

The Phillips Curve, the NAIRU, and unemployment asymmetries

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The Phillips Curve, the NAIRU, and unemployment asymmetries

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1. Introduction

Central Banks in most economies now manipulate short-term interest rates (and hence the slope of the yield curve) to keep the rate of inflation within some target range. The consequences of this “inflation-first” monetary policy has manifested in the form of persistently high unemployment in most OECD economies since 1975 (Modigliani, 2000). The policy has been expressed by economists in terms of the need to stabilise the economy at the natural rate of unemployment, or in more modern parlance, at the NAIRU. Despite its centrality in the policy debate, the NAIRU has evaded accurate estimation (Staiger, Stock and Watson, 1997) and several authors have cast serious doubt on its usefulness as a policy tool (Chang, 1997; Fair, 2000; Mitchell, 1987, 2001a). If the economy fails to generate a unique NAIRU then serious questions have to be asked about the efficacy of monetary policy which uses high unemployment rates to control inflation.

It is well-established that persistent demand shocks change the equilibrium unemployment rate. This is consistent with the major findings of the hysteresis literature (see Hargreaves-Heap, 1980; Cross, 1986; Mitchell, 1987; for early contributions). It is also well documented that unemployment behaves asymmetrically with respect to the business cycle and sharp increases are followed by very slow declines (see Rothman, 1998; Skalin and Teräsvirta, 2002; Mitchell, 2002). Recession, therefore, has a disproportionately negative impact on long-term unemployment.

It is less recognised that a temporary change in aggregate demand can cause an adverse permanent change in the relationship between long-term unemployment and inflation and this change is asymmetric with respect to a symmetric shock in demand. This point is elaborated on by Ball (1999), who uses the short-term rate of unemployment as the proxy for excess demand in an otherwise standard Expectations-augmented Phillips curve. Ball (1999: 227) says that his “model allows for hysteresis by modifying the textbook Phillips curve. The modification builds on ... the distinction between short- and long-term unemployment... the long-term unemployed do not affect inflation: the Phillips curve includes only *short-term* unemployment. Under this assumption there is a unique level of short-term unemployment consistent with stable inflation, but total unemployment can settle at any level.” In Ball’s model an economy always converges to a constant

equilibrium rate of short-term unemployment after employment is disturbed by an aggregate demand shock. From a policy perspective, if the dynamics implied by Ball (1999) are empirically robust, then aggregate demand stimulation by government during a recession can prevent a permanent rise in unemployment without a major cost in inflation. In addition, the uniqueness of this level of short-term unemployment depends on other behavioural aspects of the inflationary process, in particular whether the estimated models are homogenous with respect to expectations and whether the steady-state unemployment rate is cyclically responsive (see Fair, 2000; Mitchell, 2001a).

Ball (1999: 240) says “hysteresis is reversible: a demand expansion can reduce the NAIRU” because “they ... [employers] ... would rather pay the training costs than leave the jobs vacant” (Ball, 1999: 230). A similar observation underpins the hysteresis models in Mitchell (1987, 1993). In a high pressure economy, firms lower hiring standards and address the skill deficiencies of the long-term unemployment by offering on-the-job training. However, it is not commonly accepted that long-term unemployment is amenable to cyclical factors. Indeed, the whole thrust of active labour market policy is predicated on the belief that the long-term unemployed represent a structural bottleneck that can only be addressed by supply initiatives like training and welfare reform (OECD, 1994, 2001). Layard (1998: 27) argues that “in the very bad old days, people thought that unemployment could be permanently reduced by stimulating aggregate demand ... This belief has died everywhere ... these ideas did not address the fundamental problem: to ensure that inflationary pressures do not develop while there are still massive pockets of unemployed people ... The only way to address this problem is to make all the unemployed attractive to employers ... Nothing else will do the trick.”²

The evidence from the last expansion in Australia is very clear and is shown in Table 1. The first observation is from the trough of the last recession (1993:1) and the second (2000:3) represents the peak of the subsequent (long) expansion. Over this robust growth period, annual trend inflation remained below 3 percent. The proportion of long-term unemployment fell in lock step with the declines in the official unemployment rate (although underemployment rose, see Mitchell and Carlson, 2001). The strong demand led contraction in long-term unemployment provides no adverse inflationary impacts.

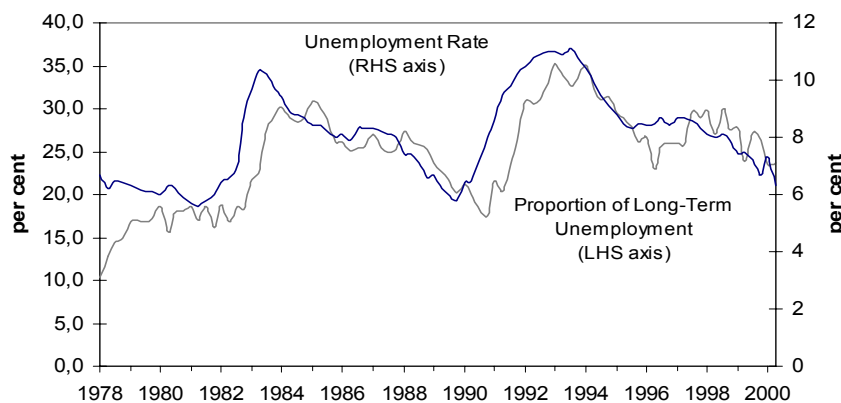
Table 1 Movements in official unemployment and long-term unemployment, Australia.

Quarter	Official Unemployment Rate (% of Labour Force)	Long-term Unemployment Rate (% of Labour Force)	Proportion of Long-term Unemployed (% of Total Unemployment)
1993:1	10.7	3.6	33.6
2000:3	6.1	1.5	24.2

Source: ABS AUSSTATS.

In Figure 1, the evolution of the share of long-term unemployment in total unemployment is shown to be strongly influenced by cyclical fluctuations in Australia over the last 25 years. As unemployment rises (falls), the proportion of long-term unemployed rises (falls) with a lag. Several studies have formally examined this relationship. Chapman *et al.* (1992), EPAC (1996), and Mitchell (2001a) have all found that a rising proportion of long-term unemployment is not a separate problem from that of the general rise in unemployment. This casts doubt on the supply-side policy emphasis that OECD governments have adopted over the last two decades. So while Layard (1998) may wish to abstract from the problem of a lack of employment opportunities, it is highly probable that long-term unemployment responds to exogenous (policy-driven) demand expansion.

Figure 1 Official unemployment rate and long-term unemployment, Australia.



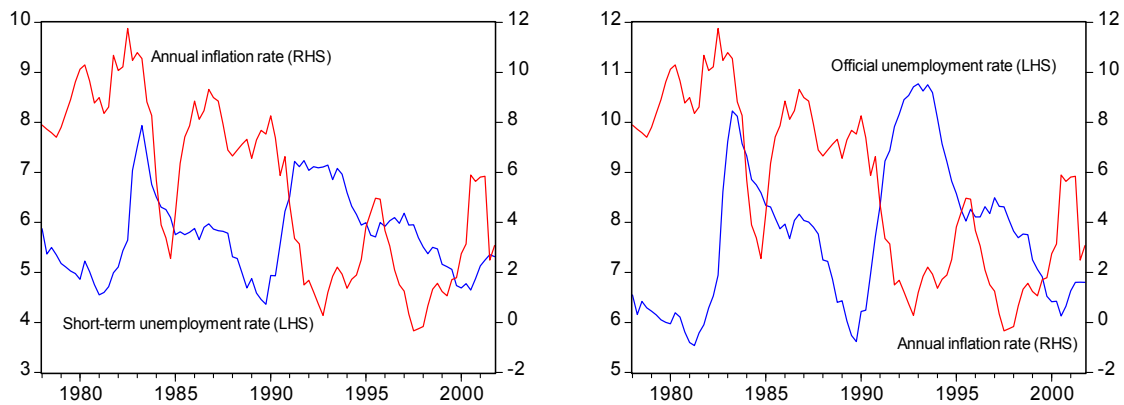
Source: ABS AUSSTATS.

This evidence supports Ball's second proposition (1999: 240), "that a policy response to a recession can prevent a permanent rise in unemployment without a major cost in inflation". The logic is that the long-term unemployed do not put pressure on inflation. Ball (1999: 231) says "[T]his is possible because of the small cost of hiring the long-term

unemployed. With this cost, firms prefer the short-term unemployed to the long-term unemployed, making the latter irrelevant to wage determination, but they prefer to hire the long-term unemployed rather than hire nobody.” It is thus important to test whether long-term unemployment put pressure on inflation given that evidence suggests that they do become re-employed when demand conditions are strong enough.

The relationships between annual inflation and the short-term unemployment rate and the official unemployment rate, respectively are plotted in Figure 2. One sees that the short-term unemployment rate varies more in concordance with the annual inflation rate. For instance the aggregate unemployment rate shows a stronger deviation in the early 1980s and again around 1993, when compared to short-term unemployment.

Figure 2 Inflation, short-term and long-term unemployment, Australia, 1978-2001



(a) Annual inflation rate and short-term unemployment rate

(b) Annual inflation rate and the official unemployment rate

Source: ABS, AUSSTATS.

Ball illustrates his model in a broad brush way for stylised facts that might pertain to a typical European economy.³ However, he admits that the model has to be elaborated before it can be tested in any rigorous manner. Section 2 presents a sophisticated version of the model, incorporating more complex labour market dynamics including the impact of changes in the labour force and introducing a full specification of the Phillips curve. We test this model in Section 3 for the Australian economy, which is in many relevant ways similar to a typical European economy as Figures 1 and 2 also show. Our partial estimation results allow us to conclude that the hypotheses underlying Ball his model are broadly consistent with the data and more detailed empirical analysis is indicated. While

employment shocks have a symmetric impact on the labour-force participation rate, they have an asymmetric impact on short-term unemployment. Moreover, the inflationary process is more sensitive to movements in the short-run unemployment rate rather than unemployment overall given other factors like import prices. Concluding remarks follow.

2. Ball's non-linear inflation model

Ball (1999) develops a model based on an Expectations-augmented Phillips curve using the rate of short-term unemployment as the measure of wage pressure. He argues that a unique level of short-term unemployment consistent with stable inflation may exist, but total unemployment can take on any value. Hence the NAIRU, as defined in the conventional sense, is undetermined. Moreover, since short-term unemployment is affected in an asymmetric way by employment shocks, the impact of cyclical variations in employment on inflation is asymmetric too.

The model needs to be extended in at least two ways to make it fit the stylised facts outlined in the introduction. First, the model ignores the impact of cyclical changes in the labour force, which represent an extra channel through which changes in employment affect both short-run unemployment and the rate of inflation. Second, the Phillips curve is too simplistic and requires further elaboration and theoretical underpinning. In this section, we extend the model to take these two features into account.

2.1 Labour market dynamics in Ball

The new element in Ball's analysis is that employment shocks arising from aggregate demand movements have asymmetric impacts on short-term unemployment, defined as a spell of unemployment up to 12 months in duration. This follows from the determination of short-term unemployment, U_s (assuming no labour force changes):

$$(1a) \quad U_s = sE_{t-1} \quad E_t \geq E_{t-1}, s < 1$$

$$(1b) \quad U_s = sE_t + (E_{t-1} - E_t) \quad E_t < E_{t-1}$$

s is the job separation rate and E is the level of employment. In the steady-state, $E_t = E_{t-1}$, which requires that $U_s = sE_t$ and thus the ratio of $U_s/E = s$.

By conducting the analysis in yearly terms Ball (1999) avoids any complications with data frequencies that are less than annual. To understand Equations (1a) and (1b), in terms of annual data frequencies, we start with the accounting statement that the change in unemployment is the sum of inflows into and outflows from unemployment. Inflow in unemployment is the result of a fixed rate of job separations, s from employment at the end of last period, E_{t-1} . Outflow from unemployment is at a fixed rate r of U_{t-1} , which is the level of unemployment at the end of last period. Thus:

$$(2a) \quad U = U_{t-1} + sE_{t-1} - rU_{t-1} = sE_{t-1} + (1-r)U_{t-1} \quad E_t \geq E_{t-1}, s, r < 1$$

This is consistent with Equation (1a) because the inflow in unemployment over the year constitutes short-term unemployment and the outflow is by construction from long-term unemployment. Thus we have $U_s = sE_{t-1}$.⁴

In the case of declining employment, inflow into unemployment is augmented by redundancies, by definition equal to the decline in employment, $E_{t-1} - E_t$. Thus:

$$(2b) \quad U = U_{t-1} + sE_{t-1} + (E_{t-1} - E_t) - rU_{t-1} = sE_{t-1} + (E_{t-1} - E_t) + (1-r)U_{t-1} \quad E_t < E_{t-1}$$

Given that the inflow in unemployment over the year constitutes short-term unemployment and the outflow is by construction from long-term unemployment, this is consistent with Equation (1b). Hence we have: $U_s = sE_{t-1} + (E_{t-1} - E_t)$.⁵

In both cases, within-year changes in unemployment are neglected. The consequences of this become clear when we construct the analysis in quarterly terms but still define short-term unemployment on a yearly basis.⁶ While Equations (2a) and (2b) remain relevant, it becomes more plausible to relate inflow into unemployment to employment at the end of the previous quarter and outflow from unemployment to unemployment at the same time. To see the consequences for short-term unemployment, we note that in each quarter the addition to short-term unemployment is given as $\max[sE_{t-1}, sE_{t-1} - \Delta E_t]$. Recursive substitution from Equations (2a) and (2b) then gives:

$$(3) \quad \sum_{j=1}^4 \max \left[s(1-r)^{j-1} E_{t-j}, s(1-r)^{j-1} E_{t-j} - (1-r)^{j-1} \Delta E_{t+1-j} \right]$$

which replaces Equation (1). Comparison of Equations (3) and (1) shows that *within-year* movements in unemployment are captured through the presence of the outflow rate r .

2.2 The impact of labour force dynamics

To help him focus on the impact of exogenous employment changes on short-run unemployment, Ball (1999) abstracts from labour force changes. However, cyclical labour force participation rate changes are likely to be an important source of variation in short-term unemployment. In this section, we redress this gap by developing a model that incorporates the dynamic impacts of labour force changes. To begin, flows from Employment and Unemployment to Not in the Labour Force (retirements, discouraged workers, quits) need to be incorporated. Let these flows be at a rate q for employment and v for unemployment. Then the flows out of the labour force from employment and unemployment are qE_{t-1} and vU_{t-1} , respectively. In addition, the exogenous change in the labour force (for example, due to demographic changes, migration) is defined as X . The current labour force is then defined as:

$$(4) \quad LF_t = LF_{t-1} - qE_{t-1} - vU_{t-1} + X$$

The quarterly change in the labour force is $\Delta LF_t = X - qE_{t-1} - vU_{t-1}$. The flows qE_{t-1} and vU_{t-1} are likely to be different depending on the state of the business cycle. In a growing economy, vU_{t-1} will likely to be low and qE_{t-1} will mainly constitute retirements. In a downturn, vU_{t-1} will increase as discouraged workers stop actively searching for the diminishing job opportunities and qE_{t-1} will include previously employed workers who lose their jobs and join the discouraged workers out of the labour force.⁷

The maximum capacity of employment to absorb the new inflow X is given by $R = \Delta E_t + qE_{t-1}$, given that retirements free up existing jobs by qE_{t-1} . It is then clear that Equation (2a) no longer holds when $R \geq 0$, but instead requires $R = \Delta E_t + qE_{t-1} \geq X$. From Equation (4), we know that $X = \Delta LF_t + qE_{t-1} + vU_{t-1}$. Therefore the demarcation condition (between growth and contraction), $R \geq X$ can be written as $\Delta E_t \geq \Delta LF_t + vU_{t-1}$, which says that the change in employment has to equal the change in labour force plus the number of unemployed who dropped out of the workforce.⁸

Equation (2a) is therefore replaced by:

$$(5a) \quad U = U_{t-1} + sE_{t-1} - (r + v)U_{t-1} = sE_{t-1} + (1 - r - v)U_{t-1} \quad \Delta E_t \geq \Delta LF_t + vU_{t-1}$$

Since the component of the labour force change that cannot be absorbed by employment will be added to unemployment, Equation (2b) is similarly replaced by:

$$(5b) \quad U = sE_{t-1} + (\Delta LF + vU_{t-1} - \Delta E_t) + (1 - r - v)U_{t-1} \quad \Delta E_t < \Delta LF_t + vU_{t-1}$$

Short-run unemployment is then given by:

$$(6a) \quad U_s = sE_{t-1} \quad \Delta E_t \geq \Delta LF_t + vU_{t-1}$$

$$(6b) \quad U_s = sE_t + (\Delta LF + vU_{t-1} - \Delta E_t) \quad \Delta E_t < \Delta LF_t + vU_{t-1}$$

We can alternatively express short-term unemployment in terms of shocks to employment and the labour force, R and X , respectively:

$$(7a) \quad U_s = sE_{t-1} \quad R \geq X$$

$$(7b) \quad U_s = sE_t + (X - R) \quad R < X$$

The analysis changes if quarterly data is used but we define short-term unemployment in annual terms. Clearly, Equations (5a) and (5b) remain relevant. But now the extra short-term unemployment each quarter is given as $\max[sE_{t-1}, sE_{t-1} + (\Delta LF_t + vU_{t-1} - \Delta E_t)]$. Recursive substitution from Equations (5a) and (5b) then gives:⁹

$$(8) \quad \sum_{j=1}^4 \max \left\{ \begin{array}{l} s(1-r-v)^{j-1} E_{t-j}, \\ s(1-r-v)^{j-1} E_{t-j} + (1-r-v)^{j-1} (\Delta LF_{t+1-j} + vU_{t-j} - \Delta E_{t+1-j}) \end{array} \right.$$

which replaces Equation (6). Comparing Equations (8) and (6) shows that *within-year* movements in unemployment are captured by the outflow rate r and the exit rate v .¹⁰ Equation (8) shows that employment shocks have asymmetric impacts on the short term unemployment rate, as in Equation (1). In our model, the impact is stronger because of the impact of employment shocks on the labour force.

We now seek to determine the impact of employment shocks on the “equilibrium rate of unemployment” and, in turn, on inflation. To accomplish this task we need to incorporate these results in the specification of the Phillips curve.¹¹

2.3 A conventional Phillips curve

We begin with a “conventional” approach to the Phillips curve as “the battle between mark-ups”, which results from imperfectly competitive wage- and price-setting behaviour (see Carlin and Soskice, 1990). In terms of wage setting behaviour, we seek to model the impact of unemployment on wages using cU/H , where cU is interpreted as the number of effective job seekers (c being the average job search effectiveness and U being the total number of unemployed) and H is the total number of new hires. Assuming flow equilibrium prevails in the labour market (hence $sE = H$), we derive $cU/H = cu/s$ with $u = U/E$ as the rate of unemployment. The wage equation then becomes:

$$(9) \quad w - p = h + \beta_0 - \beta_1 cu/s - \beta_2 (\dot{p} - \dot{p}^e) + z_w$$

where w and p are log of wage costs and output prices, respectively, h is the log of labour productivity and z_w reflects all other factors affecting wage setting. The latter include the wedge between consumer and output prices and between wage costs and net wages. Inflation surprises $(\dot{p} - \dot{p}^e)$ have a negative impact on the bargained real wage.

We can rewrite the wage equation in terms of the labour share in national income:¹²

$$(10) \quad w - p - h = \beta_0 - \beta_1 cu/s - \beta_2 (\dot{p} - \dot{p}^e) + z_w$$

In the conventional approach, firm wage setting behaviour is modelled by combining the labour demand and price setting behaviour as shown in the Appendix. We then find:

$$(11) \quad w - p - h = \theta_0 - \theta_1 (p_k - p_l) - z_p$$

Here $(p_k - p_l)$ represents the impact of the relative price of capital.¹³ The vector z_p reflects other price setting influences, including the wedge between domestic and foreign prices.

Combining equations (10) and (11) yields the following short-run Phillips curve:

$$(12) \quad \dot{p} = \dot{p}^e + (\beta_1 / \beta_2)(c/s) [u^* - u]$$

with inflation $\dot{p} = p_t - p_{t-1}$ and \dot{p}^e is expected inflation as before, and:

$$(13) \quad u^* = (1/\beta_1) [\beta_0 - \theta_0 + \theta_1(p_k - p_l) + z_w + z_p] (s/c)$$

u^* can be interpreted as the NAIRU or “equilibrium rate of unemployment”. Equation (13) shows that the NAIRU increases with wage- and price-push factors, as is elaborated in Layard *et al.* (1991). It also increases when the price of capital increases relative to that of labour, as is emphasised by Phelps (1994) and Blanchard (1999). Finally it increases when the average rate of search effectiveness c decreases, as is also elaborated in Layard *et al.* (1991). The latter is interesting from the point of view of the analysis of Ball (1999), since in his view search effectiveness is affected by the state of the labour market.

2.4 Modelling search effectiveness

Ball (1999) identifies cU with short-term unemployment and hence from Equation (5) we find:^{14,15}

$$(14) \quad cu/s = \max [1 - g_E, 1 - g_E/s + (r/s)g_{LF}(1+u)]$$

where g_{LF} represents the rate of labour force growth. As a consequence and consistent with Ball (1999), search effectiveness c relative to the rate of separation s is given by:

$$(15) \quad c/s = (1/u) \max [1 - g_E, 1 - g_E/s + (r/s)g_{LF}(1+u)]$$

If we assume a steady-state situation where employment grows at the rate $g_E^* > 0$ and unemployment is at u^* we find that:¹⁶

$$(16) \quad c/s = (1/u^*)(1 - g_E^*)$$

Substitution of this result into Equation (11) yields:

$$(17) \quad g_E^* = 1 - (1/\beta_1) [\beta_0 - \theta_0 + \theta_1(p_k - p_l) + z_w + z_p]$$

While consistent with the conclusion of Ball (1999) that the steady-state unemployment rate u^* is undetermined, we would note instead that employment growth should satisfy (17). The intuition is that only short-term unemployment matters and this is determined

by employment growth. Long-term unemployment can take any value, without having an impact on inflation.

The equilibrium rate of short-term unemployment can be found from $u_s^* = cu^*$, with u^* given by Equation (13):

$$(18) \quad u_s^* = s(1/\beta_1) [\beta_0 - \theta_0 + \theta_1(p_k - p_l) + z_w + z_p]$$

So the factors that normally affect the NAIRU in an extended specification of the Phillips curve, now only affect the equilibrium rate of short-term unemployment.

3. Estimation and results

In this section, we subject the theoretical model and its underlying hypotheses to some empirical analysis. We do not estimate nor test the model simultaneously nor do we compute the labour flow parameters directly.¹⁷ We present separate estimations for the impact of employment shocks on the labour force following Equation (4) and for short-run unemployment following Equation (8). We finally use a short-run Phillips curve to examine the claim that short-term unemployment is a more effective measure of demand pressure than the official unemployment rate following Equation (14).

The data sources and construction of variables are outlined in detail in the Data Appendix. The time series properties of the data are presented in Table 2. These properties were initially examined using Augmented Dickey-Fuller (ADF) tests and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests, which provide some contrast because in the former case the null is that the time series contains a unit root, whereas in the KPSS test, trend-stationarity is the null. A constant and trend term were included and the lag order was determined using the AIC statistic. The inconsistency of the results when the null is reversed is evident. In general, the inflation variables (prices, import prices) used in the Phillips curve estimation are expressed as annualised differences and are likely to be stationary, and the unemployment rate terms (given they are bounded from above and below) are assumed to be stationary by construction. Any finding consistent with the presence of a unit root in the unemployment terms points to the low power of the tests given a finite sample. The employment terms used in this section are also marginally inconclusive.

Table 2 Unit root tests for model variables, Australia, 1978:1 to 2001:4

	Unit Root Null	Trend Stationary Null
	ADF	KPSS
	<i>t-stat</i>	<i>LM</i>
Price level	-1.131	0.323
Annual inflation	-4.213	0.083
Import price level	-2.228	0.297
Annual import price inflation	-8.669	0.073
Short-term unemployment	-3.234	0.110
Change in short-term unemployment	-4.303	0.042
Unemployment	-3.011	0.134
Change in unemployment rate	-3.648	0.041
Employment	-3.329	0.067
Change in Employment	-3.518	0.046
<i>Critical Values</i>		
1% level	-4.058	0.216
5% level	-3.458	0.146
10% level	-3.155	0.119

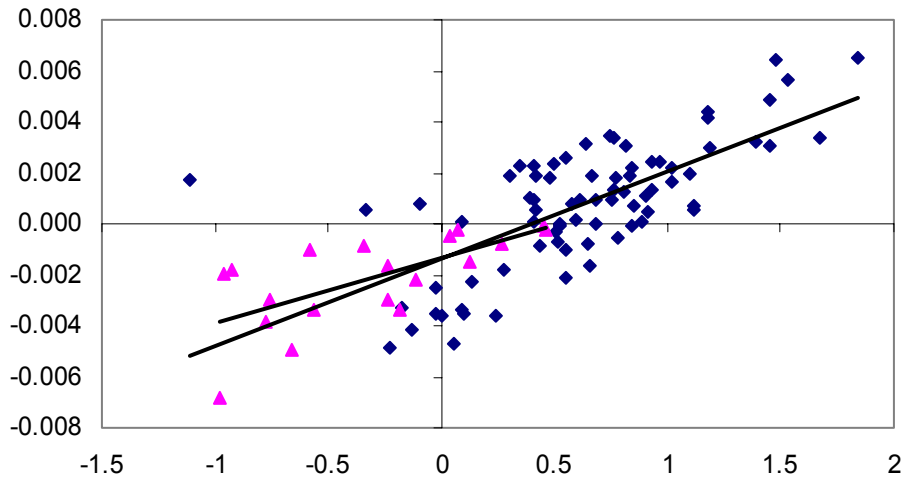
Source: Critical values from Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

3.1 Cyclical sensitivity of the labour force participation rate

It is well documented that the labour force participation rate displays cyclical variability (Mitchell, 2001b). Discouraged workers, for example, are said to exit the labour force when employment opportunities are sparse despite remaining willing to work. They return to the labour force when employment opportunities improve. The alternative added worker phenomenon describes the entry of marginal workers into the labour force to supplement family income when the labour market deteriorates and exit when the incomes of the primary breadwinner improve. Empirical studies suggest that the discouraged worker effect dominates (see evidence in Mitchell, 2001b).

This response is depicted in Figure 3 for Australia using quarterly data over the period 1966 to 2001. The data was divided into the two regimes according to Equations (7a) and (7b). The triangular plot symbols correspond to $R < X$. Simple linear trends are shown for observations corresponding to each regime. Graphically, the responsiveness of changes in the labour force participation rate (LFPR) seems to be largely symmetrical across the two regimes.

Figure 3 Relationship between employment growth and changes in LFPR, 1966-2001



Source: ABS AUSSTATS.

We regress the change in the labour force participation rate on employment growth (both sorted according to regimes noted above) and Chow's breakpoint and predictive failure test statistics computed to correspond with the regime break in the sorted series. Both tests fail to reject the null that the labour force participation response is symmetric.

We thus assume that labour force participation rate changes, $\Delta lfpr$ responds symmetrically to the business cycle with a factor ϕ and also increases autonomously by $\Delta lfpr^*$ percentage points. As a consequence we specify:

$$(19) \quad \Delta lfpr_t = \phi(g_E - g_E^*) + \Delta lfpr^*$$

with g_E as employment growth and g_E^* is trend employment growth. The new entrants and re-entrants to the labour market then are given by:

$$(20) \quad \Delta LF_t = \Delta lfpr_{t-1} P_{t-1} + (lfpr_{t-1} + \Delta lfpr_t) \Delta P$$

where P represents the size of the relevant population. Equations (19) and (20) show that both shocks in employment growth and in population growth condition labour force changes. Equation (8) shows that employment shocks affect short-term unemployment, in part, via their impact on the labour force. Accordingly, the direct negative impact of a decline in employment on short-term unemployment is somewhat attenuated by a decrease in the labour-force.

3.2 Testing the asymmetric approach to unemployment

In order to test the asymmetric impact of employment on short-term unemployment, we rewrite Equation (8) as:

$$(8') \quad U_s = \sum_{j=1}^4 s(1-r-v)^{j-1} E_{t-j} - regime_i(1-r-v)^{j-1}(\Delta E_{t+1-j} - vU_{t-j} - \Delta LF_{t+1-j})$$

where the regime demarcation variable, $regime_i = 1$ when $\Delta E < \Delta LF + vU_{t-1}$ and 0 otherwise. To find a reasonable value of v , we calculated $v^* = (\Delta E - \Delta LF) / U_{t-1}$ for each period. The series for v^* shows three distinctive jumps around the values zero, 0.007 and 0.013 implying that we would enter the contractionary regime (where $regime_i = 1$) in 52, 46 and 37 per cent of the cases, respectively. Using one of these values to identify the relevant regime allows for v to vary at least somewhat without affecting the demarcation. Moreover, the implied rates of quarterly outflow from unemployment to outside the labour force in the range from 0.7 to 1.3 percent seem plausible.

The model estimated is:

$$(21) \quad U_s = \mu + \beta_1 U_{st-1} + \sum_{i=1}^5 \alpha_j N_{t-i} + \sum_{j=1}^5 \gamma_j u_dum_j + \varepsilon_t$$

where $u_dum_t = regime_{t-j}(\Delta E_{t+1-j} - vU_{t-j} - \Delta LF_{t+1-j})$ and ε_t is the error term, assumed to be white noise. A test of the statistical significance of the interactive variables (switching on the contractionary regime) provides a proximate test of the presence of asymmetries in the dynamics of the short-term unemployment rate. Further, if Equation (8') is considered in first differences, we would expect the impact of quarters 1, 4 and 5 to show up prominently.¹⁸ The estimation results for Equation (8') for the period 1979:2 to

2001:4 are shown in Table 3 for $\nu^* = 0.013$. This value yielded the best estimation results as judged by the standard error of estimate of the regression.

Table 3 Estimating asymmetric effects of employment change on short-term unemployment, Australia, 1979:2 to 2001:3.

Dependent Variable: STU	Coefficient Estimate (<i>t</i> -statistic)
Constant	-0.72 (0.08)
STU(t-1)	0.97 (51.01)
N(t-1)	0.01 (0.38)
N(t-2)	-0.03 (0.84)
N(t-3)	-0.02 (0.57)
N(t-4)	0.09 (2.17)
N(t-5)	-0.04 (1.39)
u_dum(t-1)	-0.96 (17.8)
u_dum(t-2)	0.12 (1.89)
u_dum(t-3)	0.05 (0.87)
u_dum(t-4)	0.15 (2.31)
u_dum(t-5)	0.09 (1.36)
R-squared	0.99
S.E. as % of mean of dependent variable	1.91

The hypothesis that $\beta_l = 1$ cannot be rejected and so the model can be simplified in first-difference form. Moreover, the dummy variables are jointly significant with a formal test strongly rejecting the hypothesis that the impact of all *u_dum* is zero. This provides support for the view that asymmetries are important in explaining the changes in short-

term unemployment. Finally, the high value of the one-quarter lagged dummy variable implies that in the first quarter, almost all excess supply is added to short-term unemployment when $\Delta E < \Delta LF + \nu U_{t-1}$. This is fully consistent with the reasoning developed above.¹⁹

While not conclusive, the results of this section suggest that the short-term unemployment dynamics for Australia are consistent with our formal model.

3.3 Phillips curve analysis

In this section, we utilise the measure of short-term unemployment available from the ABS Labour Force Survey, assuming that the asymmetries behave as suggested in Equations (6a) and (6b) are already incorporated in the *extant* data. We thus estimate the Phillips curve of equation (12) independent of the other equations.

Four major contentions are examined:

1. Does the short-term unemployment rate provide a stronger constraint on the annual inflation rate relative to the overall unemployment rate? We expect the coefficient on the short-term unemployment rate in a Phillips curve model to be larger in absolute value and negatively signed when compared with coefficients corresponding to other unemployment measures.
2. Does the long-term unemployment rate exert any statistically significant impact on the annual inflation rate? We expect the coefficient on the long-term unemployment rate in a Phillips curve model to be statistically insignificant.
3. Does the TV-NAIRU model of the evolution of excess demand provide an inferior explanation of the inflation process compared to the models developed under hypothesis (1)? We expect an inflation models using the gap between the short-term unemployment and its filtered trend to be superior to that which uses the gap between the official unemployment rate and its filtered trend as the excess demand measure. The latter variable is typically used in TV-NAIRU studies (see Mitchell, 2001a).
4. Does the estimated Phillips curve exhibit NAIRU dynamics? Fair (2000) and Mitchell (2001a) present tests based on the coefficients on the lagged dependent inflation

variable to determine whether the inflation dynamics are consistent with a constant NAIRU model. The test is a simple homogeneity test on the lagged inflation terms.

We use a general autoregressive-distributed lag Phillips curve representation like:

$$(22) \quad \dot{p}_t = \alpha + \sum_{i=1}^n \delta_i \dot{p}_{t-i} + \sum_{i=0}^m \beta_i u_{t-i} + \sum_{i=0}^q \gamma_i z_{t-i} + \varepsilon_t$$

where \dot{p}_t is the rate of inflation at time t , u is the unemployment rate, z is a cost shock variables (like import price inflation, capital costs), and the ε is a white-noise error term.

In addition, the u variable can take the form of the aggregate unemployment rate or the short-term unemployment rate to facilitate the testing of the hypotheses (1) to (3) outlined above. In the case of hypothesis (3) we compute UR^* and $STUR^*$ using a Hodrick-Prescott (HP) filter on the official unemployment rate, UR and the short-term unemployment rate, $STUR$, respectively. The variables $(UR - UR^*)$ and $(STUR - STUR^*)$ are the original series less the HP filtered trend series in each case.

Further, if the δ coefficients sum to unity, the model gives a constant NAIRU of $-\alpha / \sum_{i=0}^m \beta_i$. At this unemployment rate, the inflation rate will only exhibit short-run changes due to changes in changes in z and/or random shocks (changes in ε). So we can test hypothesis (4) by testing for homogeneity.

We initially develop a Phillips curve model for Australia using Equation (22) using 4 lags on the annualised inflation terms ($D4LP$) and import prices ($D4LPM$), the level of the unemployment rate, a dummy variable, $DGST$ (defined as 1 in 2000:3 and zero otherwise) to take into account the introduction of the Goods and Services Tax system in Australia in July 2000, and other variables capturing the cost of capital, interest spread, and payroll taxes and the like. The other variables were not retained in the final tested-down specification. Sequential testing down from the general equation using different measures of the unemployment variable yielded the results shown in Table 4. In each case, the dynamics were so close and the coefficient estimates for the other variables were highly stable that a common specification is employed, which aids comparison considerably. The diagnostics of all equations were satisfactory.

Equation (1) in Table 4 describes a typical Phillips curve using the aggregate unemployment rate (UR). The unemployment rate exerts a negative influence on the rate of inflation (-0.18). A comparison with Equation (2) which splits the unemployment rate into short-term and long-term components shows that the $LTUR$ is not statistically significant (even at the 10 per cent level). Further, the degree of negative pressure on inflation exerted by the highly significant $STUR$ rises to -0.53, substantially above that estimated for UR . Equations (3) and (4) are inferior specifications and warrant no specific comment.

Mitchell (2002) argues that the NAIRU concept remains on shaky theoretical grounds. Importantly, the original theory underpinning the NAIRU provides no guidance about its evolution although, we would be looking to the evolution of unspecified structural factors to remain faithful to that theory. In this theoretical void, econometricians have used techniques that allow for a smooth evolution although there is no particular correspondence with any actual economic factors. Some authors assert that a Hodrick-Prescott filter through the actual series captures the TV-NAIRU (for example Boone, 2000 among many). Of-course, the Hodrick-Prescott filter merely tracks the underlying trend of the unemployment and follows it down just as surely as it follows it up. The unemployment rate is highly cyclical and the TV-NAIRU proponents are silent on this apparent anomaly – why do the alleged structural factors cycle with the actual rate?

Equations (5) and (6) use the alternative form of the unemployment variables in terms of the actual value (of UR and $STUR$) being expressed as gaps on their respective filtered trend values. These regressions constitute an improvement on (1) to (4). Equation (5) is thus in the TV-NAIRU vein and performs reasonably in statistical terms. The coefficient on the demand pressure gap ($UR - UR^*$) is -0.409, substantially higher than that estimated for Equation (1). However, Equation (5) is inferior to Equation (6) that replaces ($UR - UR^*$) with the short-term unemployment rate gap ($STUR - STUR^*$). This has a lower standard error of estimate and the deviation of $STUR$ from its current (shifting) HP-filtered value, $STUR^*$ is -0.648. In other words, a 1 per cent deviation above the filtered value leads to a 0.64 per cent slowdown in the annualised inflation rate.

It is interesting to consider the different values of the coefficients on the STUR and UR variables. They suggest the following dynamics are taking place. An initial downturn initially increases (according to our model) short-term unemployment, which reduces inflation because the inflow into short-term unemployment is comprised of those currently employed and active wage bargaining processes. As the downturn continues, long-term unemployment starts to rise because some of the unemployed were in their 4th quarter of short-term unemployment. This progressively becomes the case in a protracted downturn and the pressure exerted on the wage setting system by unemployment overall falls. This requires higher levels of short-term unemployment being created to reach low inflation targets with the consequence of increasing proportions of long-term unemployment being created.

The results taken together provide strong support for the hypotheses (1) to (3) outlined above and for the theoretical model developed in Section 2.

An additional finding is that a long-term trade-off between unemployment and inflation is implied in all regressions. The NAIRU dynamics test statistic shown in Table 4 allows us to easily reject the null that the sum of the coefficients on the lagged inflation terms is unity in all regressions. In that sense, we would reject the constant NAIRU hypothesis.²⁰ So even though the short-term unemployment rate is relatively more effective in controlling inflation, there is no convergence to a constant equilibrium rate of short-term unemployment after an employment shock. The transitory equilibrium short-term unemployment rate is contingent on the evolution of employment growth and demand in general. In the next paper we will demonstrate that our estimation results confirm that even a temporary change in demand causes an adverse permanent change in inflation and this change is asymmetric with respect to a symmetric shock in demand. Combined with the other findings relating to hypotheses (1) to (3) and the underlying model in Section 2, we interpret these results as being consistent with a hysteretic vision of the inflationary dynamics in Australia. The results indicate that a deflationary strategy using demand repression (tight monetary and fiscal policy) will be costly in terms of unemployment.

These results are also consistent with the findings of other studies (Franz, 1987; Mitchell, 1987, 1993) and support the conceptual underpinning of the main hypothesis in Ball

(1999). One may therefore conclude “that increases in the NAIRU in most countries have come disproportionately from increases in long-term unemployment” Ball (1999: 40).

Table 4 Phillips curve regressions, Australia, 1978:1 to 2001:4

	(1)	(2)	(3)	(4)	(5)	(6)
	UR	STUR-LTUR	STUR	LTUR	URGAP	STURGAP
Constant	0.02 (2.96)	0.02 (3.77)	0.02 (3.53)	0.01 (1.91)	0.00 (1.62)	0.00 (1.21)
$\Delta 4LP(-1)$	0.88 (29.4)	0.93 (25.6)	0.90 (32.9)	0.88 (25.4)	0.89 (32.9)	0.91 (35.1)
UR	-0.18 (2.84)					
UR-UR*					-0.409 (4.10)	
STUR		-0.53 (3.22)	-0.35 (3.42)			
STUR-STUR*						-0.648 (4.53)
LTUR		0.30 (1.36)		-0.25 (1.72)		
$\Delta 4LPM$	0.05 (4.13)	0.05 (4.31)	0.05 (4.26)	0.05 (3.94)	0.06 (4.98)	0.06 (4.83)
DGST	0.02 (2.46)	0.02 (2.49)	0.02 (2.43)	0.02 (2.60)	0.02 (2.63)	0.02 (2.72)
R-Squared	0.94	0.95	0.94	0.94	0.95	0.95
S.E. of regression	0.00814	0.00796	0.00821	0.00836	0.007806	0.00767
se % mean	15.0	14.7	15.1	15.4	14.4	14.1
SC LM(1)	2.24	0.35	0.47	3.51	0.50	0.06
ARCH 4)	0.49	0.99	0.70	0.38	0.51	0.88
RESET(2) F	0.10	0.09	0.04	0.12	0.35	0.19
NAIRU dynamics test						
F-statistic	14.9	3.3	15.3	11.0	16.3	13.1
d.f.	(1,90)	(1, 90)	(1, 92)	(1, 91)	(1,91)	(1,91)
Prob-value	0.0000	0.0711	0.0002	0.0013	0.0001	0.0005

Notes: SC LM(1) is a Breusch-Godfrey Serial Correlation 1st order LM Test, ARCH(4) is a 4th order test for Autoregressive conditional heteroscedasticity, RESET(2) is the Ramsey RESET test with 2 added terms, *t*-statistics are in parentheses. UR* and STUR* were computed using a Hodrick-Prescott filter on the UR and STUR, respectively. The variables UR-UR* and STUR-STUR* are the original series less the HP filtered trend series in each case.4.

4. Conclusion

In this paper we have presented a sophisticated version of the Ball (1999) model, which uses the dynamics of short-term unemployment to show that a temporary change in aggregate demand can cause an adverse permanent change in the relationship between long-term unemployment and inflation and this change is asymmetric with respect to a symmetric shock in demand. We incorporate more complex labour market dynamics, including the impact of changes in the labour force, in the model and introduce a full specification of the Phillips curve. The distinction between short- and long-term unemployment allows the differential impact of each on inflation to be assessed. The essential results remain that the equilibrium unemployment rate is dependent on the state of the business cycle and the long-term unemployed do not exert a significant negative influence on the inflation rate.

The convergence to a short-term unemployment does not mean that there is a unique NAIRU if the long-term unemployed do not affect inflation. From a policy perspective, the dynamics implied by Ball (1999) allow aggregate demand stimulation by government during a recession to prevent a permanent rise in unemployment without a major cost in inflation. Ball (1999) also argues that hysteresis is reversible and the long-term unemployed can be reabsorbed in a non-inflationary manner back into employment if aggregate spending is strong enough. This model poses major problems for the supply-side orthodoxy, which posits that the long-term unemployed represent a structural bottleneck and only supply initiatives like training and welfare reform can be effective.

The empirical modelling provides strong support for the theoretical model and suggests further research is needed to more precisely estimate the labour market flows that underpin it. While employment shocks have a symmetric impact on the labour-force participation rate, they have an asymmetric impact on short-term unemployment. Moreover, the inflationary process is more sensitive to movements in the short-run unemployment rate rather than the aggregate unemployment rate. The results are also consistent with other evidence presented that long-term unemployment can be reduced by creating more employment overall without fears of an accelerating inflation rate.

Data Appendix

Inflation measure

The annual inflation rate is expressed as the four-quarter log change in the Consumer Price Index taken from the ABS TRYM database.

Import price index

The import price index is expressed as the four-quarter log change in the TRYM Model Import Price Index (1990/91 = 1) taken from the ABS TRYM database.

Labour Market Variables

All the labour force data are taken from the ABS Time Series Service available via AUSSTATS. The short-term unemployment rate is computed as official unemployment minus long-term unemployment expressed as a percentage of the labour force. Long-term unemployment is defined as a spell of unemployment longer than 52 weeks.

Appendix on the derivation of the Phillips curve

The labour demand function assumes that output has a positive impact on labour demand, while the cost of labour relative to capital has a negative impact. Thus:

$$(A1) \quad l = \alpha_0 + l / \xi y - \alpha_1 p_l - g - h_t \quad \alpha_1 = \alpha_2 = \alpha$$

where y and l are log output and demand for labour, respectively, with $\xi \geq 1$ as the returns to scale parameter. The efficiency-corrected price for labour is p_l , and the price of capital is p_k . We assume that annual wage costs w are corrected for the impact of working time g and the growth of labour productivity h_t . Hence, in log terms:

$$(A2) \quad p_l = w - g - h_t$$

The price of capital relates investment price p_i to the nominal interest rate r plus depreciation δ . For simplicity, we ignore the impact of taxes. Hence, in log terms:

$$(A3) \quad p_k = p_i + (r + \delta)$$

We assume that the output price, p is set as a markup over average costs and that total costs C allow for economies of scale. Hence:

$$(A4) \quad C = cy^{1/\xi} \quad \text{with} \quad c = k_1 p_l \left[1 + (k_2 / a)(p_k / p_l)^\alpha \right]$$

where c represents normal unit costs.²¹ We approximate these unit costs by a mark-up over efficiency labour costs, where the mark up depends negatively on the price of labour relative to capital.²²

The price setting equation (a mark-up over average costs) yields the domestic price:

$$(A5) \quad p_y = \mu + c_c + (1 - \xi) / \xi y$$

where μ is the log mark-up and c_c is the log unit cost measure. We approximate:²³

$$(A6) \quad c_c = \gamma_0 + \gamma_1 p_l + \gamma_2 p_k \quad l - \gamma_1 = \gamma_2 = \gamma$$

Finally output price is a weighted average of domestic price, p_y , and the price of foreign competitors, p_f , in log terms:

$$(A7) \quad p = \varphi p_y + (1 - \varphi) p_f$$

Combining the labour demand and price equations, (A1) and (A5), respectively, and using (A6) and (A7), we find:

$$(A8) \quad w - p - h = (\alpha_0 - \mu - \gamma_0) - (\gamma_1 - \alpha_1)(p_k - p_l) + (1 - \varphi)(p_y - p_f)$$

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Notes

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² Layard (1998) underpins his argument with a major assertion that new jobs follow an increase in the effective labour supply. In what represents a modern restatement of Say's Law and the efficacy of the real balance effect, he says (1998: 26) "the mechanism is simple enough. If the labour supply increases and the number of jobs does not, inflation starts to fall; this makes possible an increase in aggregate demand in the economy, which in turn increases employment in line with the increase in the labour supply." It is a pity that OECD economies in general have not witnessed these dynamics over the last 25 years.

³ Ball and Mankiw (2002), for example, argue that the model of Ball (1999) does not apply to the US economy.

⁴ Since U_t is the stock at the end of period t , the outflow rU_{t-1} refers to *long-term* unemployed who were already unemployed a year ago. On the other hand, the inflow sE_{t-1} accumulates during the current period and by definition constitutes *short-term* unemployment.

⁵ We ignore here the subtle point that separations can be related to E_t instead of E_{t-1} , in case of redundancies. The correct specification lies somewhere in between both. When quarterly data is employed this difference is not important.

⁶ When short-term unemployment is defined as unemployed for a quarter or less, the analysis with quarterly data can be applied without any modification to equations (3) and (4).

⁷ This also suggests that v will increase in a down turn, hence behaves counter cyclical, whereas q will behave pro cyclical.

⁸ Given $\Delta E = \Delta LF - \Delta U$ this condition amounts to $\Delta U_t \leq vU_{t-1}$.

⁹ Due to the interaction between various labour markets, the regime change in the labour market will likely be less strict than indicated by the demarcation $\Delta LF + qLF_{t-1} = \Delta E$. We ignore this complexity in this paper.

¹⁰ As is the case with v and q , the rates s and r may vary counter- and pro-cyclically, respectively. This can be accounted for by modelling these rates in terms of detrended employment growth.

¹¹ We use the term "equilibrium unemployment rate" to denote the unemployment rate that is associated with stable inflation. We do not impute any particular temporal significance to this rate and assume that hysteresis is the dominant process operating to determine this relationship (Mitchell, 1987).

¹² While this is an accounting construction, the imposition of behavioural assumptions on the model assumes that workers are able to translate labour productivity growth into proportionate changes in real wages growth. Evidence shows that this may not be the case (see Mitchell, Muysken and Watts, 2002).

¹³ See for example, Blanchard (1999); Blanchard and Wolfers (2000), and Phelps (1994).

¹⁴ One should remember that cu/s originally was cU/sE , which now becomes U_s/sE . We assume here that when g_E is negative, $1 - g_E$ is always dominated by $1 - g_E/s + (r/s).g_{LF}.(1 + u)$.

¹⁵ For expositional simplicity we use the yearly representation of labour market flows. Hence we ignore the impact of quarterly dynamics.

¹⁶ The unemployment rate u^* is the only rate consistent with the steady-state and, hence, constant inflation.

¹⁷ In a later paper we will use Gross Flows data (currently unavailable) to compute the unknown flow parameters more precisely and to accurately compute Equation (8) and then estimate the model as a system.

¹⁸ The variables in between do not necessarily disappear, since the rates s , r and v may show cyclical variations.

¹⁹ This also holds for the finding that the coefficients for $N(t-1)$ to $N(t-5)$ add up to unity.

²⁰ Mitchell (2001a) tested for NAIRU dynamics in similarly derived Phillips curve models for Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. There was no evidence of a constant NAIRU operating in these countries. In each case, there is evidence of a non-vertical long-run Phillips curve although for Canada, France, and Italy, the findings are weak. Further, in the case of the United Kingdom and the United States, the change of unemployment is statistically significant indicating that hysteretic forces are present.

²¹ The variables here are in levels, not logs.

²² This can be interpreted as an approximation of a CES-cost function: $c = [\theta p_l^{1-\sigma} + (1-\theta)p_k^{1-\sigma}]^{1/(1-\sigma)}$.

²³ This can be interpreted as a Cobb-Douglas cost function, when $\gamma_1 + \gamma_2 = 1$.