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HOW LABOUR MARKET FLEXIBILITY AFFECTS UNEMPLOYMENT: LONG-TERM IMPLICATIONS OF THE CHAIN REACTION THEORY*

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Much of the macroeconomic literature views unemployment as the sum of two separate, independent components, often called 'cyclical' and 'structural' unemployment. This decomposition is a salient feature of the natural rate theory. The high-frequency movements in unemployment are identified as cyclical and are attributed primarily to errors in people's wage-price expectations or to intertemporal substitution, while the low-frequency movements are identified as changes in the natural (or structural) rate of unemployment (NRU).[1]

Although this view still enjoys broad support, it is widely recognised that the two 'components' of unemployment are often so interdependent as to make their interactions more significant than the distinction between them. The oft-quoted observation that cyclical unemployment in Europe 'turns into' structural unemployment is a reflection of this idea.

There is much contention about how to interpret European unemployment movements since the 1980s in terms of the natural rate theory. Given the low and stable inflation rates over that period, the influence of errors in wage-price expectations and intertemporal substitution are unlikely to have been important. In that event, the natural rate theory implies that the NRU itself must have risen over this period. But in many European countries, the period since the early 1980s has been characterised by deregulation, privatisation, decline in union density, and partial dismantling of job protection. Under these circumstances one would have expected the NRU to have fallen, if anything. On the other hand, rising interest rates, tax rates, and unemployment benefits,[2] may all have played a role in driving the European NRU upwards, but the timing of these factors does not always mesh well with the timing of the unemployment increases.[3]

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[1] The NRU is commonly linked to the NAIRU (the non-accelerating inflation rate of unemployment), and thus it is common to infer whether unemployment is above or below its natural rate by observing whether inflation is rising or falling.

[2] See, for example, Phelps (1994) and Layard, *et al.* (1991) for explanations along these lines.

[3] For instance, the major rises in European unemployment benefits occurred predominantly in the 1960s and early 1970s, and thus extremely long and powerful lagged responses are necessary to explain the rising unemployment since the 1980s on this basis. See, for example, Grubb (1994) and Lindbeck (1994).

This paper examines a different approach. It denies that cyclical and structural unemployment are largely independent of one another and it focuses on the links between the two. Specifically, it views movements in unemployment as the outcome of the interplay between labour market shocks and a network of lagged adjustment processes. In this context, each shock has a 'chain reaction' of unemployment effects, leading from one lag to another and extending from the present into the distant future. This is the basic idea underlying the 'chain reaction theory' of unemployment.[4]

By explaining the rise of European unemployment in terms of a rise in the NRU (and the approximate constancy of US unemployment in terms of a constant NRU), the natural rate theory gives little attention to lagged adjustment processes. In fact, the NRU is commonly taken to be the rate at which the unemployment rate is constant (given the values of the exogenous variables), when all the labour market adjustment processes have worked themselves out.[5]

The chain reaction and natural rate theories of unemployment have quite distinct policy foci. The natural rate theory focuses attention on policies that affect the long-term structure of the labour market, i.e. the labour demands and supplies once the adjustment processes have been completed. From this vantage point, various authors have suggested that European unemployment could be reduced through reductions in taxes on employers and employees, in real interest rates, and in the duration and generosity of unemployment benefits.[6] The chain reaction theory, by contrast, also focuses attention on policies that affect the lagged adjustment processes and thereby make the labour market more resilient in the aftermath of shocks. For example, reductions in legislated firing costs could reduce the degree to which firm's current employment decisions depend on past employment, or reductions in the degree of wage indexation could reduce the degree to which wages depend on their past levels. These policies may of course affect the NRU as well, but that influence is conceptually and empirically distinct from their effect on the lagged adjustment processes.

A large empirical literature on labour market activity has consistently confirmed the significance of lagged endogenous variables in employment, wage setting, and labour force participation equations, with lags commonly extending over periods of one or more years.[7] A large theoretical literature provides various rationales for such lags.[8] But these contributions have tended to examine these lags in isolation from one another, rather than the interac-

[4] For detailed descriptions of the theory, see for example Karanassou and Snower (1993, 1997) and Henry and Snower (1996).

[5] Phelps (1994) however takes a broader view in his theoretical models, defining the NRU in a way that permits it to move in response to some adjustment processes.

[6] See, for instance, Nickell (1997) and Phelps (1994).

[7] See, for example, Alogoskoufis and Manning (1988), Bean *et al.* (1986), and Layard *et al.* (1991).

[8] The literature, cited below, rationalises these lags primarily on the basis of labour turnover costs, staggered wage setting, relatively low search effort by the long-term unemployed, the exercise of market power by incumbent employees, and costs of entry and exit from the labour force.

tions between them. This is also true of the literature on hysteresis[9] and unemployment persistence,[10] which is highly aggregative, focusing predominantly on single-equation unemployment autoregressions. Although the hysteresis hypothesis has found some empirical support from unemployment time series extending over two to three decades, it fails to explain why unemployment rates everywhere show a marked tendency to return to values lying within a narrow range,[11] generally 2%–15%.

It is very tempting to think that, in the absence of hysteresis, lagged adjustment processes cannot be responsible for the long-term rise in European unemployment. However this view is mistaken for two main reasons. First, in the standard theoretical and empirical labour market systems (typically comprising employment, wage setting, and labour force participation equations), the lags are often *complementary* to one another in prolonging the unemployment effects of a shock, in the sense that the joint influence of all the existing lags is greater than the sum of their individual influences.[12] If the complementarities are large, it can take unemployment a long time to approach its long-run rate in the aftermath of a shock, and then there is no sharp observational distinction between a change in the natural unemployment rate and a prolonged chain reaction to a labour market shock. But the policy implications of the two approaches are, as noted, radically different.

Second, in labour market systems containing growing exogenous variables, we shall see that even the *long-run* equilibrium unemployment rate depends on the lagged adjustment processes. For example, in the presence of technological progress, capital accumulation, and population growth, the labour demand and labour supply curves are continually drifting upwards, and thus some lagged adjustment processes - such as the effect of past employment on current employment, or of the past labour force on the current labour force - never have a chance to work themselves out entirely. Instead, employment and the labour force are chasing after moving targets, continually adjusting to the growing exogenous variables. Under these conditions, the long-run equilibrium unemployment rate (in period t) depends not only on the values of the

[9] We define unemployment hysteresis in the most common way, namely, as unemployment having a unit root. See, for example, Blanchard and Summers (1986).

[10] In the case of an AR(p) model of unemployment:

$$u_t = a_0 + \sum_{j=1}^{p} a_j u_{t-j} + \varepsilon_t, \ \varepsilon_t \sim \text{ i.i.d } (0, \sigma^2),$$

persistence arises when the roots of $1 - a_1 B - a_2 B^2 - \cdots - a_p B^p = 0$ (B is the backshift operator) lie outside the unit circle. Moreover, we require the sum of the autoregressive coefficients to be non-zero. See, for example, Karanassou and Snower (1997).

[11] When unemployment has a unit root, random labour market shocks drive the unemployment rate to zero or 100% with the passage of time.

[12] For instance, in the presence of hiring and firing costs, a temporary fall in current labour demand will reduce employment in the future. This, in turn, may raise the number of long-term unemployed people. If these people devote little effort to job search (in comparison with the short-term unemployed), employment will remain depressed in the more distant future. But in that event, the hiring and firing costs will then keep employment low in the even more distance future, and so on. In this way, the chain reaction of unemployment effects may take a long time to work itself out.

exogenous variables (in period t), but also the lagged adjustment processes, which determine how close employment and the labour force come to their moving targets.

This phenomenon cannot be captured by the standard linear, single-equation, natural rate models of unemployment, such as $u_t = \alpha u_{t-1} + \boldsymbol{\beta} x_t$, where α is a constant and $\boldsymbol{\beta}\mathbf{x}_t$ is a linear combination of exogenous variables. In order for the unemployment rate u_t to approach a stationary value (u^*) in the long run,[13] the equation must be dynamically stable ($|\alpha| < 1$) and $\boldsymbol{\beta}\mathbf{x}_t$ in the equation must approach a stationary value. Then the lagged adjustment process in the equation *does* work itself out in the long run. In this context, changes in the NRU through time are independent of the lagged adjustment processes, but are driven exclusively by changes in the exogenous variables. It is only in a multi-equation labour market system that we can observe employment, real wages, and the labour force all drifting upwards while unemployment remains stationary, and thus it is only in this context that the influence of lags on the long-run equilibrium unemployment rate becomes visible.

In this way, the chain reaction theory can shed light on how labour market flexibility affects long-term unemployment, where flexibility is understood in terms of the speed of the lagged adjustment processes. The rest of this paper is organised as follows. Section 1 provides some conceptual underpinnings of the chain reaction theory. Section 2 analyses how lagged adjustment processes affect the unemployment rate in the medium and long run. Section 3 describes our empirical methodology and summarises our empirical results, and Section 4 concludes.

1. Conceptual Underpinnings

To bring the central concepts of the chain reaction theory into sharp focus, consider a simple, illustrative model of the labour market. Following the conventional set-up, the model contains an aggregate labour demand equation, a wage setting equation (describing wage determination through efficiency wage, insider-outsider, union, or other mechanisms), and an aggregate labour supply equation. The equilibrium levels of employment and the real wage are given by the intersection of the labour demand and wage setting curves, and the equilibrium level of unemployment (u_t) is the difference between labour supply and labour demand at the equilibrium real wage. In the labour demand equation, let aggregate employment (E_t) depend on the real wage (w_t), previous employment (E_{t-1}) (on account of firm's costs of adjusting employment) and the capital stock (K_t). In the wage setting equation, let the real wage depend on past employment (on account of an 'insider membership effect', whereby the size of firms' insider workforces affects the insiders'

[13] It is reasonable to assume that the unemployment rate approaches a stationary value, since non-stationarity would imply that the unemployment rate hits zero or 100% within a finite span of time.

objectives in the wage setting process).[14] And in the labour supply equation, let the aggregate labour force (L_t) be exogenously given:

$$E_t = \theta(1 - a_E - a_w b_I) + a_E E_{t-1} - a_w w_t + \delta(1 - a_E - a_w b_I)K_t + \varepsilon_{1t}, \quad (1)$$

$$w_t = \phi(1 - a_E - a_w b_I) - b_I E_{t-1} + \varepsilon_{2t}, \quad (2)$$

$$L_t = \overline{L} + \varepsilon_{3t}, \quad (3)$$

$$u_t = L_t - E_t, \quad (4)$$

where $0 < a_E < 1$, θ, ϕ, δ, a_w, b_I, and $\overline{L}$ are positive constants. The two lagged adjustment effects above may be called the 'employment adjustment effect' (whose magnitude is given by a_E) and the 'insider membership effect' (whose magnitude is given by b_I). In this model specification, observe that changes in a_E and b_I affect the degree to which employment and wage formation depends on lagged employment, but do not affect the long-run unemployment rate. The capital stock is assumed to be an I(1) variable: $K_t = K_{t-1} + v_t$. The error terms ε_{1t}, ε_{2t}, ε_{3t} and v_t are strict white noise processes independent of one another. All variables, except the unemployment rate, are in logarithms.[15]

Substituting (1)–(3) into (4), we obtain the following first-order unemployment rate equation:

$$u_t = \left(\overline{L} - \theta + a_w\phi - \delta K_t\right)(1 - a_E - a_w b_I) + (a_E + a_w b_I)u_{t-1} + \left[-\varepsilon_{1t} + a_w\varepsilon_{2t} + \varepsilon_{3t} - (a_E + a_w b_I)\varepsilon_{3,t-1}\right]. \quad (5)$$

For stability, we assume that $a_E + a_w b_I < 1$. The corresponding long-run expected unemployment rate is $u_t^* = \overline{L} - \theta + a_w\phi - \delta K_t$.

In this context, it is easy to derive the chain reaction of unemployment changes in response to a *temporary* labour market shock. Let the shock take the form of a unit drop in labour demand in period t: $d\varepsilon_{1t} = -1$, so that the initial effect on unemployment is $du_t = 1$. Thereafter the shock disappears $\left(d\varepsilon_{1,t+j} = 0,\ j \geqslant 1\right)$, but the initial employment drop has two effects in period $t+1$: (i) it reduces employment E_{t+1} below what it would have been in the absence of the shock (due to the employment adjustment costs) and (ii) it raises the wage w_{t+1} above what it would have been (since it reduces the insider workforce, thereby raising the marginal product of labour and, with it, the insiders' wage claims). The first effect reduces employment E_{t+1} by $-a_E$; the second reduces it further by $-a_w b_I$. Thus the total effect of the temporary shock on unemployment in period $t+1$ is $du_{t+1} = a_E + a_w b_I$. In the same vein, employment in period $t+1$ affects employment in period $t+2$, so that the unemployment effect in that period is $du_{t+2} = (a_E + a_w b_I)^2$. Along these lines it can be shown that the entire chain reaction of unemployment effects from the temporary shock, from period t onwards, is

[14] See, for example, Blanchard and Summers (1986) and Lindbeck and Snower (1987).

[15] Since L_t and E_t are in logarithms, (4) is an approximation.

$$du_{t+j} = (a_E + a_w b_I)^j, j \geqslant 0. \tag{6a}$$

Observe that the higher the employment adjustment (a_E) or insider membership (b_I) effect, the higher will be the impact of the shock on unemployment: $\partial du_{t+j}/\partial a_E = j(a_E + a_w b_I)^{j-1}$, $\partial du_{t+j}/\partial b_I = j a_w (a_E + a_w b_I)^{j-1}$, $j \geqslant 1$. In addition, for $j \geqslant 2$, the two lagged effects are complementary, in the sense that the combination of the two effects has a greater influence on unemployment than the sum of the two effects operating individually: $\partial^2 du_{t+j}/\partial a_E \partial b_I = j(j-1)a_w(a_E + a_w b_I)^{j-2} > 0$, for $j \geqslant 2$. It is on account of this complementarity that the unemployment repercussions of a temporary shock could be prolonged well beyond the time spanned by the individual lags.

Next, consider the chain reaction of unemployment changes in response to a *permanent* labour demand shock. Recalling that the capital stock follows a random walk ($K_t = K_{t-1} + v_t$), let the permanent shock be represented by a one-off unit drop in v_t: $dv_t = -1$, $dv_{t+j} = 0$, $j \geqslant 1$, $\Rightarrow dK_{t+j} = -1$, $j \geqslant 0$. In the initial period, the employment effect of this fall in the capital stock is $-\psi = -\delta(1 - a_E - a_w b_I)$, and the unemployment effect is $du_t = \psi$. Since the shock is permanent, it has three effects in period $t+1$: (i) it reduces employment directly by $-\psi$, as in period t; (ii) the induced fall in employment E_t reduces employment E_{t+1} by $-a_E$ below what it would have been in the absence of the shock; and (iii) the fall in E_t raises the wage w_{t+1} and thereby reduces employment E_{t+1} further by $-a_w b_I$. Thus the effect of the permanent shock on unemployment in period $t+1$ is $du_{t+1} = \psi + \omega\psi$, where $\omega = a_E + a_w b_I$. In the same way, the unemployment effect in period $t+2$ is $du_{t+2} = \psi + \omega\psi + \omega^2\psi$. Extrapolating, the entire chain reaction in response to the permanent shock, from period t onwards, is

$$du_{t+j} = \sum_{i=0}^{j} \psi\omega^i = \sum_{i=0}^{j} \delta(1 - a_E - a_w b_I)(a_E + a_w b_I)^i$$

$$= \delta\left[1 - (a_E + a_w b_I)^{j+1}\right], j \geqslant 0, \tag{6b}$$

and the long-run change in the unemployment rate is $du^* \equiv \lim_{j\to\infty} du_{t+j} = \delta$. Thus the full effects of the permanent shock emerge only gradually, and the disparity between the short and long-run changes in unemployment is $du_{t+j} - du^* = -\delta(a_E + a_w b_I)^{j+1}$, $j \geqslant 0$. Once again, it can be shown that, for $j > 1$, the two lagged effects are complementary.[16]

2. The Role of Labour Market Lags in the Medium and Long Run

We now examine how the lagged labour market adjustment processes affect the unemployment rate in the medium and long run. To do this in a

[16] An increase in each adjustment coefficient makes unemployment (in any particular time period) less responsive to the permanent labour demand shock: $\partial(du_{t+j} - du^*)/\partial a_E = -\delta(j+1)(a_E + a_w b_I)^j < 0$ and $\partial(du_{t+j} - du^*)/\partial b_I = -\delta(j+1)a_w(a_E + a_w b_I)^j < 0$, $j \geqslant 0$. Each of these effects is amplified by the other: $\partial^2(du_{t+j} - du^*)/\partial b_I \partial a_E = -\delta(j+1)j a_w(a_E + a_w b_I)^{j-1} < 0$, for $j \leqslant 1$.

particularly transparent analytical context,[17] let us consider the following modified variant of the labour market model above:[18]

$$E_t = a_E E_{t-1} + \delta(1 - a_E)K_t, \tag{1'}$$

$$L_t = c_L L_{t-1} + \gamma(1 - c_L)Z_t, \tag{3'}$$

$$u_t = L_t - E_t, \tag{4}$$

where $|a_E| < 1$, $|c_L| < 1$, γ and δ are positive constants, and Z_t is the logarithm of working age population in period t. Consequently the unemployment rate may be expressed as[19]

$$u_t = (\gamma Z_t - \delta K_t) + \left(\frac{a_E}{1 - a_E}\Delta E_t - \frac{c_L}{1 - c_L}\Delta L_t\right). \tag{7}$$

If we define the NRU as the unemployment rate that would prevail if the lagged adjustment processes worked themselves out fully in each time period (so that $a_E = c_L = 0$), given the values of the exogenous variables in that period, we find that the NRU is $u_t^n = \gamma Z_t - \delta K_t$.

To provide a useful conceptual basis for our empirical analysis in the next section, we now show how a medium run change in unemployment can be decomposed into the change in the NRU and the change due to the lagged adjustment processes. Specifically, we examine how these two changes contribute to the unemployment rate over an arbitrary, finite span of time, j periods in length. By (7), the change in unemployment from period t to $t + j$ is

$$Du_{t+j} = D(z\gamma Z_{t+j} - \delta K_{t+j}) + \left[\frac{a_E^{j+1} - a_E}{1 - a_E}\Delta E_t - \frac{c_L^{j+1} - c_L}{1 - c_L}\Delta L_t + \sum_{i=0}^{j-1}\left(\delta a_E^{i+1}\Delta K_{t+j-i} - \gamma c_L^{i+1}\Delta Z_{t+j-i}\right)\right], \tag{8}$$

where for any variable y_{t+j}, $Dy_{t+j} = y_{t+j} - y_t$. Thus the first right-hand term is the change in the NRU and the second right-hand term stands for the medium-run influence of the lagged adjustment processes.[20]

We capture the long-run influence of the lagged adjustment processes as follows. To ensure that unemployment approaches a stationary long-run equilibrium, we require that in the long run the capital stock grows at rate $\Delta K_t = g/\delta > 0$ and the population grows at rate $\Delta Z_t = g/\gamma > 0$, where g is a positive constant representing the resulting long-run growth rate of the labour

[17] For the purpose of our analysis we ignore the error terms and instead focus on the conditional expectations of the dependent variables. Thus (1') and (3') are simply the systematic components of the underlying stochastic equations.

[18] Here (1') may be viewed as the result of substituting the wage setting equation into the labour demand equation.

[19] We derive this expression by rewriting (1') and (3') as $E_t = \delta K_t - [a_E \Delta E_t/(1 - a_E)]$ and $L_t = \gamma Z_t - [c_L \Delta L_t/(1 - c_L)]1 - c_L \Delta L_t$ (respectively) and substituting the latter equations into (4).

[20] Observe that these processes operate on the initial changes in employment and the labour force (ΔE_t and ΔL_t) and on the interim changes in the exogenous variables (ΔK_{t+j-i} and ΔZ_{t+j-i}).

force and of employment.[21] Then, by (7), we find that the long-run unemployment rate is

$$u_t^* = (\gamma Z_t - \delta K_t) + \frac{(a_E - c_L)g}{(1 - a_E)(1 - c_L)}, \tag{9}$$

where the first right-hand term is the NRU. Observe that this rate depends not only on the values of the exogenous variables (K_t and Z_t), but also on the interaction between the lagged adjustment coefficients (a_E and c_L) and the growth rate (g) of the labour force and employment.

Traditionally, lagged adjustment processes were viewed as significant only for the transition to the long-run equilibrium unemployment rate, not for the determination of that long-run rate itself. The analysis above contradicts this conventional wisdom. The underlying intuition is contained in Fig. 1. Here the employment equation (1′) is depicted by the upward-sloping line LD_t and the labour supply equation (3′) is given by the horizontal line L_t. Given the initial employment level E_{t-1}^* (on the horizontal axis), the equilibrium employment level in period t is E_t^* (on the vertical axis). The associated equilibrium unemployment rate is u_t^*.

Moving to period $t+1$, the capital stock has increased and thus the new employment line is pictured by LD_{t+1}. Since the inherited employment level is E_t^* (on the horizontal axis), employment rises to E_{t+1}^* (on the vertical axis). Furthermore, the population has increased and thus the labour supply line shifts to L_{t+1}, and thus the resulting equilibrium unemployment rate is u_{t+1}^*. Similarly for period $t+2$. The figure pictures the stationary, long-run unemployment rate ($u_t^* = u_{t+1}^* = u_{t+2}^*$ in Fig. 1).

This illustration indicates why the long-run unemployment rate depends on the lagged adjustment coefficients. Since the capital stock grows at a positive rate, the employment line is continually shifting upward, and thus the lagged employment adjustment process never has a chance to work itself out entirely. Employment is chasing a moving target, which may be called the 'natural employment level', lying at the intersection between the employment line LD_{t+j}, $j \geqslant 0$, and the 45° line (the employment level at which there is no tendency for employment to change, given the capital stock). And since the labour supply is rising at the same rate as employment, unemployment remains constant through time $\left(u_t^* = u_{t+1}^* = u_{t+2}^*\right)$. The NRU (the difference between the labour force and the natural employment level) is also constant ($u_t^n = u_{t+1}^n = u_{t+2}^n$ in the figure), but the unemployment rate does not approach this NRU with the passage of time.

The lagged employment adjustment coefficient (a_E) determines the degree to which employment manages to approach its target (natural) level. The greater this coefficient, the slower is the employment adjustment process, and thus the greater will be the long-run unemployment rate. By the same token,

[21] By (4), $\Delta u_t = \Delta L_t - \Delta E_t$. Thus, in order for u_t to be stationary in the long run, the long-run labour force L_t and employment E_t must grow at the same rate: $\Delta L_t = \Delta E_t = g$. Substituting this value into (1′) and (3′) and taking first differences of these equations, we find that in the long run $\Delta E_t = \delta \Delta K_t = \Delta L_t = \gamma \Delta Z_t = g$.

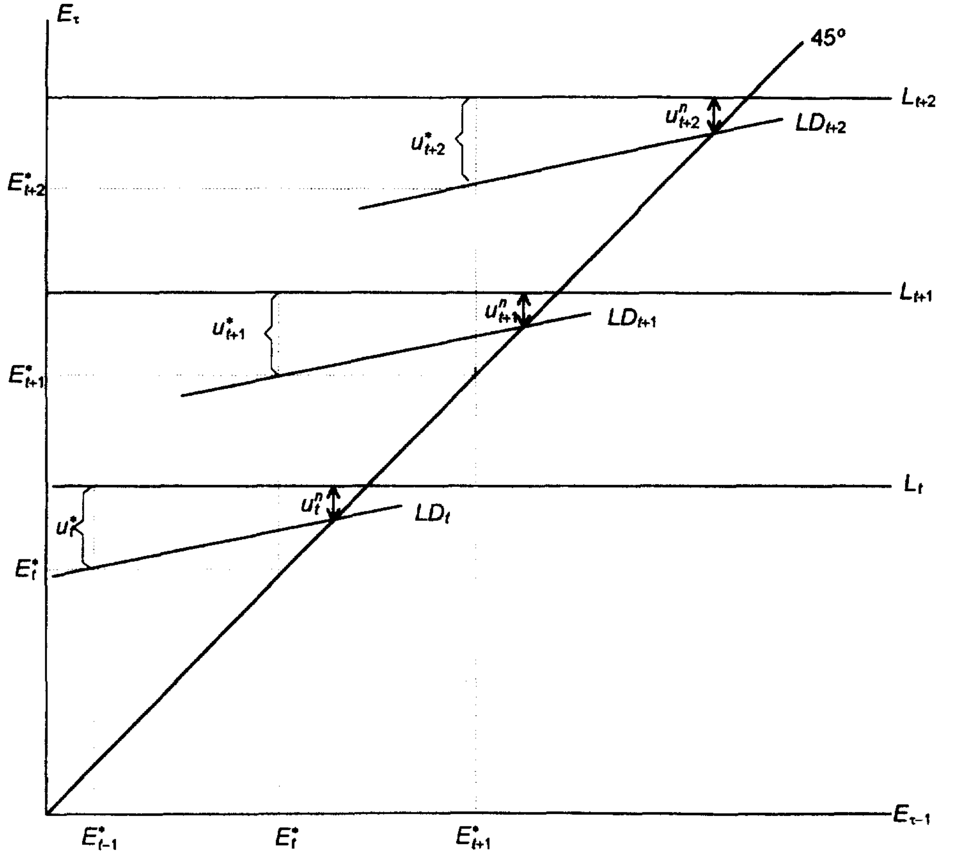

Fig. 1. *Long-Run Unemployment and the Natural Rate*

the greater is the labour force adjustment coefficient (c_L), the more slowly does the labour force adjust to its target level, and thus the smaller will be the long-run unemployment rate.

Finally, note that the broad conclusion of our analysis - that the long-run unemployment rate depends on lagged adjustment processes - holds not just for the model above, but for *any* system of labour market equations containing lagged endogenous variables, exogenous variables with non-zero long-run growth rates, and a stationary long-run unemployment rate. Our model's lags and growing exogenous variables are illustrative only; we could equally well have derived our conclusion on the basis of other lags (e.g. current wages depending on past wages or past unemployment) and other changing exogenous variables (e.g. technological progress and growth of wealth). The point is that, since lagged endogenous variables and non-stationary exogenous variables are exceedingly common features of labour market models, our conclusion is quite general.

3. Empirical Analysis

3.1. *Estimation*

Whereas it is well-known that the lagged adjustment processes identified in the prevailing empirical macro labour market systems[22] have important implications for unemployment movements in the short-run (a few years),[23] we now explore the empirical significance of these processes in explaining medium- and long-term unemployment movements.

For this purpose we estimated a labour market system for the United Kingdom using annual data over the period 1964–95. This system may be interpretted as the empirical counterpart to our theoretical model (1)–(4), containing the same endogenous variables and an extended set of exogenous variables. (These variables are defined in Table 1.) As in (1), the empirical employment equation has current employment depending on past employment, in what we have called the 'employment adjustment effect' (EA). Unlike in (2), estimating the wage equation showed the 'insider membership effect' to be insignificant, but current real wages were found to depend significantly on past real wages, in what may be called the 'wage staggering effect' (WS), since staggered wage setting introduces inertia into the wage determination process.[24] Finally, unlike (3), the size of current labour force was found to depend on the past labour force, in what we call the 'labour force adjustment effect' (LF), since costs of entry to and exist from the labour force generally introduce inertia into labour supply decisions.

Since the emergence of the unit root-cointegration literature, the common practice in empirical economics has been to test for the existence of long-run relations using cointegration techniques (given that the application of unit

Table 1

Definitions of Variables

E_t	:	log of employment
L_t	:	log of labour force
u_t	:	unemployment rate ($u_t = L_t - E_t$)
w_t	:	log of real wage (= average monthly earnings)
K_t	:	log of real capital stock
b_t	:	log of real social security benefits
c_t	:	log of real social security contributions
τ_t^I	:	indirect taxes as a % of GDP
p_t^{oil}	:	log of real oil price
Z_t	:	log of working age population

Nominal variables were deflated using the GDP deflator
Sources: OECD, IFS, Datastream

22 For example, Henry and Snower (1996) and Layard *et al.* (1991).

23 Karanassou and Snower (1998) show how the short-run unemployment effects of temporary shocks tend to persist through time and those of permanent shocks take time to manifest themselves fully.

24 See, for example, Taylor (1979).

root tests has identified the underlying variables as integrated of order 1, I(1)), and subsequently estimate the short-run dynamics and the adjustment mechanism towards equilibrium through an error correction model.

Despite the popularity of the above methodology our estimation of a labour demand, wage setting, and labour supply equations is based on the 'autoregressive distributed lag (ARDL) modelling approach to cointegration analysis', proposed by Pesaran and Shin (1995),[25] Pesaran (1997), and Pesaran *et al.* (1996).[26] The reason for adopting the ARDL modelling approach is twofold: first, since the ARDL approach is applicable irrespective of whether the regressors are I(0) or I(1), the pre-testing problems that surround the cointegration analysis do not arise, and second, the estimated coefficients can be given a straightforward economic interpretation, e.g. the coefficients of the lagged employment terms in the labour demand equation may be interpreted in terms of the employment adjustment effect.

The equations for our labour market model were selected on the basis of either the Akaike Information Criterion or the Schwartz Bayesian Criterion, equations [T1]-[T3] in Table 2, and they all pass the CUSUM and CUSUMSQ tests for structural stability. Taking into consideration the possibility of endogeneity and cross-equation correlation, we also estimated the preferred specifications as a system using 3SLS (equations [T4]–[T6] in Table 3). Note that the 3SLS estimates are similar to the OLS ones. Table 4 presents a full range of misspecification tests (for serial correlation, homoscedasticity, linearity, and normality) of the above equations and Table 5 reports the Sargan's test for overidentifying restrictions. Observe that our selected equations consist of stationary, well-specified linear combinations of the variables involved.[27]

Following the conceptual framework outlined in Section 2, we now proceed to evaluate the role of the NRU versus the lagged adjustment processes in accounting for UK unemployment over the medium and long run.

[25] According to Pesaran and Shin (1995) '... the traditional ARDL approach justified in the case of trend-stationary regressors, is in fact equally valid even if the regressors are first-difference stationary'.

[26] Once the order of the ARDL has been specified, by using either the Akaike Information Criterion or the Schwartz Bayesian Criterion, the long-run relation of the variables is given by the steady-state solution of the estimated equation.

[27] Several features of our empirical system deserve mention. First, labour productivity (Q_t/E_t) was not included as a regressor in the wage equation, since that would have required including a production function in our system. Instead, we interpret the equations of our system as semi-reduced forms into which the production function has already been substituted. Second, in the labour demand equation we have not followed the reasonably common practice of restricting the long-run coefficient of the capital stock to be unity, since labour and capital are not the only factors of production (there are, for example, raw material resources as well) and thus this value of the coefficient cannot be interpretted as representing returns to scale. Third, note that employment depends positively on the real wage. This result is readily interpreted in terms of the recent theoretical literature demonstrating that although the labour demand curve is generally downward-sloping under full capacity and diminishing returns to labour, but it may be flat or upward-sloping under excess capital capacity (e.g., Lindbeck and Snower (1994)). The reason is that, in the presence of unused capital, a rise in employment is generally accompanied by a rise in the amount of capital used, and thereby returns to scale - rather than returns to labour - come to play a dominant role in determining the slope of the labour demand curve. In a stochastic environment, excess capacity can be a long-run (as well as a short-run) phenomenon.

Table 2

UK, OLS, 1964–1995

[T1]	$\Delta E_t =$	1.54	$-0.36E_{t-2}$	$+0.08w_t$	$+3.91K_t$	
		(0.42)	(0.07)	(0.03)	(0.57)	
		$-6.02K_{t-1}$	$+2.21K_{t-2}$	$-0.33\tau_t^l$	$-0.06c_t$,	$R^2 = 0.87$
		(0.97)	(0.47)	(0.13)	(0.03)	
[T2]	$\Delta w_t =$	-1.12	$-0.22w_{t-2}$	$+0.10b_t$	$-0.02p_t^{oil}$	
		(0.33)	(0.06)	(0.03)	(0.01)	
		$-1.03\Delta\tau_t^l$,				$R^2 = 0.41$
		(0.45)				
[T3]	$\Delta L_t =$	-7.62	$-0.52L_{t-2}$	$-0.18u_t$	$+0.01w_{t-1}$	
		(1.81)	(0.09)	(0.08)	(0.01)	
		$+0.95Z_t$,				$R^2 = 0.57$
		(0.20)				

(standard errors in parentheses)

Table 3

UK, 3SLS, 1964–1995

[T4]	$\Delta E_t =$	1.64	$-0.38E_{t-2}$	$+0.07w_t$	$+3.49K_t$	
		(0.28)	(0.05)	(0.02)	(0.39)	
		$-5.27K_{t-1}$	$+1.89K_{t-2}$	$-0.33\tau_t^l$	$-0.06c_t$,	$R^2 = 0.87$
		(0.63)	(0.30)	(0.10)	(0.02)	
[T5]	$\Delta w_t =$	-1.14	$-0.22w_{t-2}$	$+0.11b_t$	$-0.02p_t^{oil}$	
		(0.30)	(0.05)	(0.03)	(0.005)	
		$-1.10\Delta\tau_t^l$,				$R^2 = 0.41$
		(0.41)				
[T6]	$\Delta L_t =$	-6.95	$-0.55L_{t-2}$	$-0.16u_t$	$+0.02w_{t-1}$	
		(1.40)	(0.08)	(0.07)	(0.01)	
		$+0.90Z_t$,				$R^2 = 0.57$
		(0.16)				

Instruments: const., $E_{t-1}, E_{t-2}, w_{t-1}, w_{t-2}, L_{t-1}, L_{t-2}, K_t, K_{t-1}, K_{t-2}, \tau_t^l, \tau_{t-1}^l, p_t^{oil}, b_t, c_t, Z_t$ (asymptotic standard errors in parentheses)

Table 4

Misspecification Tests

Equation	[T1]	[T2]	[T3]	[T4]	[T5]	[T6]
$SC[\chi^2(1)]$	2.94	0.06	3.78	3.83	0.25	4.50
SC[F(1, 25)]						3.42
$LIN[\chi^2(1)]$	1.11	0.12	0.90	2.71	0.16	1.44
$NOR[\chi^2(2)]$	2.08	2.23	3.93	4.00	2.28	5.09
$HET[\chi^2(1)]$	0.57	0.03	0.45	0.19	0.06	0.39
$ARCH[\chi^2(1)]$	0.29	1.24	1.17	0.00	1.30	0.78

5% critical values: $\chi^2(1) = 3.84$, χ^2 (2) = 5.99, F (1, 25) = 4.24

Table 5

Sargan's test

Labour demand equation : $\chi^2(8) = 12.82$ [0.12]
Labour supply equation : $\chi^2(11) = 12.30$ [0.34]

[probabilities in squared brackets]

3.2. *Explaining Unemployment in the Medium and Long Run*

3.2.1. *Explaining the medium-run movement in UK unemployment.* Let us examine how much of the change in the UK unemployment rate between 1980 and 1995 is due to the change in the NRU and how much is accounted for by the interaction between lagged adjustment processes and changing exogenous variables. We first solve the estimated UK labour market system [T4]–[T6] for the given time series of the exogenous variables and compute the resulting difference between the unemployment rates in 1980 and 1995. We denote this difference by Du_{80-95}, which we call the 'medium-run change in unemployment'. Next, we set all the lagged endogenous variables in the model equal to their current values (so that the lagged adjustment processes are assumed to work themselves out completely in each period) and solve the resulting system, again for the given time series of the exogenous variables. The associated change in the unemployment rate between 1980 and 1995, denoted by Du^n_{80-95}, we call the 'medium-run change in the NRU'. Then the difference between Du_{80-95} and Du^n_{80-95} measures the contribution of the lagged adjustment processes to the medium-run change in the unemployment ($Du^{\Lambda}_{80-95} = Du_{80-95} - Du^n_{80-95}$), where the superscript 'Λ' stands for 'lags'.

As Table 6 shows, the medium-run change in the unemployment rate in the presence of all the lagged adjustment processes is $Du_{80-95} = 3.30\%$, and the medium-run change in the NRU is $Du^n_{80-95} = 1.44\%$. Thus the contribution of the adjustment processes is $Du^{\Lambda}_{80-95} = 1.86\%$. In short, more than half of the overall change in unemployment between 1980 and 1995 is accounted for by the adjustment processes.

3.2.2. *Complementarities among lagged adjustment processes.* In Section 1 we argued that lagged adjustment processes may play a particularly important role in explaining the movement of unemployment if these processes are complementary to one another. To assess such complementarity in our empirical model, we compare (i) the sum of the individual contributions of these processes to the medium-run change in unemployment with (ii) the joint contribution of these processes. To compute the individual contribution of the employment adjustment process (EA) to the medium-run change in unemployment, we set all the lagged endogenous variables in the system [T4]–[T6] equal to their current values except the employment lags in the labour demand equation[28] and find the associated medium-run change in the unemployment rate, which we denote by $Du_{80-95}(EA)$. Then the individual contribution of the employment adjustment process may be measured as $Du^{\Lambda(EA)}_{80-95} = Du_{80-95}(EA) - Du^n_{80-95}$. The individual contribution of the wage setting process, $Du^{\Lambda(WS)}_{80-95}$, and of the labour force adjustment process, $Du^{\Lambda(LF)}_{80-95}$, may be derived along analogous lines.

[28] In other words, the lag operator associated with all endogenous variables except employment is set equal to unity.

As Table 6 shows, the contribution of the employment adjustment process is $Du_{80-95}^{\Lambda(EA)} = 1.89\%$, the contribution of the wage setting process is $Du_{80-95}^{\Lambda(WS)} = 0.17\%$, and the contribution of the labour force adjustment process is $Du_{80-95}^{\Lambda(LF)} = -0.51\%$. The sum of these individual contributions is 1.55%, which is less than their joint contribution $Du_{80-95}^{\Lambda} = 1.86\%$. In this sense, the three lagged adjustment processes may be viewed as complementary.

3.2.3. *Explaining the long-run UK unemployment rate.* To examine the influence of the lagged adjustment processes on the long-run unemployment rate, we assess the difference between the long-run equilibrium unemployment rate in the presence and absence of these processes. For this purpose, we first solve the estimated UK labour market system [T4]–[T6] from 1995 onwards, making plausible assumptions about the long-run growth rates of the exogenous variables. Specifically, we assume that the capital stock, working age population, and social security contributions grow at 2%, 0.4%, and 4% (respectively) in the long run, and we set the long-run growth rate of social security benefits so as to ensure that the unemployment rate converges to a constant in the long run. (See the Appendix for details.) Table 6 shows that the resulting long-run equilibrium unemployment rate is $u^* = 7.3\%$.

Next, we set all the lagged endogenous variables in this system equal to their corresponding current values, and derive the associated long-run equilibrium unemployment rate (in the absence of the lagged adjustment processes).

Table 6

Contributions of the Lagged Adjustment Processes

Medium-run contribution (aggregate):
$Du_{80-95} = 3.30\%$
$Du_{80-95}^{n} = 1.44\%$
$Du_{80-95}^{\Lambda} = Du_{80-95} - Du_{80-95}^{n} = 1.86\%$
Medium-run contribution (individual):
$Du_{80-95}(EA) = 3.33\%$
$Du_{80-95}(WS) = 1.61\%$
$Du_{80-95}(LF) = 0.93\%$
$Du_{80-95}(EA + WS) = 3.86\%$
$Du_{80-95}^{\Lambda(EA)} = Du_{80-95}(EA) - Du_{80-95}^{n} = 1.89\%$
$Du_{80-95}^{\Lambda(WS)} = Du_{80-95}(WS) - Du_{80-95}^{n} = 0.17\%$
$Du_{80-95}^{\Lambda(LF)} = Du_{80-95}(LF) - Du_{80-95}^{n} = -0.51\%$
$Du_{80-95}^{\Lambda(EA+WS)} = Du_{80-95}(EA + WS) - Du_{80-95}^{n} = 2.43\%$
$Du_{80-95}^{\Lambda(EA)} + Du_{80-95}^{\Lambda(WS)} + Du_{80-95}^{\Lambda(LF)} < Du_{80-95}^{\Lambda}$
$Du_{80-95}^{\Lambda(EA)} + Du_{80-95}^{\Lambda(WS)} < Du_{80-95}^{\Lambda(EA+WS)}$
Long-run contribution:
$u^* = 7.3\%$
$u^n = 5.3\%$
$u^{\Lambda} = u^* - u^n = 2\%$

Table 6 shows that this long-run NRU is $u^n = 5.3\%$. This result is in line with other studies[29] that have found the recent UK natural rate to be quite low.

However, the important point of this exercise is that, in the presence of lagged labour market adjustment processes and growing exogenous variables, the unemployment rate does not approach this NRU in the long run. In our empirical model the NRU lies a full 2 percentage points below the long-run equilibrium unemployment rate. By implication, the conventional practice of using the NRU to formulate macroeconomic policy - e.g. deciding whether monetary policy should be contractionary or expansionary by examining whether the actual unemployment rate lies above or below the NRU - is likely to be seriously misguided.

4. Concluding Thoughts

The natural rate and chain reaction theories of unemployment offer markedly different visions of the steady-state labour market. The natural rate theory pictures a fully equilibrated labour market in the long run, one in which all lagged adjustment processes have been completed, so that the NRU depends solely on the exogenous determinants of labour market behaviour. This vision implies that countries where unemployment has been high for a long time (such as Belgium, Denmark, France, Spain and several other EC member states) require policies that influence these exogenous determinants so as to reduce the NRU, e.g. policies that reduce the duration of unemployment benefits, reduce taxes impinging on labour, or raise the skill levels of those at the bottom rungs of the labour market ladder.

The chain reaction theory, by contrast, envisages a labour market that is in a continual state of flux, one in which the relevant adjustment processes are never completed. Here unemployment in the long run depends not only on the exogenous determinants of labour market behaviour, but also on the degree of labour market 'flexibility', viz., the speed with which the labour market participants react to the unending sequence of labour market changes. In this context, high-unemployment countries require not only NRU-reducing policies, but also policies that improve labour market adjustment processes, such as employment vouchers to help speed up the rate at which the long-term unemployed find jobs, reductions in legislated firing costs to make firms' employment decisions more responsive to external shocks, or the removal of regulations that inhibit the entry and exit of firms in the economy.

The effect of these latter policies on unemployment in the long run cannot be captured in the standard, linear, single-equation models of unemployment (such as in Phelps (1994, ch. 17)); nor can their influence be evaluated through cross-country regressions (such as those in Layard *et al.* (1991) and Nickell (1997)). What is required, rather, are dynamic, multi-equation systems

[29] See, for example, Minford, *et al.* (1990) and Joyce and Wren-Lewis (1991).

that depict the influence of labour market adjustment processes in the presence of exogenous variables with non-zero growth rates.

In this context, the evaluation of how government policies affect the lagged behavioural adjustment processes becomes an important area for future research. The reason is that different labour market policies influence different adjustment processes. For instance, changes in job security legislation may have a stronger influence on the employment adjustment effect than on the wage staggering effect, whereas the opposite may be the case for changes in the degree of public-sector wage indexation. But estimating the relation between policy variables and lagged adjustment processes can only be a first step in the overall research agenda since, as we have seen, the unemployment effects of different adjustment processes may be interdependent. Identification of complementarities and substitutabilities among labour market adjustment processes becomes an important research objective as well.

Finally, it is worth emphasising that these issues cannot be dismissed as merely topics of specialist interest in labour economics. As long as policy makers keep a close watch on the relation between actual unemployment and its long-run value when formulating monetary and fiscal policies, the relative significance of the NRU versus the adjustment processes in determining the long-run unemployment rate will remain a matter of critical policy interest.

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Appendix

The estimated UK labour market system (see Table 3) is given by

$$\Delta E_t = \beta_1 + \beta_2 E_{t-2} + \beta_3 w_t + \beta_4 K_t + \beta_5 K_{t-1} + \beta_6 K_{t-2} + \beta_7 \tau_t^I + \beta_8 c_t, \qquad (A1)$$

$$\Delta w_t = \beta_9 + \beta_{10} w_{t-2} + \beta_{11} b_t + \beta_{12} p_t^{oil} + \beta_{13} \Delta\tau_t^I, \qquad (A2)$$

$$\Delta L_t = \beta_{14} + \beta_{15} L_{t-2} + \beta_{16} u_t + \beta_{17} w_{t-1} + \beta_{18} Z_t, \qquad (A3)$$

where Δ is the difference operator, and the β's are the estimated parameters. An alternative way to express the above system of equations is

$$(1 - \mathrm{B} - \beta_2 \mathrm{B}^2) E_t = C_t^E + \beta_3 w_t, \qquad (A1')$$

$$(1 - \mathrm{B} - \beta_{10} \mathrm{B}^2) w_t = C_t^w, \qquad (A2')$$

$$(1 - \mathrm{B} - \beta_{15} \mathrm{B}^2) L_t = C_t^L + \beta_{16} u_t + \beta_{17} w_{t-1}, \qquad (A3')$$

where B is the backshift operator, $C_t^E = \beta_1 + \beta_4 K_t + \beta_5 K_{t-1} + \beta_6 K_{t-2} + \beta_7 \tau_t^I + \beta_8 c_t$, $C_t^w = \beta_9 + \beta_{11} b_t + \beta_{12} p_t^{oil} + \beta_{13} \Delta\tau_t^I$, and $C_t^L = \beta_{14} + \beta_{18} Z_t$.

Algebraic manipulation of equations (A1')-(A3') together with the definition of the unemployment rate, $u_t = L_t - E_t$, gives the following *reduced form equation*:

$$\begin{aligned}(1 - \beta_{16} - \mathrm{B} - \beta_{15}\mathrm{B}^2)(1 - \mathrm{B} - \beta_2\mathrm{B}^2)(1 - \mathrm{B} - \beta_{10}\mathrm{B}^2) u_t \\ = - (1 - \mathrm{B} - \beta_{10}\mathrm{B}^2)(1 - \mathrm{B} - \beta_{15}\mathrm{B}^2) C_t^E \\ + [\beta_{17}\mathrm{B}(1 - B - \beta_2\mathrm{B}^2) - \beta_3(1 - \mathrm{B} - \beta_{15}\mathrm{B}^2)] C_t^w \\ + (1 - \mathrm{B} - \beta_2\mathrm{B}^2)(1 - B - \beta_{10}B^2) C_t^L. \qquad (A4)\end{aligned}$$

Application of the difference operator to the above yields:

$$\begin{aligned}(1 - \beta_{16} - \mathrm{B} - \beta_{15}\mathrm{B}^2)(1 - \mathrm{B} - \beta_2\mathrm{B}^2)(1 - \mathrm{B} - \beta_{10}\mathrm{B}^2) \Delta u_t \\ = - (1 - \mathrm{B} - \beta_{10}\mathrm{B}^2)(1 - \mathrm{B} - \beta_{15}\mathrm{B}^2) \Delta C_t^E \\ + [\beta_{17}\mathrm{B}(1 - \mathrm{B} - \beta_2\mathrm{B}^2) - \beta_3(1 - \mathrm{B} - \beta_{15}\mathrm{B}^2)] \Delta C_t^w \\ + (1 - \mathrm{B} - \beta_2\mathrm{B}^2)(1 - \mathrm{B} - \beta_{10}\mathrm{B}^2) \Delta C_t^L. \qquad (A4')\end{aligned}$$

Let g_k, g_z, g_c, and g_b denote the long-run growth rates of capital stock, population, social security contributions and benefits, respectively.[1] By setting the backshift operator in equation (A4') equal to one we obtain its long-run solution:

$$-(\beta_{16}+\beta_{15})\beta_2\beta_{10}\Delta u^* = -\beta_{10}\beta_{15}[(\beta_4+\beta_5+\beta_6)g_k+\beta_8 g_c] + (\beta_3\beta_{15}-\beta_{17}\beta_2)\beta_{11}g_b+\beta_2\beta_{10}\beta_{18}g_z.$$

Observe that for the unemployment rate to be constant in the long-run ($\Delta u^* = 0$) the long-run growth rates of the exogenous variables should be linearly dependent. In particular, *given the values* of g_k, g_z, g_c, if

$$g_b = \frac{\beta_2\beta_{10}\beta_{18}g_z - \beta_{15}\beta_{10}[(\beta_4+\beta_5+\beta_6)g_k+\beta_8 g_c]}{\beta_{11}(\beta_{17}\beta_2-\beta_3\beta_{15})}, \tag{A5}$$

then the unemployment rate stabilises in the long-run. To compute the long-run unemployment rate, u^*, we assume that the capital stock, working age population, and social security contributions grow at rates $g_k = 2\%$, $g_z = 0.4\%$, and $g_c = 4\%$, we use (A5) to derive the rate at which the benefits grow, and we conduct a post-sample simulation of equations (A1')–(A3'). To obtain the long-run unemployment rate in the absence of the lags (u^n) we repeat the above simulation by setting the back-shift operator in (A1')–(A3') equal to one. The long-run contribution of the lagged adjustment processes is measured as $u^\Lambda = u^* - u^n$.

[1] Without loss of generality, we assume that the long-run growth rates of τ_t^f, and p_t^{oil} are zero.