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Asymmetric unemployment rate dynamics in Australia

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Abstract

The unemployment rate in Australia is modelled as an assymmetric and non-linear function of aggregate demand, productivity, real wages and unemployment benefits. Negative changes in aggregate demand cause the unemployment rate to rise rapidly, while real wage rigidity contributes its to slow adjustment back towards a lower level of unemployment. The model is developed by exploiting recent developments in automated model-selection procedures.

Keywords

unemployment,
non-linearity,
dynamic modelling,
aggregate demand,
real wages.

JEL Classification: C12; C52; C87; E24; E32.

1   Introduction

There is a growing body of research which points to the fact that the unemployment rate exhibits asymmetric behaviour in the sense that it increases more quickly than it decreases.[1] Various explanations of this nonlinear behaviour have been offered in the literature. For example, Aolfatto (1997) uses Pissarides (1985) simple search and matching model to explain cyclical asymmetry in unemployment rate fluctuations in the US. He finds that the asymmetry comes from an adverse productivity shock, which brings about the destruction of certain jobs in the economy that are not recreated as aggregate economic conditions improve, forcing individuals to seek out new job opportunities. Jovanovic (1987), Greenwood et al. (1996), and Mortensen and Pissarides (1994) also use various search and matching models to explain the behaviour of the unemployment rate in the US. A related literature has pointed to asymmetries in Okun's Law where changes in output can cause asymmetric changes in the unemployment rate ((Lee, 2000; Crespo-Cuaresma, 2003; Silvapulle et al., 2004; Huang and Chang, 2005). Finally, several papers relate non-linearities to hysteresis: (Akram, 2005; Papell et al., 2000; Proietti, 2003).

Empirical evidence also exists on the nonlinear properties of the aggregate Australian unemployment rate (Peat and Stevenson, 1996; Bodman, 1998, 2001, 2002; Skalin and Teräsvirta, 2002). While these non-linear models show that the aggregate unemployment rate in Australia does indeed behave differently during periods of low and high unemployment, they do not have an effective explanation of what drives the unemployment rate to increase at such a rapid rate or what contributes to its much slower decrease.

This paper demonstrates that aggregate demand, productivity, real wages and unemployment benefits are all important factors in the asymmetry in the Australian unemployment rate.

In terms of methodology, this paper shows that automated model-selection

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[1]For the US see (Hansen, 1997; Verbrugge, 1997; Parker and Rothman, 1998; Rothman, 1998; Koop and Potter, 1999; Altissimo and Violante, 2001); for Europe contributions include (Acemoglu and Scott, 1994; Peel and Speight, 1998; Brännäs and Ohlsson, 1999; Akram and Nymoen, 2001; Skalin and Teräsvirta, 2002)

techniques, introduced by Hoover and Perez (1999), and further developed by Hendry and Krolzig (1999, 2001) and Doornik (2009) for linear models, can be usefully applied in nonlinear environments. It is shown that the nonlinear model can efficiently be developed by testing the linearized expansion against its linear alternative at the same time as identifying the variables that are crucial to the final nonlinear specification.

The rest of the paper is structured as follows. Section 2 sets out a simple LSTAR model of the unemployment rate and demonstrates the key features of the model that enables it to capture asymmetries in the data. Section 3 looks at the asymmetry in the Australian unemployment rate and explores in an informal way its positive relationship with aggregate demand and its negative relationship with real wages. In Section 4 an enhanced non-linear modelling cycle is implemented based on the automated model-selection procedures available in the *Autometrics* software Doornik (2009). The empirical results obtained are evaluated in Section 5. The end result is a model of the Australian unemployment rate which is linear in demand shocks, real wages and productivity with non-linear behaviour caused primarily by unemployment rigidities. Section 6 is a brief conclusion.

2   Asymmetries in Unemployment: A Benchmark LSTAR Model

Figure 1 plots the evolution of the Australian unemployment rate from 1971 to 2005. It shows how large, swift upward changes are followed by slow, downward drifts. According to Skalin and Teräsvirta (2002), this non-linear behaviour is consistent with large, linear responses to economic shocks, followed by slow, non-linear movements towards equilibrium.

They propose a simple univariate LSTAR model as a useful way of summarizing the main features of the asymmetric behaviour of the unemployment rate. To highlight the main properties of the model, we consider a version with only 1.order dynamics on Equilibrium Correction (EqC) form:

$$\Delta u_t = -\alpha_1 \left(u_{t-1} - \frac{\mu_1}{\alpha_1} \right) - \alpha_2 \left(u_{t-1} - \frac{\mu_2}{\alpha_2} \right) G_t + \varepsilon_t \qquad 0 < (\alpha_1 + \alpha_2) < 1.$$

Figure 1: Australia's aggregate unemployment rate measured for the period 1971:1 to 2005:3.

with

$$G_t = [(1 + \exp\{-\gamma \left(\Delta u_{t-1} - c\right)\})]^{-1} , \qquad \gamma > 0 .$$

The parameter c is the threshold that determines the size of the shock that is required for the activation of the transition function $G(\cdot)$ and the value of γ determines the speed of the change in $G(\cdot)$ from the value of zero to unity in the vicinity of the threshold.

Assume a constant long-run equilibrium rate of unemployment μ_1/α_1 for which $\Delta u_t = 0$, and therefore $G_t = 0$. Suppose a large positive shock affects unemployment such that $\Delta u_t > c$ and $G_t = 1$. In the next period, the growth in unemployment Δu_t will be given by

$$\Delta u_t = -(\alpha_1 + \alpha_2) \left(u_{t-1} - \frac{\mu_1 + \mu_2}{\alpha_1 + \alpha_2} \right) + \varepsilon_t.$$

The restrictions on the parameters ensure that Δu_t will fall below c as u_t approaches $\dfrac{\mu_1 + \mu_2}{\alpha_1 + \alpha_2}$, which has the effect of resetting the transition function G_t to zero and returning the process for Δu_t to

$$\Delta u_t = -\alpha_1 \left(u_{t-1} - \mu_1/\alpha_1 \right) + \varepsilon_t .$$

If the value of α_1 is small, the return of the unemployment rate towards its long-run equilibrium level μ_1/α_1 is likely to be slow, thus reinforcing the likelihood that the transition function remains zero. This deceptively simple model is thus potentially capable of mimicking the asymmetric fluctuations

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in the Australian unemployment rate. We therefore start by estimating this univariate specification enhanced with richer dynamics. The parameter estimates of this benchmark model, using using the lagged four-quarter-ended growth rate of unemployment, $\Delta_4 u_{t-1}$, as the transition variable, are reported in Table 1.[2]

Table 1:

The baseline LSTAR specification of the unemployment rate with $\Delta_4 u_{t-1}$ as the transition variable for the period 1972:3 to 2005:3.

Coefficients	Estimates	Std. Errors	t-values
Linear parameters:			
μ_1	0.081	0.025	3.203
Δu_{t-1}	0.534	0.084	6.322
Δu_{t-2}	0.311	0.095	3.256
Δu_{t-3}	0.186	0.092	2.010
Δu_{t-4}	-0.377	0.083	-4.537
u_{t-1}	-0.036	0.013	-3.053
Transition parameters:			
γ	1999	——	——
c	0.389	0.001	3.203
Non-linear parameters:			
μ_2	0.660	0.427	1.545
Δu_{t-1}	-1.209	0.767	-1.575
Δu_{t-2}	-0.408	0.455	-0.897
Δu_{t-3}	-0.768	0.300	-2.561
Δu_{t-4}	-0.181	0.611	-0.2969
u_{t-1}	-0.192	0.133	-1.449

Diagnostics:

RSS	0.273	$\hat{\sigma}$	0.048
AIC	-5.95	SC	-5.65

The overall impression from the estimation is very promising, although some of the individual nonlinear parameters are not statistically significant. In particular, the coefficients on u_{t-1} in the two regimes, respectively $u_{t-1} = -0.036$ and $u_{t-1} \cdot G_t = -0.192$, are of the relative order of magnitude that would support the pattern of asymmetry in the behaviour of the unemployment rate illustrated in Figure 1. The estimate of the parameter

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[2]Estimation of the LSTAR models was conducted using Ivar Pettersen's *STR2* compiled *OxPack* routines translated from Gauss programmes written by Timo Teräsvirta and the Non-linear algorithms in *Oxmetrics4.10*.

governing the speed of the transition from periods of low to periods of high unemployment, $\widehat{\gamma} = 1999$, indicates a very abrupt transition in the vicinity of the threshold $\widehat{c} = 0.389$. This specification is only a preliminary one and as such only a minimum set of diagnostics are reported, but there does appear to be support from this simple univariate model for the hypothesis that the Australian unemployment rate can be estimated using a non-linear framework. The interesting economic question to ask, however, is what drives this asymmetric behaviour, so we can improve upon this univariate, autoregressive specification.

3   Sources of unemployment variation

Deficient aggregate demand and high real wages appear to be the two macroeconomic variables widely recognized as explaining the existence of unemployment in Australia. Empirical studies have consistently found statistical support for a negative relationship between aggregate demand and unemployment and a positive relationship between real wages and unemployment (Pitchford, 1983; McMahon and Robinson, 1984; Trivedi and Baker, 1985; Dao, 1993; Valentine, 1993). These findings are also consistent with results obtained from reduced-form equations of the unemployment rate in structural labour market models (Pissarides, 1991; Huay and Groenewold, 1992; Scarpetta, 1996; Powell and Murphy, 1997; Debelle and Vickery, 1998; Downes and Bernie, 1999). Moreover, these empirical findings are supported by more descriptive work that demonstrates that a common theme in papers on unemployment in Australia is that business cycle fluctuations and real wage growth are the two primary factors influencing Australian unemployment (Gregory, 2000; Le and Miller, 2000; Thomson, 2000; Borland, 1997; Goodridge et al., 1995).

Figure 2 provides support for this hypothesis. As can be seen, changes in the unemployment rate are negatively correlated with changes in GDP, while the sluggish decrease in the unemployment rate from very high peaks, parallels similar behaviour in real wages. Since 1996, a divergence in the positive relationship between the unemployment rate and real wages in Aus-
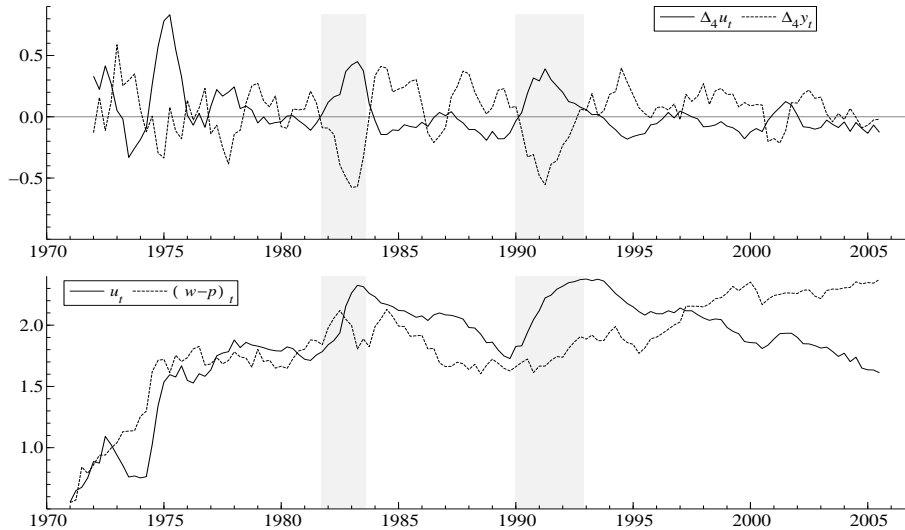
Figure 2: Four-quarter-ended growth rates of the (logs) unemployment rate and real GDP (upper panel) and levels of (logs) the unemployment rate and real wages (lower panel). Means and scales are adjusted.

tralia is apparent. This phenomenon appears to be able to be explained by the surge in labour productivity in Australia during the 1990s which accelerated greatly in the last half of the decade. Hence, it seems that high real wages did not affect unemployment as greatly given the more than commensurate increase in productivity. These observations suggest that the tentative dynamic specification of the aggregate unemployment rate in Australia, estimated in Section 2, will, at the very least, need to be augmented by the inclusion aggregate demand, real wages and productivity. In addition we control for the effects of real unemployment benefits.

The variables used are seasonally adjusted quarterly observations of the first differences of the logs of the unemployment rate u, real wages rw, average labour productivity pr, and real unemployment benefits rub for 1971:1 to 2005:3. As shown in Figure 3, the series appear to be stationary, which is confirmed by standard unit-root tests, results of which are available upon request. Appendix A provides a detailed description of the data and its sources.

There are several additional interesting aspects of the estimation period 1974-2005. Figure 1 showed that the asymmetry in the unemployment rate is particularly evident from the mid-1970s, while the sample period also cov-
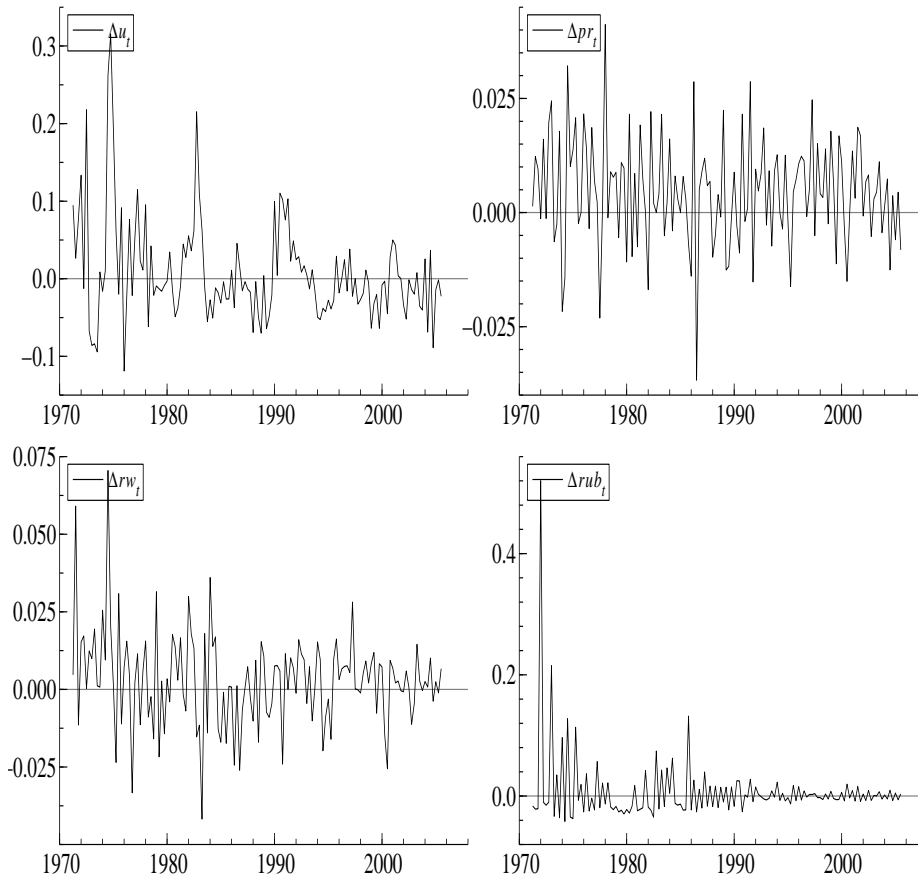
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Figure 3: Differenced logarithms of the unemployment rate (upper left), productivity (upper right), real wages (lower left), and real unemployment benefits.

ers three, possibly four, complete, asymmetric cycles of the unemployment rate. This period also includes two widely recognized economic downturns in the Australian economy[3], represented by by the shaded areas in Figure 2. The dates of these two recessions, and the subsequent recoveries, appear to coincide with the rapid increases and the gradual decreases in the rate of unemployment. This lends support to the hypothesis that there is a relationship between economic growth and the rate of unemployment which may be further clarified within the context of a model of asymmetric unemployment dynamics.

Having established null hypotheses both about the general functional

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[3]According to the Melbourne Institute of Applied Economic and Social Research (2000) Australia experienced two classical recessions during this time. These periods include September 1981 to May 1983 and December 1989 to December 1992.

form as well as the forcing variables, the most important task of specifying and testing the model remains. Since all variables can enter both linearly and non-linearly, the problem of model specification is highly accentuated. We therefore propose to use Automated model selection techniques to test the proposed model of unemployment dynamics in Australia.

4 Automated Model Selection

In this section, a modelling cycle of specification, estimation, evaluation and encompassing of a nonlinear econometric model within an automated modelling environment is described. Consider the general smooth transition model

$$\Delta u_t = \phi' x_t + \theta' x_t G\left(\gamma, c, s_t\right) + u_t\,. \tag{1}$$

The transition variable is $s_t = \Delta_4 u_{t-1}$, while the information set x_t consists of

$$x_t = [1, u_{t-1}, \Delta u_{t-l}, \Delta_4 y_{t-m}, \Delta rw_{t-m}, \Delta pr_{t-m}, \Delta rub_{t-m}]'\,,$$

for $l = 1, \cdots, 4$ and $m = 0, \cdots, 4$.

Following Teräsvirta (1994, 1998), the non-linear smooth-transition model may be linearized by using a Taylor expansion of the logistic function in equation (2), to give

$$\Delta u_t = \beta_0' x_t + \beta_1' x_t s_t + \beta_2' x_t s_t^2 + \beta_3' x_t s_t^3 + v_t\,. \tag{2}$$

A test for linearity against the LSTR specification involves an F-test of the joint hypothesis

$$H_0 : \beta_1 = \beta_2 = \beta_3 = 0.$$

A more efficient approach, however, could be to test not only against non-linearity, but simultaneously to test down the general linear specification of equation (2) to obtain a correctly specified linear model. With the model in this form, the testing down of the general linearized model (2) may be conducted by means of an automated model-selection program.[4] For this

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[4]We are grateful to David Hendry who suggested this approach to us. See also Castle and Hendry (2008).

purpose we use the automated modelling procedures available in the software *Autometrics*, developed by Doornik (2009).

The modelling cycle may now be described as follows.

Step 1: Specification.

Given the number of variables in the full Taylor expansion in equation (2), the suggestion of Teräsvirta (1998) is followed and only the 3rd-order term in the Taylor expansion is used. The general linearized model which is passed to *Autometrics* for testing is therefore

$$\Delta u_t = \beta_0 x_t + \beta_3' x_t s_t^3 + v_t \tag{3}$$

Autometrics conducts a specification search of equation (3) and returns the chosen specification. If the model chosen by *Autometrics* returns the coefficient values

$$\beta_3 = 0,$$

then the final model is linear and the modelling cycle is complete. If, on the other hand, the model chosen by *Autometrics* includes non-zero values for any of the elements of β_3, then the hypothesis of linearity is rejected and the chosen model contains non-linear elements. In this instance, the modelling cycle proceeds to Step 2.

Step 2: Estimation.

Let $x_{0,t}$ and $x_{3,t}$ contain those elements of x_t with corresponding non-zero elements in β_0 and β_3 in the specification chosen by *Autometrics* in Step 1. The LSTAR model to be estimated is then

$$\Delta u_t = \delta_0' x_{0,t} + \delta_3' x_{3,t} G_t \left(\gamma, c, s_t \right) + \varepsilon_t, \tag{4}$$

with the function $G_t \left(\cdot \right)$ given by equation (2) and with $\Delta_4 u_{t-1}$ used as the transition variable, s_t.

Step 3: Evaluation and encompassing.

Step 2 yields estimates of the parameters of the transition function which are then used to create the observed function, $\widehat{G}_t \left(\widehat{\gamma}, \widehat{c}, s_t \right)$. Augmenting the general linearized model (3) to

$$\Delta u_t = \theta_0' x_t + \theta_3' x_t s_t^3 + \kappa_3' x_{3,t} \widehat{G}_t \left(\widehat{\gamma}, \widehat{c}, s_t \right) + \eta_t \tag{5}$$

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enables a test of parsimonious encompassing (Hendry, 1995, p. 511), corresponding to the joint test of

$$H_0 : \theta_0 = \delta_0, \ \theta_3 = 0, \ \kappa_3 = \delta_3,$$

conditional on $\widehat{G}_t (\widehat{\gamma}, \widehat{c}, s_t)$. This test is again easily implemented by letting *Autometrics* evaluate (5), and see if the outcome is the estimated LSTAR from (4). If so, the test statistic is the F-test of omitted variables in the final specification.

5 Empirical Results

The results obtained in each of the steps of the enhanced modelling cycle described in the previous section are now discussed in turn.

5.1 Specification

The specification of the general linear model chosen by *Autometrics* is reported in Table 2. These results suggest that, although there are strong and significant linear effects from both output growth ($\Delta_4 y_t = -1.810$) and labour productivity growth ($\Delta pr_{t-1} = 0.869$), the model rejects the hypothesis of linearity through the joint significance of the many interaction terms. It is interesting to note the difference in the coefficients of mean reversion, respectively $u_{t-1} = -0.035$ and $s_t^3 \cdot u_{t-1} = -0.295$. When changes unemployment are below the threshold required to trigger the transition function, the Australian unemployment rate exhibits strong hysteresis. This would be consistent with the long slow decline in the unemployment rate observed at various times the data. In addition, real wages and real unemployment benefits both enter in interaction with the transition variable which may be due to these variables having stronger effects in periods of high unemployment growth. The presence of the cubic terms is rejection of a null hypothesis of linearity with a LSTR specification as the alternative Teräsvirta (1994).

5.2 Estimation

Based upon the results of the specification stage, a LSTR model is estimated using non-linear least squares and the results are reported in Table 3.

Table 2:

The baseline linearized model of the unemployment rate for the period 1972:3 to 2005:3.

Coefficients	Estimates	Std. Errors	t-values
$Const.$	0.133	0.026	5,02
Δu_{t-4}	-0.261	0.080	-3.25
$\Delta_4 y_t$	-1.810	0.230	-7.84
$\Delta_4 y_{t-3}$	1.094	0.306	3.57
$\Delta_4 y_{t-4}$	-1.400	0.309	-4.53
Δrw_t	0.645	0.259	2.49
Δrub_t	0.449	0.120	3.73
Δrub_{t-2}	-0.348	0.123	-2.82
Δpr_t	0.869	0.290	2.99
u_{t-1}	-0.035	0.011	-3.08
s_t^3	0.721	0.210	-3.44
$s_t^3 \cdot \Delta u_{t-3}$	-0.772	0.200	-3.88
$s_t^3 \cdot \Delta_4 y_{t-3}$	-9.805	1.673	-5.86
$s_t^3 \cdot \Delta_4 y_{t-4}$	6.124	1.118	5.48
$s_t^3 \cdot \Delta rw_{t-1}$	2.768	0.754	3.67
$s_t^3 \cdot \Delta rub_{t-2}$	-1.717	0.400	-4.29
$s_t^3 \cdot \Delta rub_{t-4}$	-1.259	0.227	-5.54
$s_t^3 \cdot u_{t-1}$	-0.295	0.089	-3.36

Diagnostics:

RSS	0.151	$\hat{\sigma}$	0.0365
AIC	-3.65	SC	-3.26
$F_{AR(1-5)}$ (5,108)	0.228 [0.949]	$\chi^2_{normality}$ (2)	8.330 [0.015]
RESET (1,112)	32.161 [0.000]	F_{het} (28,84)	1.001 [0.477]

The growth rates of aggregate demand and unemployment benefits all enter non-linearly. The coefficient on the unemployment level terms, respectively $u_{t-1} = -0.019$ and $u_{t-1} \cdot G = -0.294$, are consistent with the observed asymmetric behaviour in the Australian unemployment rate. Moreover, it can be seen that the LSTR model provides a good explanation of the data when compared against the simple univariate specification (Table 1) with the RSS and the information criteria (AIC and SC) substantially reduced.

The size of the steepness parameter, $\gamma = 100$ indicates a rapid change in the transition between periods of low and high unemployment. This suggests that a potential simplification of the LSTR model can be achieved by esti-

Table 3:

The LSTAR model of the unemployment rate with $\Delta_4 u_{t-1}$ as the transition variable for the period 1972:3 to 2005:3.

Coefficients	Estimates	Std. Errors	t-values
Linear parameters:			
μ_1	0.112	0.025	4.375
Δu_{t-4}	-0.205	0.076	-2.675
$\Delta_4 y_t$	-2.025	0.220	-9.193
$\Delta_4 y_{t-3}$	1.238	0.314	3.931
$\Delta_4 y_{t-4}$	-1.547	0.303	-5.095
Δrw_t	0.528	0.238	2.218
Δrub_t	0.496	0.122	4.042
Δrub_{t-2}	-0.339	0.128	-2.641
Δpr_t	0.903	0.291	3.098
u_{t-1}	-0.019	0.011	-1.717
Transition parameters:			
γ	100.0	—	—
c	0.262	0.018	14.36
Non-linear parameters:			
μ_2	0.636	0.131	4.857
Δu_{t-3}	-0.451	0.148	-3.052
$\Delta_4 y_{t-3}$	-6.122	1.134	-5.397
$\Delta_4 y_{t-4}$	3.041	0.821	3.701
Δrub_{t-4}	-0.517	0.131	-3.937
u_{t-1}	-0.294	0.057	-5.092

Diagnostics:

RSS	0.147	$\hat{\sigma}$	0.036
AIC	-6.51	SC	-6.11

mating a switching regression model, originally developed by Quandt (1958)

$$\Delta u_t = \sum_{i=1}^{q} \rho_{1i} x_{it} + \sum_{i=1}^{q} \rho_{2i} x_{it} I_t + \varepsilon_t \,, \tag{6}$$

where I_t is the Heaviside indicator function

$$I_t = \begin{cases} 1 & \text{if} \quad s_t > c \\ 0 & \text{if} \quad s_t < c \end{cases} \tag{7}$$

5.3 Evaluation and encompassing

The chosen model to be examined in terms of the evaluation and encompassing phase of the modelling cycle is, therefore, the specification of Table

3 simplified to a threshold model, with transition variable $s_t = \Delta_4 u_{t-1}$ and threshold parameter $\hat{c} = 0.2624$ and augmented with all the terms of the general linearized model (3). This general model is then tested down using *Autometrics*.

Table 4:

The estimated threshold model of the unemployment rate with $\Delta_4 u_{t-1}$ as the transition variable for the period 1972:3 to 2005:3.

Coefficients	Estimates	Std. Errors	t-values
Linear parameters:			
μ_1	0.112	0.025	4.38
Δu_{t-4}	-0.215	0.076	-2.83
$\Delta_4 y_t$	-2.041	0.218	-9.35
$\Delta_4 y_{t-3}$	1.223	0.313	3.91
$\Delta_4 y_{t-4}$	-1.545	0.302	-5.12
Δrw_t	0.520	0.237	2.20
Δrub_t	0.468	0.118	3.95
Δrub_{t-2}	-0.285	0.115	-2.48
Δpr_t	0.870	0.288	3.02
u_{t-1}	-0.019	0.011	-1.66
I_t	0.559	0.103	5.41
$I_t \cdot \Delta u_{t-3}$	-0.372	0.121	-3.05
$I_t \cdot \Delta_4 y_{t-3}$	-5.567	0.967	-5.75
$I_t \cdot \Delta_4 y_{t-4}$	2.740	0.751	3.65
$I_t \cdot \Delta rub_{t-4}$	-0.443	0.096	-4.60
$I_t \cdot u_{t-1}$	-0.260	0.045	-5.68
Diagnostics:			
RSS	0.148	$\hat{\sigma}$	0.035
AIC	-6.678	SC	-6.396
$F_{AR(1-5)}$ (5,110)	0.665 [0.650]	F_{ARCH} (4,107)	0.816 [0.338]
$\chi^2_{normality}$ (2)	11.88 [0.002]	RESET (1,114)	3.779 [0.0544]

The final preferred model is documented in Table 4. It is clear from these results that the chosen model encompasses the general linearized model. *Autometrics* chooses the simplified threshold model as the final specification, and the F-test of omitted variables from the augmented generalized linear model (5) has a p-value of $F_{pGUM} = 0.205$.

The results suggest that when unemployment growth is low, changes in the Australian unemployment rate are predominantly a function of the growth rate in aggregate demand, $\Delta_4 y_t = -2.041$, real wage growth, $\Delta rw_t = $

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0.520 and growth in productivity, $\Delta pr_t = 0.87$. Furthermore, there appears to be marked hysteresis in the level of unemployment $u_t - 1 = -0.019$.

When the growth rate of unemployment exceeds the threshold level, the dynamics are much more complex, with a quicker mean reversion in the level of unemployment $I_t \cdot u_{t-1} = -0.260$. The main driver of continued high growth rates of unemployment is negative demand growth, $I_t \cdot \Delta_4 y_{t-3} = -5.567$. Another rather interesting result is the influence of changes in unemployment benefits. Any move to reduce unemployment benefits $\Delta rub < 0$ is likely to be counterproductive, although the effect is a small one compared to the influence of negative growth in aggregate demand. Sustained high growth rates in unemployment due to this aggregate demand effect will ensure that the reversion of the level of unemployment to the long-run mean will be slow.
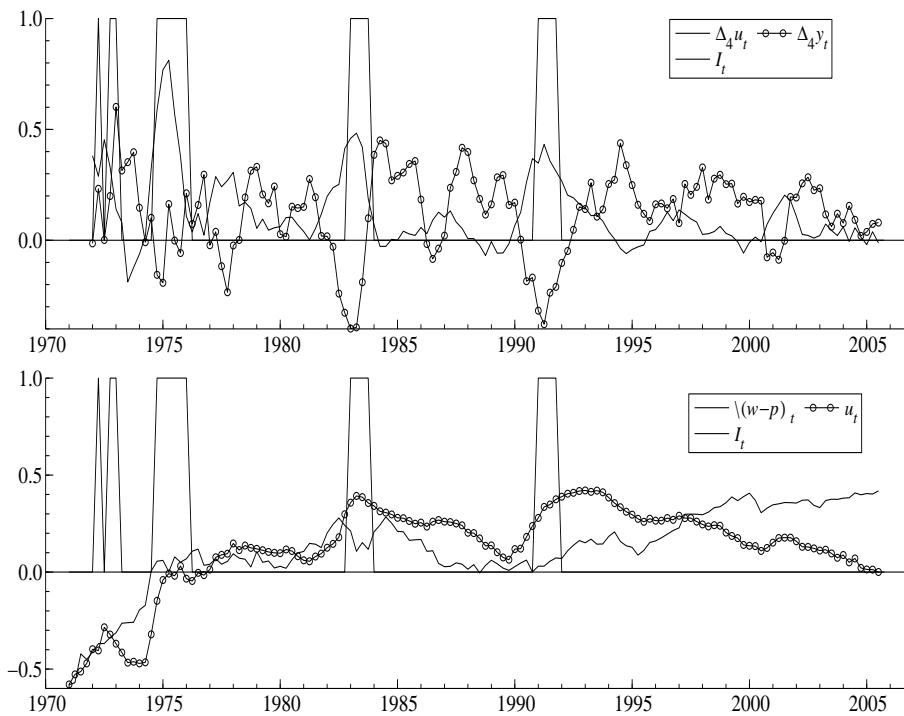

Figure 4: Annual percentage changes in unemployment and GDP (upper panel), and the unemployment rate and real wages (lower panel), together with the regime indicator.

The model is consistent with the following plausible economic scenario. Suppose there is a large, negative demand shock in the economy as would

occur, for example, during an economic recession. This would cause the growth rate of unemployment to rise above the threshold level. At the new higher level, the mean reversion is much slower, augmented by real rigidities in wages and unemployment benefits.

This potential scenario is supported by Figure 4 which compares the estimated transition function from the model with the annual percentage change in the unemployment rate and GDP and the unemployment rate and the real wage. The rapid increases in the unemployment rate, which occurred in Australia during the recessions of 1982/1983 and 1990/1991, are associated with a switch in the transition function to the second regime where the main source of high unemployment growth is negative growth in aggregate demand shocks, a combination which implies that the reversion of the level of unemployment to a long-term mean is a slow one.
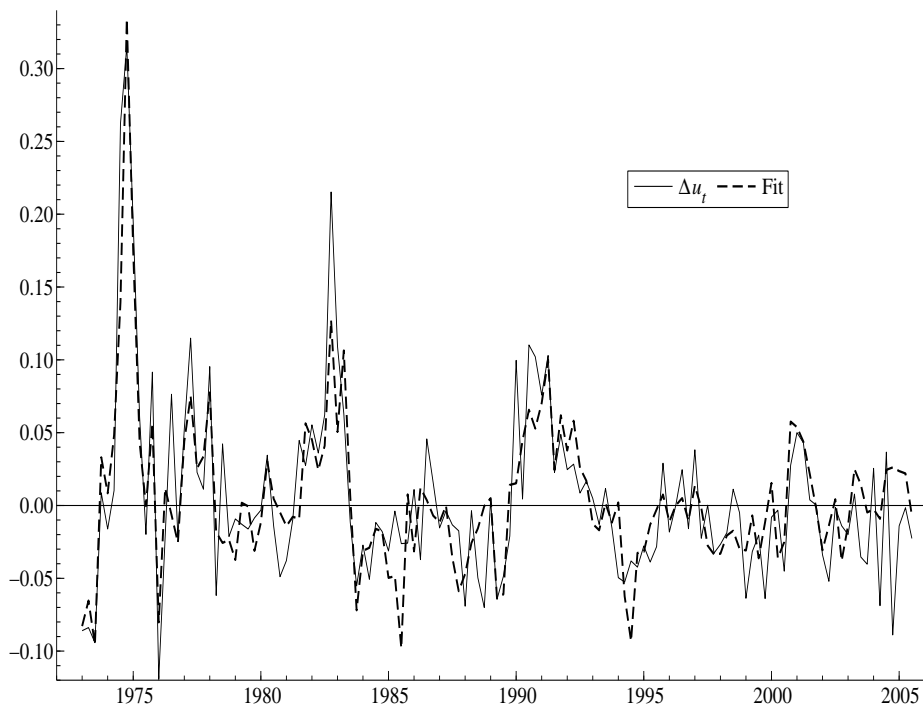

Figure 5: Actual and fitted values from the treshold model.

Given its simplicity and parsimony, the switching model does a surprisingly good job of describing the unemployment process (Figure 5) which plots fitted values of the model against the actual unemployment rate. Clearly, the non-linear model does a good job of explaining the sharp pick-up in unem-

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ployment in Australia observed in the early 1980s and 1990s.

6 Conclusion

The existing empirical work on Australian unemployment which models the unemployment rate directly in a single-equation framework makes the assumption that the unemployment rate is linear. This is inconsistent with empirical evidence which suggests that the structure of Australia's unemployment series is asymmetric.

Consequently, this paper estimates a nonlinear model of the unemployment rate for Australia. In so doing, the research presented here demonstrates that automatic model selection has a potentially valuable role to play in nonlinear econometric modelling. A cycle of specification, estimation, evaluation and encompassing is implemented to aide in the search for an effective model of the Australian unemployment rate. The final empirical model is both simple and parsimonious and is able to capture the dynamics of the Australian unemployment rate. The nonlinear specification chosen represents an improvement in explanatory power by comparison with a baseline linear model.

In contrast to earlier, purely time-series-based models, it is found that several macroeconomic variables are important determinants of the unemployment rate in Australia. It is shown that changes in unemployment are predominantly a result of deficient aggregate demand and real wage growth. Further, as unemployment rises, it continues to remain high due mainly to continued negative growth in aggregate demand.

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A   Data description and sources

- **Unemployment rate**:

  Definition: Number of unemployed people as a proportion of the civilian labour force (%). Seasonally adjusted.

Source: ABS Cat. No. 1364.0 Table 10. Accessed 24/01/06.

- **Real output:**

Definition: Real, non-farm GDP ($Am). Seasonally adjusted. This series is used to construct the four-quarter-ended domestic growth rate which is defined as the difference between real GDP this quarter and real GDP in the same quarter in the previous year.

Source: RBA Bulletin Statistics Table G10.

Accessed 23/12/05

- **Nominal average weekly earnings**:

Definition: Nominal, average weekly earnings of employed wage and salary earners (excluding those employed in private agriculture) ($A). Seasonally adjusted. Estimates of average weekly earnings are derived by dividing estimates of total weekly earnings by the number of employees.

Earnings are average, before tax earnings of employees and do not relate to average award rates nor to the earnings of the 'average' person. Employees refer to all wage and salary earners, including part-time workers.

Source: Commonwealth Treasury Economic Data: Unit Labour Cost Index. September 2005.

Accessed 23/12/05

- **Consumer prices**:

Definition: All groups, consumer price index (CPI): analytical series. Index 1989/90=100.

Source: ABS Cat. No. 6401.0 Table 9(b).

Accessed 24/01/06.

- **Aggregate labour productivity**:

Definition: Real, non-farm GDP per person, per hour. Seasonally adjusted.

A person is defined as all wage and salary earners, the self-employed and unpaid helpers.

Source: Commonwealth Treasury Economic Data: Unit Labour Cost Index.

Data taken from the September Quarter 2005, National Accounts.

Accessed 23/12/05

- **Nominal unemployment benefits:**

Description: Weekly payment for single persons, over 21 with no children ($ per week).

Source: RBA & Department of Social Security.

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