similar to that set out in the framework used by Layard, Nickell and Jackman (1991). To quote from the Layard Nickell and Jackman book:

> "The reason for this is that, while wage determination reveals the demands of wage bargainers at given unemployment, the price setting behaviour of firms governs the real wage that is actually available. The sharpest expression of this point arises with mark-up pricing when the real wage available in the long run is independent of the level of activity. Workers may then press for higher wages as much as they wish. Their quest is wholly unsuccessful, and all that is achieved is higher unemployment". (Ch 8, P.384)

In common with the Layard, Nickell and Jackman framework, workers in TRYM bargain over wages while firms set prices in accordance with input costs, productivity and the state of demand. Workers thus have little control over prices and hence the real wage in the medium to long term. (The real wage is largely determined by technology/productivity.) Hence, increases in wage pressures at a given level of unemployment eventually lead to higher unemployment with no significant improvement in the real wage. Moreover, as the government has to increase taxes to finance an increase in unemployment benefit pay outs, the after-tax real wage can actually fall.

Simulation Baseline

The baseline used for the shock below is the TRYM equilibrium or steady state baseline. That is, the shock starts from a point where the economy is in equilibrium. In TRYM, a steady-state baseline has output growing in line with the supply potential of the economy, equal to the growth of factor inputs plus underlying productivity growth (the steady-state growth rate). Growth is balanced, all real variables growing at the same rate and relative prices do not change. Inflation is determined by the rate of growth of the money supply less the steady-state growth rate. Real wages grow in line with productivity growth. Australian real interest rates are equal to their world counterparts. Capital stocks have fully adjusted to equilibrium levels where the rate of return on capital equals the risk adjusted real interest rate, and labour is fully utilised with the unemployment rate equal to the NAIRU.

This steady-state world is somewhat different to the realities of a labour market today with the unemployment rate above the estimated NAIRU. Nonetheless, it is a useful baseline for examining the pure effects of a NAIRU shock (one of the goals of this paper being to illustrate linkages in TRYM), as it will not be distorted by the lagged flow-on of past shocks in historical data.

In the shocked simulation, all exogenous factors are the same as the baseline simulation. The only exception being that the economy's NAIRU is assumed to fall by one percentage point immediately in the first quarter of the simulation and stay at the lower level.

In the description that follows, all references to movements in variables (up, down, increase, decrease, stronger or weaker), are relative to the baseline simulation. That is, movements are with respect to what would otherwise occur. All results are presented as a deviations from the baseline level, usually as the per cent difference (unless otherwise indicated). The detailed results are presented in Table 1 at the end of Section 5, and in the following charts.

5.1 Long Run Effects

In TRYM, supply side factors determine the long run level of output in the economy.

In the long run, the unemployment rate is set by the NAIRU. Accordingly, the unemployment rate falls by one percentage point. Real wages adjust to allow the unemployment rate to fall to the new lower NAIRU.

The level of employment is determined by the participation rate and the unemployment rate (NAIRU). A one per cent reduction in the NAIRU leads to a more than proportional increase in labour supply in equilibrium (around 1.7 per cent). The availability of more employment encourages previously discouraged workers to enter the labour market increasing equilibrium labour supply. As a result, employment rises by 2.8 per cent in the long run.

The elasticity of the labour demand curve suggests that real producer wages would need to fall by 3.3 per cent to achieve this employment outcome. However, real wages only fall by 0.4 per cent in the long run. This is due to the fact that the aggregate employment elasticity is determined by the sensitivity of net exports to real exchange rate changes rather than the elasticity of the labour demand curve. In the long run, the aggregate demand curve is relatively flat for an open economy like Australia. As a small economy, Australia can almost sell as much as it likes on the world market. Small changes in the real exchange rate would be expected to increase net exports in the long run by a significant amount. Thus, output is very elastic with respect to small changes in import prices relative to export prices (and hence relative to business prices and the nominal wage).

The higher level of employment increases domestic supply. GDP therefore, increases by around 2.6 per cent in the long run due to this supply side boost. The capital stock also increases broadly in line with output (as does the level of investment) since the real capital costs remains unchanged. The real cost of capital is little changed because Australian real interest rates return to world levels (through the interest parity condition).

The equilibrium price level depends on the monetary policy assumption (see Section 5.22). In this simulation, monetary policy is assumed to be non-accommodating of the increase in real activity. Hence, the long run price level is lower. The inflation rate (as opposed to the price level) returns to the monetary authorities target rate. A lower domestic price level (with world prices unchanged) causes the nominal exchange rate to appreciate (by around 1.2 per cent).

On the demand side, incomes rise in line with output bringing corresponding increases in private expenditure components of GDP, namely consumption, business investment and dwelling investment. Government final demand remains unchanged in the long run (by assumption).

In the goods market, the real exchange rate acts to balance aggregate supply and demand through its effect on net exports. On the export side, a downward sloping world demand curve for non-commodity exports implies that an increase in the supply of exports (assumed to increase in line with domestic supply) leads to a depreciation in the real exchange rate (by around 1.2 per cent).[13] While on the import side, the relative price effects of the depreciation in the real exchange rate shift demand towards less import intensive expenditures. As a consequence, the increase in imports (1.9 per cent) is less than that implied by the import demand equation (an income elasticity of one in the long run). The boost to net

[13]In the long run, this effect drives the reduction in real wages by shifting relative prices. The real depreciation increases the cost of imported capital goods, and this increases the user cost of capital. A higher user cost of capital implies a less capital intensive, and more labour intensive economy. A real wage reduction is then required to increase the labour output ratio.

exports from the depreciation of the real exchange rate is however, broadly offset by a deterioration in the terms of trade leaving the current account deficit as a percentage of nominal GDP little changed.

The net PSBR as a percentage of GDP is unchanged in the long run (see Section 5.22). Similarly, net private lending is unchanged in the long run with a small increase in gross private investment offset by an increase in gross private saving.

5.2 Short To Medium Run Impact

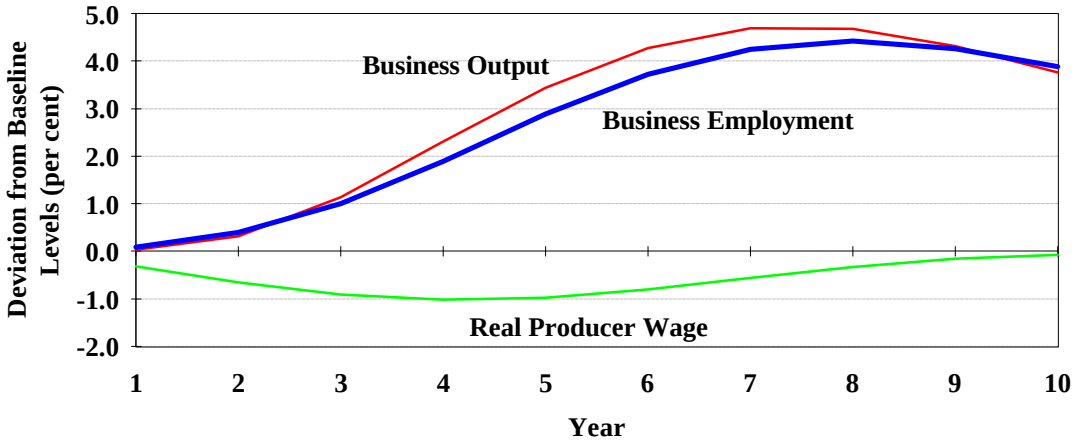
In the short to medium run, aggregate demand determines the level of output in the economy. The initial impact of a fall in the NAIRU, however, is on the supply side of the economy. The gains from a reduction in the NAIRU are only slowly realised because the short-run dynamics in the model imply slow adjustment in prices and wages in the goods and labour markets (ie they do not immediately jump to their equilibrium levels). There are further lags in the adjustment of real variables (eg employment demand, investment) because firms and households only gradually change their behaviour in response to new information. Financial sector agents are assumed to take some account of future movements in the economy and therefore they respond relatively quickly.

5.21 Wages, Employment and Prices

The fall in the NAIRU creates a gap between the current unemployment rate and the new NAIRU, thereby boosting the supply of effective labour. This could be thought of as increasing the relative labour market competitiveness of outsiders or an outward shift of the labour supply curve. The excess supply in the labour market leads to nominal and real wage restraint. Real producer wages fall for the first 3 to 4 years of the simulation.

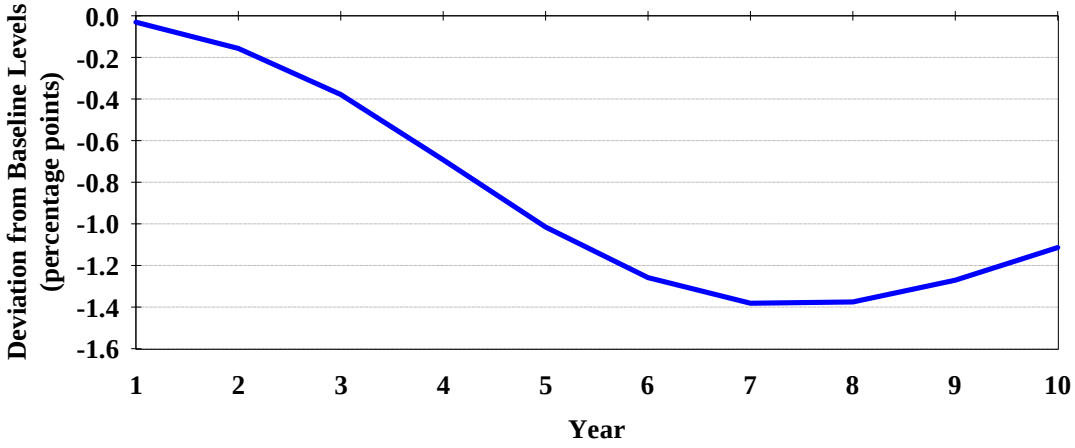
Real wage restraint stimulates employment by encouraging employers to substitute labour for capital for a given level of output. However, the response of employment is much greater than would be thought from simply looking at the short run wage elasticity of the labour demand curve. The additional employment is the result of increased demand for firms' output (see Section 5.24). In the face of an increase in demand, firms initially increase the utilisation of capital by employing more labour. The investment response and adjustment of the capital stock is slower due to time to build lags, uncertainty, risk aversion etc. Business employment peaks after 8 years.

Chart 8: Producer Real Wage, Business Employment and Output



The rise in the employment ratio encourages greater labour force participation[14], offsetting around half of the effect of the rise in employment on the unemployment rate. The unemployment rate steadily declines towards the new NAIRU and is around 1 percentage point lower after 5 years.

Chart 9: Unemployment Rate

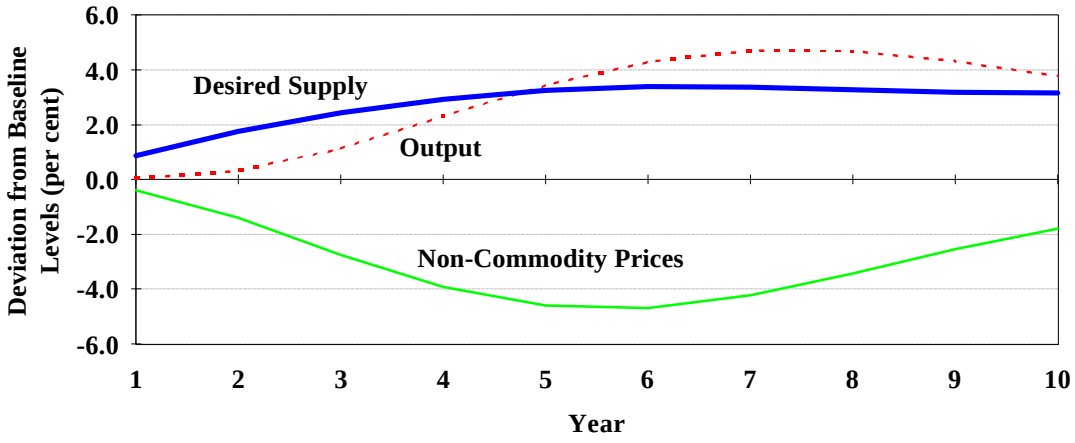


The fall in producer real wages results in an increase in the level of output that firms would desire to supply if they were profit maximising[15]. Current demand in the economy responds more slowly, thereby creating an excess of supply in the goods market. This excess supply places downward pressure on domestic non-commodity prices and leads to lower consumer price inflation during the early years of the simulation.

[14]The encouraged worker effect is partially offset by a real wage effect. Real wage restraint leads to a small decrease in those willing to work due to a elasticity of substitution between work and leisure of 0.05 in the short run.

[15]In the TRYM model, desired output of the business sector is measured by a theoretical construct, GSTWK. This measure is a hypothetical output given employment consistent with current real wages and the current capital stock.

Chart 10: Desired Supply, Output and Non-Commodity Prices



5.22 Government Policy Responses

A number of assumptions regarding how Governments react to shocks in the economy are embedded in the TRYM model's monetary and fiscal policy default reaction functions. These do not necessarily represent how Governments *have*, *would* or *should* respond to developments in the economy, but are plausible, stable ways in which Governments *could* respond. The Government sector plays an influential role in the economy and stable policy rules are needed to close simulation models like TRYM.

The default monetary policy reaction function in the TRYM model, ties short term nominal interest rates to deviations in nominal GNE from a fixed nominal target path for the economy. The growth rate of this nominal target path is consistent with the steady state growth of the economy plus the monetary authorities assumed target inflation rate. The nominal target path for nominal transactions in the economy defines the stance of monetary policy (in this case a non-accommodating stance for monetary policy).

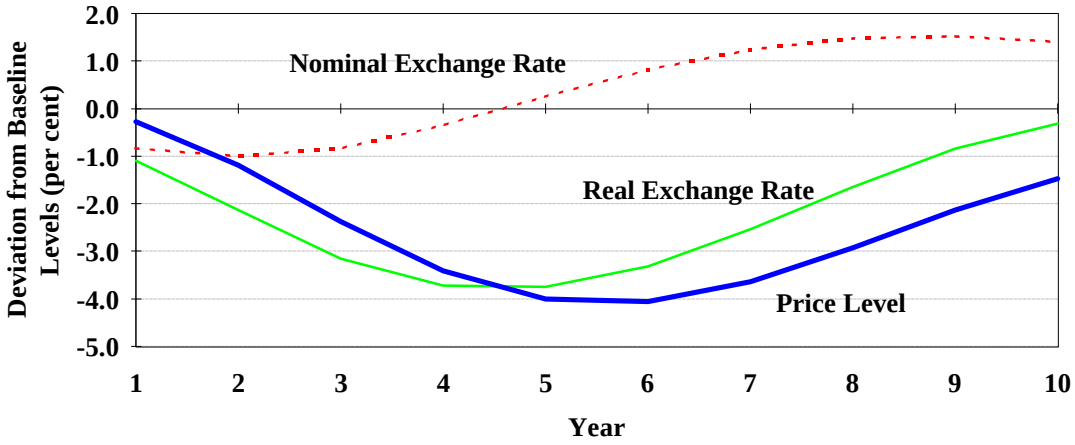
The default fiscal policy reaction function, ties direct tax rates on labour and business incomes to a public debt to nominal GDP target. Changes to the public sector borrowing requirement induced by shocks to the economy, are initially bond financed in the short run, but in the long run are tax-financed. Government market expenditure and employment do not change as a result of any other developments in the economy. In this simulation, the public debt to GDP target is unchanged in the long run.

5.23 Financial Markets

In the TRYM model, financial market agents are assumed to form their expectations[16] for inflation by assessing the effect of any new information or shock on the future equilibrium price level. This price level expectation in turn affects their expectation for the equilibrium exchange rate.

[16]The form of quasi-rational expectations exhibited by financial market agents in TRYM is not as strong as the rational expectations (or more correctly model consistent expectations). While financial sector agents correctly anticipate the long run consequences of a shock or policy change, the dynamic path to this long run outcome has a backward looking orientation.

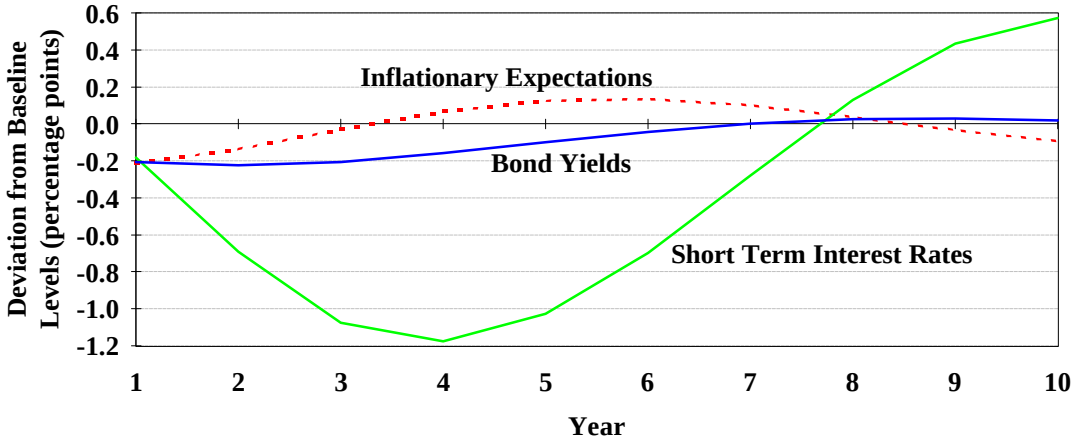
Chart 11: Exchange Rate and Price Level



Accordingly, financial market agents understand that a lower NAIRU will increase the effective supply of labour and boost output in the long run. They are also aware of the non-accommodating stance of monetary policy, and that therefore prices will be lower and the nominal exchange rate will appreciate in the long run.

Given the lower long run price level, agents reduce their inflationary expectations immediately, and this flows into lower nominal bond yields. The nominal exchange rates depreciates as the impact of the higher expected long run exchange rate is offset by the fall in Australian bond yields relative to the rest of the world. Lower prices reduce the transactions demand for money relative to the desired monetary path, placing downward pressure on short term interest rates.

Chart 12: Inflationary Expectations, Short Term Interest Rates and Bond Yields



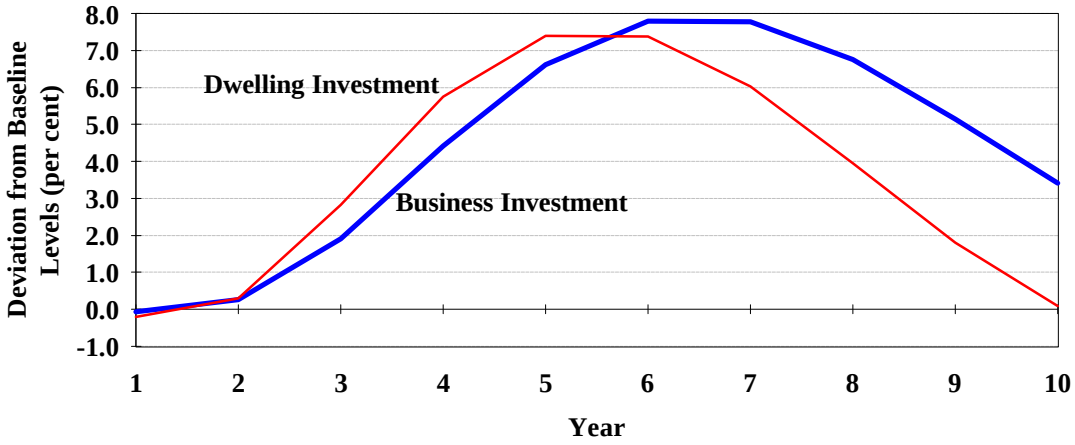
5.24 Demand and Output

The demand side of the economy responds to the lower interest rates and a lower real exchange rate primarily through changes in dwelling investment, business investment and consumption.

After being little changed in the first two years, dwelling investment increases strongly as a result of lower real interest rates (both short and long). In the TRYM model, dwelling investment is the most interest rate sensitive expenditure component. This response is also strongly influenced by time-to-build factors in the short run which lead to a significant amount of inertia in dwelling investment.

Lower real producer wages (increasing firm profitability, and therefore, the rate of return on their capital) and lower real interest rates (lowering the cost of funds) stimulate business investment in the short to medium run. Both these mechanisms encourage firms to adjust their capital stock towards a new higher desired level. However, in the first two years this stimulatory effect is offset by the effects of lower levels of capacity utilisation[17]. Investments may be profitable over the medium to long run but may be delayed as a result of a lack of demand or the presence of spare capacity in the short run. However, by year 3 business investment expands strongly in line with the recovery in demand.

Chart 13: Business Investment and Dwelling Investment

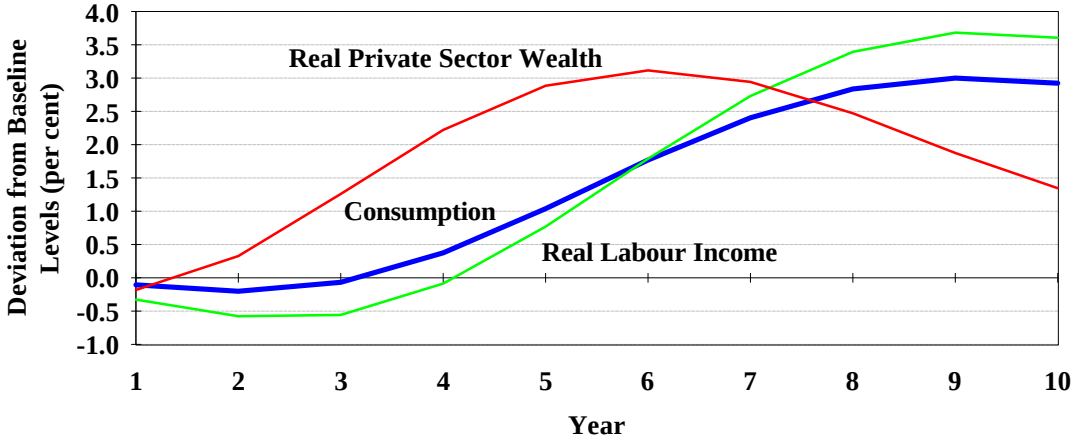


Households adjust consumption sluggishly to changes in economic circumstances. Initially, consumption is little changed with the impact of lower real after-tax labour income (due to a fall in the real consumer wage) offset by higher real wealth[18]. However, as after-tax labour income recovers in line with an increase in after-tax real wages (see Section 5.26) and higher employment, consumption increases to be 2.9 per cent higher after 10 years.

[17]In the TRYM model, the capacity utilisation term in the investment equation relates current private business sector output to a theoretical construct, GSTAR. Conceptually, GSTAR is the maximum output consistent with firms' current levels of employment and capital stock.

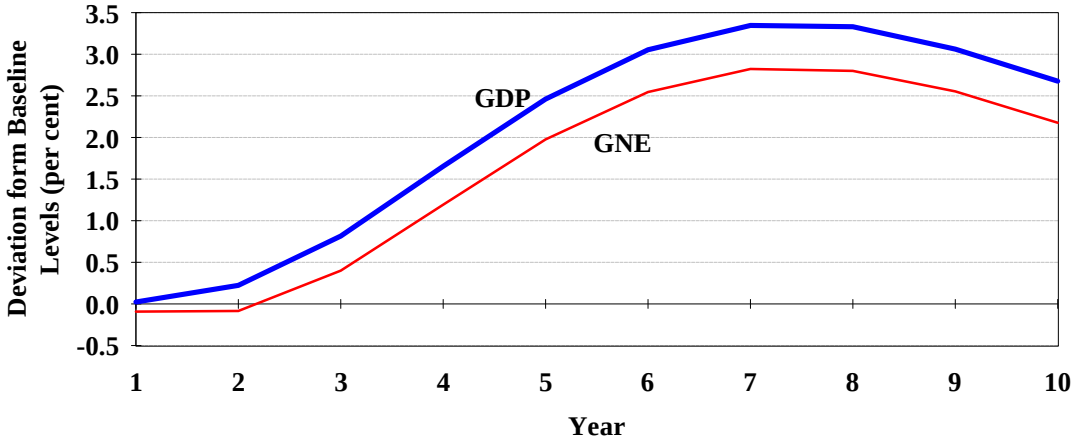
[18]The wealth term introduces a mechanism by which interest rates affect consumption. An increase in interest rates reduces the market value of wealth via their effect on the business and dwelling investment Q-ratios.

Chart 14: Consumption, Labour Income and Private Wealth



GNE and GDP are higher for most of the simulation period. GNE falls slightly in the first two years, but is growing strongly by year 3. The increase in GDP and aggregate demand feeds back into to the labour market, increasing employment and reducing the unemployment rate towards the new lower NAIRU.

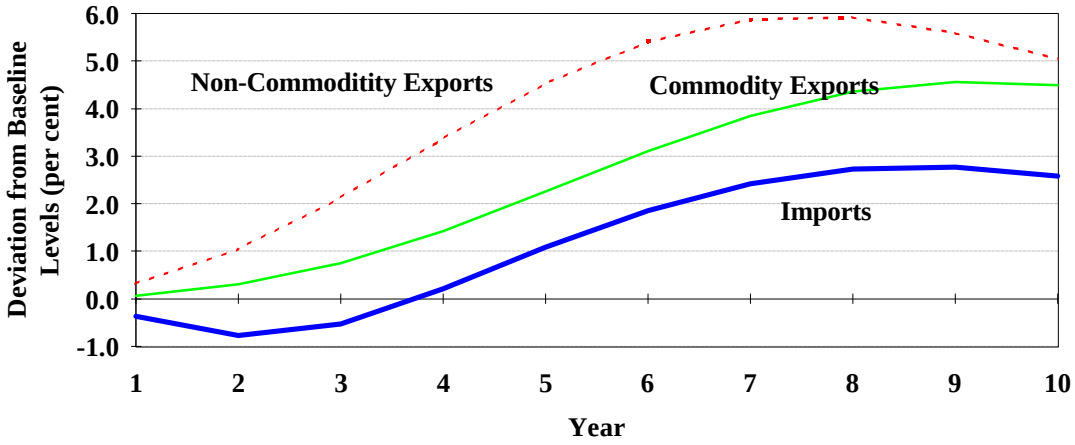
Chart 15: GDP and GNE



5.25 External Sector

In the external sector, the depreciation in the real exchange rate provides an immediate boost to non-commodity exports via an increase external competitiveness. In contrast, commodity export markets are characterised by higher prices but unchanged volumes. After the second year the fall in domestic non-commodity prices boosts the internal competitiveness of commodity exports. This encourages producers to shift resources into the export markets.

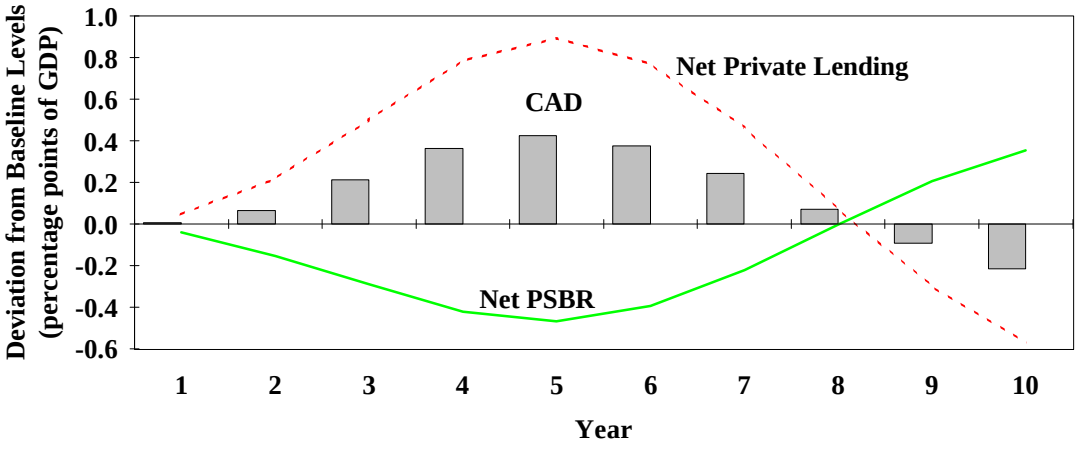
Chart 16: Exports and Imports



On the import side, the decline in volumes is primarily driven by the relative price effects of the depreciation in the real exchange rate (an increase in external competitiveness of domestic goods). However, by year 4 higher demand (particularly business investment) arrests the decline, leading to higher import volumes thereafter. Net exports are higher throughout the simulation period.

5.26 Net Lending and the CAD

Chart 17: Current Account Deficit, Net PSBR and Net Private Lending



For the first five years the net PSBR falls as a percentage of GDP due to both expenditure and revenue side effects. On the expenditure side, the improvement is due to the fall in unemployment benefit payments (as the unemployment rate declines) and the fall in the public sector wage bill (as real wages decline). While on the revenue side, taxation collections increase as output increases.

Despite the reduction in the net PSBR, the CAD as a share of GDP is higher for the first eight years due to an increase in net private lending. Business investment increases strongly as firms adjust their capital stock towards a higher desired level consistent with the increase in employment and output in the long run.

By year 8, the movements in the CAD, the net PSBR and net private lending have been reversed. Since the public debt to GDP target is unchanged in this simulation, the initial improvement in the net PSBR provides the Government with scope to reduce income tax rates. The significant size of these tax cuts is reflected in the fact that the after-tax consumer real wage is higher by year 8 despite pre-tax consumer

real wages being lower. The process working here could be thought of as a social wage/budget deficit trade-off, with the benefits from a lower NAIRU to the budgetary position being transferred to workers.

On the net private lending side, an increase in private saving (in response to higher after-tax real wages) and smaller increases in private investment (as the capital stock approaches its desired level) lead to a significant fall in net private lending.

5.3 Medium Run Adjustment

In the medium run, there are several factors that lead to the unwinding of some of the stimulus to output and demand and pull the economy back towards the supply determined equilibrium.

Improving labour market conditions start to encourage insiders to place upward pressure on wages. In the first few years, the effect from outsiders dominates (lower wages pressure due to the gap between the unemployment rate and the NAIRU). However, by year 5 higher wages pressure from insiders starts to arrest and then reverse some of the fall in real wages.

In the financial markets, interest rates and the exchange rate rise as demand accelerates. Consumption, dwelling investment and business investment all respond to higher interest rates in the medium to long run, while the higher exchange rate increases imports and reduces exports.

In the goods market, the excess supply is eliminated by year 6, moving into excess demand after this time. This arrests the fall in the price level, stabilising prices at a new lower level.

CONCLUSION

This paper has presented the results of a re-examination of the behavioural equations in TRYM labour market, particularly the wage equation. The primary motivation for this re-examination was the desire to more fully integrate the specification of the various labour market equations and to improve their explanatory power. While the results are based on work in progress, a number interesting findings can be drawn out from the re-specification of the labour market to date.

A fairly simple formulation of an unemployment/vacancy relationship (Beveridge curve) has been estimated. This specification, common with other research in this area, found a significant shift outwards in the Beveridge curve around 1974, but not in the 1980s and 1990s. This formulation was then introduced into the wage equation as a simple summary measure of search effectiveness. Estimation of the wage equation in turn suggested that changes in search effectiveness only explained a part of the estimated increase in the NAIRU over the past twenty years.

On the wage equation, two other significant changes have been implemented with varying degrees of success. Firstly, attempts to improve the wage-price inertia in the model proved only partially successful with lagged changes in prices being only jointly determined. Secondly, attempts to incorporate the effects of taxes and relative import prices on wages in the short run dynamics proved successful with a well determined estimate. That said, ideally the effects of taxes and relative import prices should be incorporated in level terms. However, this would have involved major changes to the model structure. Consequently, this has been left for future work.

The re-specification of labour demand and supply equations lead to a significant improvement in the explanatory power of each equation. More specifically, the introduction of vacancies data in the labour demand specification (by way of the estimated Beveridge curve equation) proved to be successful with an increase in the estimated elasticity of substitution in the long run (as predicted by economic theory). With respect to the labour supply equation, the effects of after-tax real wages were removed from the long run and successfully incorporated into the short-run dynamics.

More generally, the re-specification of the labour market (in particular the incorporation of unfilled vacancies data) will enable TRYM to be used to explore a wider range of issues relating to the link between labour market imbalances and other areas of the economy. For example, TRYM will now be able to examine the macroeconomic implications of changes in search effectiveness of the unemployed and wage setting factors separately.

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