Unemployment, cycle and gender*

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Abstract

This study analyses the relationship between unemployment and business cycle in two countries: the UK and the USA. For both economies, a strong and definite association is found that shows that cyclical shocks extend their effect on unemployment over several quarters. This association is much more intense for male unemployment than for female unemployment, and it has lost some strength in the UK in the last years. Markov switching regime models with two regimes display clear differences between expansions and recessions in both countries.

Key words: business cycle, gender, Markov switching regime model, unemployment

Subject area and JEL classification: Business Fluctuations, Cycles (E32); Unemployment: Models, Duration, Incidence, and Job Search (J64).

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1 Introduction

The cyclical nature of economic dynamics is commonly accepted. Periods of high economic activity, or expansions, are followed by periods of low economic activity, or contractions, in a non-regular sequence. Although the duration of all these periods may be very different, they are recurrent and present certain comovements among important economic variables. Numerous researchers have studied these business cycles for many decades. Burns and Mitchell (1946) was a milestone in the research on this issue, with its contribution to the definition and measurement of business cycles, and since then the dating of phases and the extraction of cyclical components of economic variables has attracted the attention of many researchers.

Output and unemployment are two key variables of the business cycle, as they are taken into account in virtually all the research on cycles, and are of the maximum importance in macroeconomic performance. Their role in business cycles is clear, but their movements have opposite signs. Output is a clear procyclical variable, undoubtedly the most defining variable of business cycles phases, and just its movements give rise to the different expansions and contractions in many chronologies. On the contrary, unemployment is a clear countercyclical variable, and, consequently, increases in contractions and decreases in expansions. These opposite directions across business cycles should give rise to an inverse relationship between output and unemployment. Nevertheless, several issues may hide this relationship. Firstly, there may be flows from unemployment to out of labor force and vice versa that could distort or cause difficulties in studying the link between these two variables. These flows may be induced by phenomena such as 'the added worker effect' or 'the discouraged unemployed'. Secondly, the relationship between output and unemployment may be dynamic instead of fully contemporaneous. In addition to a simultaneous effect, the response of unemployment to cyclical shocks may take some time and therefore unemployment could be a lagging indicator of business cycles. In fact, according to NBER business cycle dating for the US, unemployment peaked more than one year after the trough in the last two recessions (15 and 19 months after, respectively). To complicate things even further, besides this dynamic relationship, labour market could also anticipate future cyclical movements. Finally, changes in aspects such as employment protection legislation or in dismissal costs may affect the relationship or its dynamics (see, for example, Alewell, Schott, and Wiegand, 2009 or Wolfers, 2005). This possible distribution of the effects of business cycles on unemployment may imply that the effect is relatively weak in each single time period, but it spreads over time; unemployment may react to cyclical shocks or policy measures far from the moment when they took place. Consequently, from a policy perspective, it is important to elucidate the time distribution of unemployment variations provoked by business cycles.

The relationship between unemployment and business cycle may have changed in the last decades. In fact, many researchers think that recent business cycles are rather different from the preceding ones. Variability in main economic aggregates have decreased, and recessions have been less frequent and severe (since November 1982 the NBER has dated only two recessions in the US lasting eight months each). Factors such as the increase of the service sector with respect to industry or agriculture, or a major role of public sector in modern economies, could lie behind these changes, and this weakening of cyclical movements may have altered their linkage with unemployment. Nevertheless, the interest in the relationship between output and unemployment over the business cycle has recently increased in the light of current economic events. The pronounced downturn in economic activity that has begun in 2008 in many countries has originated a sharp increase in unemployment. This situation has sparked a huge interest in this topic, especially in those countries which face high unemployment levels not seen in many years.

The consequences of cyclical movements on unemployment may also differ by gender. While a great deal of literature exists on gender differences in labor participation and wages, research on gender differences in unemployment and its relationship with the business cycle is much more sparse. Traditionally, it has been widely accepted that the labor supply curve is more elastic among women (Killingsworth, 1983, Blundell and MaCurdy, 1999), and this fact could be in the basis of existing differences in unemployment across the business cycle. Nevertheless, several researchers have examined these questions from different perspectives, and have come to different conclusions. Clark and Summers (1981) found that cyclical behaviour of employment is not age and gender neutral, as employment of young women was more responsive to cyclical shifts than employment of older women, and this last was, in his turn, more responsive than employment of similarly aged men. Blank (1989) found a stronger association of changes in employment with changes in GDP for women than for men of the same race. Solon, Barsky and Parker (1994) and Kandil and Woods (2003), however, report empirical evidence that questions the higher elasticity of labor supply among women, though their results do not exclude the possibility of a different cyclical behaviour in the extensive margins for men and women. Rives and Sosin (2002) show that occupational segregation is critical for explaining the differences in gender unemployment rates. Queneau and Sen (2008) consider several theories regarding the dynamics of unemployment over the business cycle, and present evidence of gender differences in unemployment dynamics in three out of eight OECD countries, but the degree of persistence in male and female unemployment rates is relatively low in all the countries under examination.

When considering the relationship of business cycles with unemployment, another important aspect is the possible existence of asymmetries. The presumption that important economic variables present asymmetric behaviour over the business cycles has a long tradition in economic thought, which traces back to the pioneering work on business cycles of Mitchell (1927). In fact many researchers, including Keynes (1936), have firmly believed that business cycles present strong asymmetries. Much later, in a seminal study, Neftçi (1984) formally tested the asymmetric behavior of unemployment over the business cycle, and since then a large number of studies have followed: DeLong and Summers (1986), Hussey (1992), Acemoglu and Scott (1994), Koop and Potter (1999), McKay and Reis (2008), among many others, have also found asymmetries in labor-market variables. Though these conclusions are not unanimous, one may conclude with Mittnik and Niu (1994) that: 'Although the empirical evidence on business cycle asymmetries is somewhat mixed, there appears to be fairly strong support for asymmetries in unemployment data, while there is somewhat weaker support for aggregate output data'. In fact, McKay and Reis (2008) have recently proposed a new business cycle feature: 'contractions in employment are briefer and more violent than expansions but we cannot reject the null of equal brevity and violence for expansions and contractions in output'.

If unemployment displays an asymmetric evolution over time but output does not present clear asymmetries, the source of unemployment asymmetries could lie in the nature of its dependence on output. Several researchers have investigated asymmetries and non-linearities in the relationship between unemployment and cyclical movements from the perspective of Okun's law. Virén (2001) presents evidence of non-linearities in Okun's relationship for 18 out of 20 OECD countries. Huang and Chang (2005) find support of threshold non-linearity for Canada. Using Hamilton's flexible nonlinear inference, Huang and Lin (2006) find clear evidence of nonlinearity between cyclical components of US unemployment and output. Silvapulle, Moosa and Silvapulle (2004) present evidence of asymmetry in the output-unemployment relationship for the US post-war economy so that the response of unemployment is stronger to negative than to positive cyclical output. Holmes and Silverstone (2006) use the Markov regime-switching model to analyse asymmetries in Okun's law for the US. When testing linearity against non-linearity in US data, Crespo (2003) concludes the existence of a regime-dependent Okun's parameter and implies that cyclical unemployment is more responsive to changes in negative cyclical output.

The aim of this paper is to examine the association between unemployment and business cycles in two main economies, the United Kingdom and the United States. Special attention will be paid to essential aspects of this relationship such as: differences by gender, changes over time, and possible asymmetries. To achieve these objectives, Section 2 presents the data used in this study. Section 3 analyses these relationships from a general perspective, by gender, and by periods of time. Section 4 examines the empirical evidence looking for possible asymmetries between expansions and contractions. Finally, Section 5 summarises the main conclusions.

2 Data

Quarterly data on GDP for the UK and the US were collected from *International Financial Statistics*, International Monetary Fund, and from the *Bureau of Economic Analysis*, US Department of Commerce, respectively. They cover the period 1971:1–2008:4 and 1948:1–2008:4, respectively, and are seasonally adjusted. With regard to labor markets, quarterly data on unemployment rates were obtained for the UK from the *UK Office for National Statistics*, and for the US from the *Bureau of Labor Statistics*, US Department of Labor. They cover the same periods as GDP and are also seasonally adjusted.

For both countries, GDP presents a clear trend. To obtain the cyclical component, these series must be detrended. The detrending procedure is highly controversial, as different methods give rise to different properties of the resulting cyclical component. Probably, the filter proposed by Hodrick and Prescott (1980 and 1997), HP, is the most widely used. This filter has been applied to the logarithm of GDP with a smoothing parameter equal to 1600, value proposed by Hodrick and Prescott (1997) for quarterly data. The difference between the original series (GDP in logs) and the trend obtained is the cyclical component, which is shown in Figure 1, panels A and B.

Perhaps the most striking feature of these two graphs is the lower variability or volatility that cyclical GDP presents in both countries in the last years of the sample (though the last quarter presents a hard fall). Table 1 shows the standard deviations of cyclical GDP in different periods: the whole sample, the first two thirds of the sample and the last third of the sample. The standard deviation of cyclical GDP is clearly lower in the last years, which are about one third in the UK, and about one half in the US. The same happens with the increments of cyclical GDP (see Figure 1, panels C and D, and Table 1). This much smoother evolution is a well known fact that has been thoroughly discussed and could be due to several factors such as better statistics, growing share of services in GDP or the role of public sector, and it has led to many researchers to enquire about the drastic change in recent business cycles or, even, their end.[1] It is also interesting to note in Figure 1, panels A and B, that most extreme values of the cyclical component are positive in the UK and negative in the US. This is also shown in Table 2. Although the mean of the cyclical components is zero, the five most extreme cyclical components are positive in the UK, while the nine most extreme are negative in the US. However, this feature disappears almost completely in both countries when examining the series of increments in cyclical components.

Insert Figure 1

Insert Tables 1–2

With regard to unemployment, a first important feature to analyse is whether the reduction of the amplitude of cyclical movements in GDP in the last decades could have been propagated to unemployment. In order to analyse this possibility, Figure 2, panels A and B, shows the unemployment rates in UK and the USA. There seems to be also a lower variability in last years, but it is not very clear. When taking increments of unemployment rates, a similar pattern to that of cyclical GDP is observed more clearly: the variability also decreases greatly in the last years. This is confirmed in 1, where both unemployment rates and their changes present a lower standard deviation in the last sub-samples.

Insert Figure 2

[1]However, the last quarter in the sample, as well as the first quarters in 2009 present a sharp decline in GDP in both countries.

Another interesting point reflected in Table 1 lies in the lower standard deviation of unemployment variables for women than for men. For both countries, for the whole sample and for each sub-sample, women series present a lower variability than their counterparts for men and the differences are often substantial. At least partially, this fact could be due to a more stable employment among women than among men, which would be a possible consequence of the differences in gender employment by economic sectors or activities. If more sensitive sectors to cyclical shocks have a large proportion of male employment, cyclical fluctuations will exert a stronger effect on male unemployment, and the relationship of cyclical movements with unemployment will be more intense for men than for women.

Finally, some asymmetries seem to happen in unemployment rates. Let us see US unemployment first. It is remarkable to note that in Figure 2, panel B, the unemployment rate in the US displays sharp peaks and much more rounded troughs: unemployment increases rapidly, but decreases more gradually. This point can be confirmed by looking at the increments of the unemployment rates in panel D. It is evident that the most extreme values are positive; in fact, the seven most extreme variations in US unemployment rate are positive, and eight out of the nine most extreme values (see Table 2). This can be observed also in the histogram of the empirical distribution of changes in unemployment rates (not shown here for reason of space), skewed to the right with a skewness statistic equal to 1.04. This phenomenon may be not so evident for the UK in panel A, but it is also somewhat noticeable in the series of increments in UK unemployment rate (see Figure 2, panel C); as shown in Table 2, the five most extreme variations in UK unemployment rate are also positive. The empirical distribution is also skewed to the right with a skewness statistic equal to 0.73. Consequently, it seems reasonable to suspect the existence of asymmetries in unemployment rates and in their increments, both in the UK and in the US.

3 Unemployment and business cycle

In order to analyse the relationship between unemployment and business cycle, different regression models could be specified. A first natural choice would be:

$$UR_t = \alpha + \beta CYCLE_t + u_t \tag{1}$$

i.e., the (quarterly) unemployment rate is regressed against the (quarterly) cyclical component of GDP. This first approach to the problem, however, does not take into account a long standing issue about empirical macroeconomics: the integration order of the involved variables. On the one hand, the cyclical component is, by construction, a stationary ($I(0)$) variable.[2] On the other hand, the unemployment rate needs some further investigation since we do not have a priori beliefs about its persistence degree. Tables 3–4 present some unit root and stationarity tests for UR.[3]

Insert Tables 3–4

Regarding UK unemployment rate, there is weak evidence against the unit root hypothesis, and strong evidence against stationarity. There is however stronger evidence against the unit root null for the US unemployment rate, and we have not found evidence against the stationarity hypothesis. Hence, we would conclude that US unemployment rate is an $I(0)$ variable, whereas we have conflicting results for UK unemployment rate. Thus, if we run the regression (1) we can not preclude the possibility that, in the case of UK, we could have an $I(1)$ variable regressed against an $I(0)$ variable, i.e., in Granger's (1995) terminology, we could have an *unbalanced equation*, in the sense that there could be an unwanted *strong property* on the left hand side of (1).

In addition, abstracting from the aforementioned possibility of facing an unbalanced equation for UK, the regression of (1) yields anomalous results. Simple regressions of the unemployment rate on a constant and current cyclical component or on a constant and one single lag or lead show significant negative slopes, for both the UK and the US. Nevertheless, for both countries, multiple regression of the unemployment rate on a constant and current cyclical component together with several leads and lags shows a highly joint significance but none of the individual coefficients are significant. Similar facts occur for the UK, or when taking increments in the unemployment rate. This phenomenon is due to the high collinearity existent among cyclical components in successive quarters, and it is a direct consequence of the

[2]In fact, the cyclical component obtained with the standard Hodrick-Prescott filter is always an $I(0)$ variable.

[3]We have computed the GLS-detrended augmented Dickey-Fuller (DF-GLS, 1996), the Ng-Perron (2001) and Breitung (2002) unit root tests, and the Kwiaikovski et al. (1992) and Bierens-Guo (1993) stationarity tests.

detrending procedure. Although cyclical component is stationary, it presents a high autocorrelation, with first-order correlations equal to 0.76 and 0.83 for the UK and the US, respectively.

Among many other problems, this collinearity prevents studying the dynamics of the response of unemployment to cyclical conditions. To avoid or mitigate these difficulties, first differences in the cyclical component were obtained. These differences present a much lower collinearity, with first-order correlations now equal to -0.12 and 0.27 for the UK and the US, respectively. Variations in unemployment rates were regressed on a constant and changes in the cyclical component,

$$\Delta UR_t = \alpha + \sum_{i=-m}^{n} \beta_i \Delta CYCLE_{t+i} + u_t \qquad (2)$$

where ΔUR_t is the variation in unemployment rate in quarter t, $\Delta CYCLE_t$ is the increment in the cyclical component in quarter t and u_t is the error term for the same quarter. Note that, with (2), simultaneously we solve the unbalanced equation problem we could face if the UK unemployment rate were a truly $I(1)$ variable, since differencing both sides of (1) renders stationary variables in any case.

Values for m and n (lag and lead selection) were chosen by using sequential F tests with a significance level set at 5%, and the conclusions were almost identical to those obtained by using Schwarz's Bayesian Information Criterion. Table 5 shows the results obtained for UK and US.

Insert Table 5

Several important results arise from this table. i) Excluding the constants, the regressors included are, as expected, always negative, thus indicating a negative relationship between variations in business cycle and changes in unemployment rates; ii) Excluding the intercepts, the regressors are always clearly significant; iii) Variations in unemployment rates depend not only on contemporaneous changes in cyclical conditions but also on cyclical changes that took place several quarters before (five quarters in the UK, and three in the US) and, interestingly, on cyclical changes that will took place in the following quarter. Therefore, labour market reacts immediately and with a delay of several quarter to cyclical shocks, but also anticipates imminent cyclical changes; iv) As expected, the values of the estimates corresponding to nearer lags are higher (in absolute values) than those corresponding to further lags. It reflects a higher sensitivity of labour market to most recent cyclical conditions; v) As reflected by the coefficients of determination, the dependence seems to be stronger in the US than in the UK, but over time it is more enduring in the UK than in the US.

It is also important to grasp the meaning of the estimates. In order to do so, let us simulate the effects of a hypothetical expansion on unemployment. Let us suppose that in a 'typical' expansionary quarter the cyclical component increases in one percentage point (sample standard deviations of increases in the cyclical component are 0.95% and 0.94%, for the UK and the US, respectively). Let us also consider an expansion composed by four consecutive expansionary quarters. According to the estimation corresponding, for example, to the UK, the change in the unemployment rate in the quarter preceding to the beginning of the expansion will be $0.017 - 4.09 \times 0.01 = -0.0239$, that is, an approximate decrease of 0.02 percentage points. The change in the unemployment rate in the quarter when expansion begins will be $0.017 - (4.09 + 9.92) \times 0.01 = -0.1231$, that is, an approximate decrease of 0.12 percentage points. Table 6 shows quarterly and accumulated reductions in the unemployment rate in the different quarters for both countries. The unemployment rate decreases slightly in the immediately preceding quarter to the beginning of the expansion. Then, it strongly decreases over the four expansionary quarters. In the following quarters, UK unemployment rate still decreases strongly, but the additional decrease in US unemployment rate is weaker. The overall effect of these four successive expansionary quarters is remarkably similar in both countries: a decrease in the unemployment rate of 2.00 percentage points for the UK, and a decrease of 2.22 points for the US. Of course, this is just a hypothetical exercise to examine the effects of a determinate expansion, and this variation will not be permanent as far as the cyclical component does not remain stable indefinitely.

Insert Table 6

The results reported above show a clear relationship between business cycles and the unemployment rate. But this relationship could be different by gender. It has been long argued that labour markets may differ greatly by gender; participation rates, wages, sectoral employment shares, among many other aspects, could be different between men and women, and the influence of cyclical shocks on the unemployment rate could also differ. Additionally, it has also been discussed the declining, or even disappearance, of business cycles in recent decades. If business cycles are much weaker than they used to be, the influence of cyclical shocks on the unemployment rate could also have diminished significantly. To study these two possibilities, new regressions similar to (2) have been carried out but: i) using male and female unemployment rate instead of total unemployment rate; ii) using two sub-samples approximately formed by the first two thirds and the last third of the total sample. Table 7 show the results of these regressions, and Table 8 and 9 show the dynamic effect of an expansion composed by four successive increases of the cyclical component equal to 0.01 in these new circumstances, for UK and the US, respectively.

Insert Tables 7–9

One main conclusion emerges from these tables. Male unemployment is more sensitive to cyclical conditions than female unemployment. It happens both in the UK and in the US, but the difference is much stronger in the UK. An expansionary period formed by four successive increases of one percentage point in the cyclical component would entail a decrease in UK male unemployment rate of 2.68 percentage points, while female unemployment rate would decrease only 0.99 percentage points. The difference is much wider than in the US, where men's unemployment rate would decrease by 2.44 percentage points while women's rate would decrease 1.71 points. With regard to changes over time in the response of unemployment to cyclical shocks, in the first sub-period UK unemployment was more responsive to cyclical conditions than in the second sub-period. The expansion formed by four consecutive expansionary quarters would have caused a diminution of 1.58 percentage points in the first sub-period, and 1.06 points in the second one. However, in the US the diminutions are 2.00 and 2.22, respectively. Therefore, this change does not seem to occur in the US, where the sensitivity of unemployment rate is very similar in both sub-periods.

One possible explanation to these facts could lie in the difference of employment by activity between men and women over time. The ratio of employment in industry to employment in services is always much higher among men than among women.[4]), both in the UK (around 0.78 for men and 0.22 for women) and the US (around 0.64 for men and 0.20 for women). If unemployment in the first activity were more sensitive to cyclical shocks than

[4]Data got from OECD Statistical Compendium.

in the second one, higher sensibility of male unemployment to cyclical conditions than that of female unemployment should be expected; as it turns out to be in both countries. The evolution of this ratio can also explain the different responsiveness of the UK unemployment rate over time. While the mean of this ratio is 0.58 in the first sub-period, it decreases to 0.33 in the second one. This decrease may be associated to the lower sensibility of the unemployment rate to cyclical conditions observed in the second sub-period. Regarding the US, no major changes are observed in the response of the unemployment rate to cyclical movements, as it seems to occur with the ratio of employment in industry to employment in services, which decreases from 0.48 to 0.33.

4 Markov switching regime models

We have investigated the link between unemployment and GDP by means of standard linear regression equations. However, such approach does not take into account possible nonlinear relationships between the variables.

As seen in Section 2, unemployment series seem to be asymmetric. In this section, first we formally test for unconditional symmetry of the unemployment rate series. To that end, we employ two recently proposed tests: the Bai and Ng (2005) and Racine et al. (2007) procedures, see Table 10.

Insert Table 10

Neither the Bai-Ng nor the Racine et al. tests allow us to reject the null hypothesis of symmetry for any of the UK unemployment rate series (there is just a marginal 10% level rejection for the male series using the $\hat{\pi}_3$ statistic). Nevertheless, we have found strong evidence against symmetry for all the US variables. This result could be the outcome of either asymmetric perturbances in a linear data generating process, or possible nonlinear mechanisms driving the dynamics of the changes in the US unemployment rates.

To get deeper insight into this question, next we test for linearity by means of the Hong and Lee (2007) test. Results in Table 11 are rather conclusive. We can not reject the null hypothesis of linearity for any UK variable. However, we clearly reject the null for all the US unemployment rate changes series.

Insert Table 11

Given the results of the symmetry and linearity tests, model (2) could be a plausible representation of the dynamics of the UK unemployment rate changes series, whereas it is an unappropriate mechanism to explain the complex movements in the US variables. Hence, alternatively, we estimate a set of Markov switching (MS) regime regression models.[5]

A stationary time series y_t is assumed to have been generated by an MS model with M regimes and p lags in the exogenous regressors:

$$y_t = \alpha(s_t) + \sum_{k=0}^{p} \beta_k(s_t) x_{t-k} + u_t, \tag{3}$$

where $y_t = \Delta UR_t$, $x_t = \Delta CYCLE_t$, $u_t|s_t \sim N(0, \sigma^2)$, and the values of the intercept and the multipliers depending on the current regime represented by s_t. If we allow for regime-dependent heteroskedasticity, then we replace the assumption $u_t|s_t \sim N(0, \sigma^2)$ by $u_t|s_t \sim N(0, \sigma^2(s_t))$.

This type of models was developed initially by Goldfeld and Quandt (1973), in response to economists' view of different behavior of variables during different cycle phases. The phase is represented by an unobservable state s_t, which takes value 1 (expansion) or 0 (recession).[6] The simplest specification is that s_t is the realization of a two-state Markov chain, where the probability of a change in regime depends on the past only through the value of the most recent regime:

$$\Pr\left(s_t = j | s_{t-1} = i, s_{t-2} = k, \ldots, y_{t-1}, y_{t-2}, \ldots\right) = \Pr(s_t = j | s_{t-1} = i) = p_{ij}.$$

The formulation of the problem, in which all parameters of interest are calculated as a by-product of an iterative algorithm similar in spirit to a Kalman filter, is due to Hamilton (1989). The maximum likelihood estimates have been obtained by the EM algorithm. Results of the selected models using the Swarchz's criterion are displayed on Tables 12 and 13.

Insert Tables 12–13

[5]The universe of available nonlinear models is large (TAR, STAR, ESTAR, LSTAR, etc). Our goal however is not to fit the "best" nonlinear model but to show how our conclusions can be enriched by alternative approaches.

[6]As tipically, we have chosen to specify a binary state variable, although we could represent a more flexible framework by allowing, for instance, an additional intermediate state between pure expansion and pure recession.

Concerning UK results, multipliers estimates for $DURT$ and $DURW$ do not largely differ among regimes, and standard deviations estimates are rather close. However, the converse is true for $DURM$: coefficients estimates are very different among regimes, and standard deviation estimate for expansions is 54% larger than the estimate for recessions.[7] US results sharply contrast with UK. Thus, multipliers estimates for $DURT$, $DURM$ and $DURW$ are very different among regimes, and the standard deviation estimate for recessions is between 16% and 76% larger than the estimate for expansions, depending on the variable. In order to assess the effect of cycle on unemployment rate, we perform the simulation of the effects of a hypothetical expansion/recession on unemployment, displayed on Table 14.

Insert Table 14

Looking at total unemployment, for both countries expansions diminish the unemployment rate at a smaller extent than a recession increases it.[8] When looking at gender variables, it is interesting to observe that the predicted changes in unemployment rates are not very different between men and women during expansions, while the differential impact during recessions is quite large. In summary:

1. For all the variables, changes in unemployment rates are larger in recessions than in expansions. Differences for UK women unemployment rates, however, are not of high order.

2. In expansions, for both countries, differences between the response of men and women unemployment rates are not very large. In the US case, they are almost identical.

3. In recessions, the differences in changes of the unemployment rate between men and women are very important, with the higher difference in the UK case.

[7]Interestingly, the $\hat{\pi}_3$ test marginally rejected symmetry only for this variable in the UK (see Table 10.)

[8]Note that the impact on UK variables is smaller than the impact on US variables.

5 Conclusions

The study of the relationship between unemployment and business cycle has received the attention of economic research for many decades. Nevertheless, the literature is very sparse on important related topics such as its dynamics, its stability over time, the existence of possible differences by gender, and the possible asymmetric response of unemployment to cyclical movements. This scarcity becomes extreme with regard to the integration of these topics in a joint analysis.

To mitigate this situation, this paper examines the relationship between unemployment and cyclical conditions over the last decades in two main economies: the United Kingdom, and the United States of America. A strong and definite dynamic relationship is found in both countries that extends over several quarters and with a reasonable and logical timely profile. These findings allow to simulate the effects of an hypothetical expansion formed by four successive expansionary quarters with a cyclical component equal to the typical value of 1%. The results obtained are similar for both economies; the expansion would decrease the unemployment rate by 2.0 and 2.2 percentage points in the UK and the US, respectively. A deeper look shows that there exist clear differences by gender and over time. The effect of cyclical shocks is clearly stronger on male unemployment than on female unemployment, specially in the UK. Over time, the effect on total unemployment has decreased noticeably in the UK, maybe due to the growing importance of services or to the role of public sector.

Numerous contributions have reported empirical evidence on unconditional asymmetry of the unemployment rate in many countries. Preliminary evidence suggests that this is the case in UK and US unemployment rates, although formal statistical tests confirm it just in the US case. Markov switching regime models are estimated to account for this feature. The estimated models effectively show an asymmetric response of the unemployment rate to cyclical movements. Unemployment rate usually reacts more strongly to negative cyclical shocks (recessions) than to positive ones (expansions), and this difference is particularly acute for male unemployment.

Table 1: Standard deviations.

UK	1971:1–2008:4	1971:1–1995:4	1996:1–2008:4
$CYCLE$	0.015	0.017	0.006
$\Delta CYCLE$	0.009	0.011	0.004
UR (all)	2.500	2.740	0.930
UR (men)	2.940	3.360	1.200
UR (women)	2.090	2.060	0.640
ΔUR (all)	0.270	0.300	0.190
ΔUR (men)	0.340	0.370	0.240
ΔUR (women)	0.200	0.220	0.160
US	1948:1–2008:4	1948:1–1987:4	1988:1–2008:4
$CYCLE$	0.017	0.019	0.010
$\Delta CYCLE$	0.009	0.011	0.005
UR (all)	1.490	1.710	0.920
UR (men)	1.620	1.850	1.050
UR (women)	1.390	1.530	0.760
ΔUR (all)	0.390	0.450	0.240
ΔUR (men)	0.430	0.490	0.280
ΔUR (women)	0.370	0.430	0.210

Standard deviations of the variables indicated in the first column. $CYCLE$ is the cyclical component obtained by subtracting to the logarithm of GDP the trend obtained with the Hodrick and Prescott filter with a smoothing parameter equal to 1600, $\Delta CYCLE$ is the increment in $CYCLE$, UR is the percentage unemployment rate and ΔUR is the increment in UR.

Table 2: . Most extreme values.

Ranking	UK *cycle*	US *cycle*	UK $\Delta cycle$	US $\Delta cycle$	UK ΔUR	US ΔUR
1	0.051 (1979:2)	-0.061 (1949:4)	0.044 (1973:1)	-0.034 (1958:1)	0.900 (1981:1)	1.6 (1975:1)
2	0.048 (1973:1)	-0.047 (1982:4)	0.039 (1979:2)	0.031 (1978:2)	0.900 (1980:4)	1.5 (1954:1)
3	0.045 (1973:2)	-0.042 (1983:1)	-0.034 (1958:2)	0.027 (1950:1)	0.800 (1980:3)	1.4 (1958:1)
4	0.033 (1979:4)	-0.042 (1958:2)	0.033 (1963:2)	-0.026 (1949:1)	0.700 (1981:2)	1.3 (1949:2)
5	0.031 (1973:3)	-0.041 (1958:1)	-0.030 (1974:1)	-0.026 (1980:2)	0.700 (1991:2)	1.1 (1958:2)
6	-0.030 (1975:3)	-0.041 (1982:3)	-0.026 (1973:3)	0.025 (1950:3)	0.5 (5 quarters)	1 (1953:4)
7	-0.029 (2008:4)	-0.040 (1949:3)	0.024 (1968:1)	-0.025 (1953:4)	- 0.5 (5 quarters)	1 (1974:4)
8	0.026 (1988:4)	-0.039 (1949:2)	-0.021 (2008:4)	-0.022 (1982:1)		-1 (1950:3)
9	-0.025 (1981:2)	-0.038 (1975:1)	-0.020 (1975:2)	-0.022 (1960:4)		1 (1980:2)
10	0.025 (1988:3)	0.038 (1973:2)	-0.020 (1980:2)	0.022 (1952:4)		-0.9 (1958:4)

The entries are the most extreme cyclical components, increments in cyclical components and increments in unemployment rates with their dates in parenthesis.

Table 3: Unit Root Tests (Unemployment rate)

	DF-GLS	Ng-Perron				Breitung
		MZ_α	My_t	MSB	MP_T	$T^{-1}\hat{\rho}_T$
UK	-1.246	-6.801*	-1.829*	0.269	3.653*	0.019
US	-0.997	-11.871**	-2.350**	0.198**	2.403**	0.014*

The entries are the Dickey-Fuller GLS detrended (DF-GLS), Ng-Perron and Breitung test statistics. In the case of the DF-GLS and Ng-Perron statistics, the optimal lags were automatically selected by using the Modified Akaike Information Criterion. The frequency zero spectrum was estimated by the AR-GLS detrended data method. The superscripts (*) and (**) indicate significance at the 10% and 5%, respectively.

Table 4: Stationarity Tests (Unemployment rate)

	KPSS		Bierens-Guo			
	Bartlett kernel	QS kernel	$BG-1$	$BG-2$	$BG-3$	$BG-4$
UK	0.386^{*}	2.625^{***}	183.87^{***}	158.76^{***}	3.42	1.65
US	0.181	0.158	3.107	3.267	0.787	0.667

The entries are the Kwiatkovski et al. (KPSS) (1992) and Bierens-Guo (BG) (1993) test statistics. The optimal truncation lag for the KPSS was automatically selected by using Andrews' (1991) procedure. The superscripts (*), (**) and (***) indicate significance at the 10%, 5% and 1% significance level, respectively.

Table 5: Regressions results

	UK	US
$\hat{\alpha}$	0.017 (0.029)	0.0064 (0.0153)
$\hat{\beta}_1$	-4.09^{*} (2.00)	-7.37^{**} (1.72)
$\hat{\beta}_0$	-9.92^{**} (2.30)	-21.84^{**} (1.75)
$\hat{\beta}_{-1}$	-10.58^{**} (2.74)	-14.19^{**} (2.21)
$\hat{\beta}_{-2}$	-9.75^{**} (2.56)	-8.78^{**} (1.39)
$\hat{\beta}_{-3}$	-8.90^{**} (2.22)	-4.70^{**} (1.58)
$\hat{\beta}_{-4}$	-6.62^{**} (1.85)	–
$\hat{\beta}_{-5}$	-4.43^{*} (1.75)	–
R^2	45%	70%

Results of the regressions $\Delta UR_t = \alpha + \sum_{i=-m}^{n} \beta_i \Delta CYCLE_{t+i} + u_t$ for both UK and US, where ΔUR_t is the change in the unemployment rate in quarter t and $\Delta CYCLE_t$ is the change in the cyclical component in quarter t. m is equal to 5 and 3, respectively, for the UK and the US, and n is 1 for both countries. Values in parenthesis are Newey-West robust standard errors. * (**) denotes significant at the 5% (1%) level.

Table 6: Unemployment predicted changes.

Quarter	UK		US	
	$-\Delta UR$	$-\sum \Delta UR$	$-\Delta UR$	$-\sum \Delta UR$
-1	0.02	0.02	0.07	0.07
0	0.12	0.15	0.29	0.35
1	0.23	0.38	0.43	0.78
2	0.33	0.70	0.52	1.30
3	0.37	1.08	0.49	1.78
4	0.34	1.42	0.27	2.06
5	0.28	1.70	0.13	2.18
6	0.18	1.88	0.04	2.22
7	0.09	1.97	–	–
8	0.03	2.00	–	–
9	–	–	–	–

The entries are the expected reductions in the unemployment rate over a four-quarter expansion when the cyclical component increases by one percentage point each quarter, and zero elsewhere. The first column indicates the number of quarters since the beginning of the expansion; that is, expansion begins in quarter 0 and ends in quarter 3.

Table 7: Additional regressions

	UK				US			
	Men	Women	1971–1995	1996–2008	Men	Women	1948–1987	1988–2008
$\hat{\alpha}$	0.025 (0.035)	0.005 (0.026)	0.051 (0.036)	−0.051 (0.032)	0.009 (0.017)	0.004 (0.016)	0.012 (0.020)	0.002 (0.024)
$\hat{\beta}_1$	-6.45^{**} (2.37)				-7.55^{**} (1.94)	-5.83^{**} (2.43)	-7.62^{**} (1.87)	
$\hat{\beta}_0$	-12.80^{**} (2.65)	-4.68^{**} (1.63)	-9.73^{**} (2.22)	-21.52^{**} (5.92)	-25.69^{**} (2.03)	-15.87^{**} (2.55)	-22.22^{**} (1.87)	-21.02^{**} (4.40)
$\hat{\beta}_{-1}$	-14.44^{**} (3.40)	-4.92^{*} (2.17)	-10.70^{**} (2.79)		-13.88^{**} (2.29)	-14.15^{**} (3.09)	-14.25^{**} (2.39)	-15.67^{**} (3.65)
$\hat{\beta}_{-2}$	-12.59^{**} (3.53)	-5.76^{**} (2.15)	-10.50^{**} (2.71)		-9.93^{**} (1.74)	-7.63^{**} (2.29)	-8.49^{**} (1.50)	-11.38^{**} (3.65)
$\hat{\beta}_{-3}$	-12.23^{**} (2.54)	-4.15^{*} (1.59)	-8.39^{**} (2.17)		-5.77^{**} (1.86)		-4.53^{**} (1.68)	-8.69^{*} (4.27)
$\hat{\beta}_{-4}$	-8.17^{**} (2.16)	-3.67^{*} (1.51)	-6.78^{**} (1.68)					
$\hat{\beta}_{-5}$	-6.63^{**} (1.92)	-2.76^{*} (1.35)	-4.86^{**} (1.79)					
R^2	51%	16%	51%	23%	70%	52%	73%	53%

Results of the regressions $\Delta UR_t = \alpha + \sum_{i=-m}^{n} \beta_i \Delta CYCLE_{t+i} + u_t$ for both UK and US, where ΔUR_t is the change in the unemployment rate in quarter t, $\Delta CYCLE_t$ is the change in the cyclical component in quarter t, and m and n take different values in the different regressions. Values in parenthesis are Newey-West robust standard errors. * (**) denotes significant at the 5% (1%) level.

Table 8: Unemployment predicted changes (UK)

	Men		Women		1971–1995		1996–2008	
Quarter	$-\Delta UR$	$-\sum \Delta UR$	$-\Delta UR$	$-\sum \Delta UR$	$-\Delta UR$	$-\sum \Delta UR$	$-\Delta UR$	$-\sum \Delta UR$
-1	0.04	0.04	–	–	–	–	–	–
0	0.17	0.21	0.04	0.04	0.05	0.05	0.27	0.27
1	0.31	0.52	0.09	0.13	0.15	0.20	0.27	0.53
2	0.44	0.96	0.15	0.28	0.26	0.46	0.27	0.80
3	0.50	1.45	0.19	0.47	0.34	0.80	0.27	1.06
4	0.45	2.90	0.18	0.65	0.31	1.11	–	–
5	0.37	2.27	0.16	0.81	0.25	1.37	–	–
6	0.25	2.52	0.10	0.91	0.15	1.52	–	–
7	0.12	2.64	0.06	0.97	0.07	1.58	–	–
8	0.04	2.68	0.02	0.99	–	–	–	–
9	–	–	–	–	–	–	–	–

The entries are the expected reductions in the UK unemployment rate over a four-quarter expansion when the cyclical component increases by one percentage point each quarter, and zero elsewhere. The first column indicates the number of quarters since the beginning of the expansion; that is, expansion begins in quarter 0 and ends in quarter 3.

Table 9: Unemployment predicted changes (US)

	Men		Women		1948–1987		1988–2008	
Quarter	$-\Delta UR$	$-\sum \Delta UR$	$-\Delta UR$	$-\sum \Delta UR$	$-\Delta UR$	$-\sum \Delta UR$	$-\Delta UR$	$-\sum \Delta UR$
-1	0.07	0.07	0.05	0.05	0.06	0.06	–	–
0	0.32	0.39	0.21	0.27	0.29	0.35	0.21	0.21
1	0.46	0.85	0.35	0.62	0.43	0.78	0.36	0.57
2	0.56	1.41	0.43	1.05	0.51	1.29	0.48	1.05
3	0.54	1.96	0.37	1.43	0.48	1.78	0.57	1.62
4	0.29	2.24	0.21	1.64	0.26	2.04	0.36	1.97
5	0.15	2.39	0.07	1.71	0.12	2.16	0.20	2.17
6	0.05	2.44	–	–	0.03	2.19	0.08	2.26
7	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–

The entries are the expected reductions in the US unemployment rate over a four-quarter expansion when the cyclical component increases by one percentage point each quarter, and zero elsewhere. The first column indicates the number of quarters since the beginning of the expansion; that is, expansion begins in quarter 0 and ends in quarter 3.

Table 10: Unconditional Symmetry Tests

Series (UK)	$\hat{\pi}_3$	$\hat{\mu}_{35}$	$\hat{S}_\rho$
DURT	1.507	2.305	0.658
DURM	1.652^{*}	3.051	0.031
DURW	0.328	0.644	0.071
Series (US)			
DURT	2.435^{***}	7.478^{**}	0.046^{***}
DURM	2.427^{***}	6.724^{**}	0.031^{***}
DURW	1.996^{**}	5.099^{*}	0.023^{***}

$\hat{\pi}_3$ and $\hat{\mu}_{35}$ are the Bai-Ng (2005) test statistics, whereas $\hat{S}_\rho$ is the Racine et al. (2007) statistic. Superscripts indicate significance at levels of: (***) 1%, (**) 5%, and (*) 10%.

Table 11: Hong-Lee (2007) Linearity Test

Series (UK)	$\bar{p} = 10$	$\bar{p} = 20$	$\bar{p} = 30$	$\bar{p} = 40$	$\bar{p} = 50$
DURT	0.114	0.090*	0.074*	0.069*	0.068*
DURM	0.122	0.128	0.144	0.154	0.154
DURW	0.486	0.334	0.211	0.150	0.114
Series (US)					
DURT	0.038**	0.049**	0.058*	0.055*	0.046**
DURM	0.000***	0.001***	0.003***	0.007***	0.010***
DURW	0.009***	0.004***	0.002***	0.001***	0.001***

The entries are the p-values of the Hong-Lee test. Superscripts indicate significance at levels of: (***) 1%, (**) 5%, and (*) 10%.

Table 12: MS estimates. UK.

DURT	$\hat{\alpha}$	$\hat{\beta}_1$	$\hat{\beta}_0$	$\hat{\beta}_{-1}$	$\hat{\beta}_{-2}$	$\hat{\beta}_{-3}$	$\hat{\beta}_{-4}$	$\hat{\sigma}$
Expansion	-0.111^{**}	-7.538^{**}	-13.392^{**}	-9.939^{**}	-7.639^{**}	-7.926^{**}	-4.981^{*}	0.137
	(0.017)	(3.468)	(2.897)	(3.038)	(2.835)	(2.452)	(2.933)	
Recession	0.187^{**}	-3.749^{**}	-9.772^{**}	-11.248^{**}	-11.092^{**}	-7.772^{**}	-4.145^{**}	0.127
	(0.022)	(1.570)	(1.650)	(1.567)	(1.582)	(1.829)	(1.719)	
DURM								
Expansion	-0.104^{**}	-6.368^{*}	-9.763^{**}	-8.979^{**}	-6.893^{**}	-7.413^{**}	-3.949	0.188
	(0.029)	(3.285)	(2.903)	(2.636)	(2.764)	(2.989)	(3.146)	
Recession	0.230^{**}	-4.184^{**}	-14.610^{**}	-19.266^{**}	-17.819^{**}	-12.983^{**}	-4.311^{**}	0.122
	(0.032)	(1.807)	(1.890)	(1.813)	(1.821)	(1.894)	(1.759)	
DURW								
Expansion	-0.091^{**}	-5.130^{*}	-9.168^{**}	-7.506^{**}	-7.598^{**}	-4.433^{**}	-4.869^{**}	0.139
	(0.016)	(2.800)	(2.792)	(2.418)	(2.645)	(2.265)	(2.445)	
Recession	0.164^{**}	-3.058^{*}	-4.724^{**}	-5.196^{**}	-5.743^{**}	-4.428^{**}	-2.472	0.123
	(0.023)	(1.576)	(1.661)	(1.638)	(1.564)	(1.953)	(1.763)	

Values in parenthesis are Newey-West robust standard errors. * (**) denotes significant at the 5% (1%) level.

Table 13: MS estimates. US.

$DURT$	Expansion	Recession
$\hat{\alpha}$	-0.080^{**} (0.014)	0.045^{*} (0.026)
$\hat{\beta}_1$	-6.329^{**} (1.786)	-3.507 (2.350)
$\hat{\beta}_0$	-8.279^{**} (1.831)	-27.832^{**} (2.453)
$\hat{\beta}_{-1}$	-1.279 (1.868)	-19.638^{**} (2.347)
$\hat{\beta}_{-2}$	-2.837 (1.917)	-8.891^{**} (2.382)
$\hat{\sigma}$	0.113	0.200
$DURM$		
$\hat{\alpha}$	-0.087^{**} (0.018)	0.049^{*} (0.027)
$\hat{\beta}_1$	-5.172^{**} (2.314)	-5.462^{**} (2.633)
$\hat{\beta}_0$	-10.382^{**} (2.130)	-32.518^{**} (2.692)
$\hat{\beta}_{-1}$	-2.058 (2.391)	-19.251^{**} (2.626)
$\hat{\beta}_{-2}$	-0.947 (2.207)	-12.827^{**} (2.743)
$\hat{\sigma}$	0.134	0.220
$DURW$		
$\hat{\alpha}$	-0.034^{*} (0.017)	0.042 (0.039)
$\hat{\beta}_1$	-7.326^{**} (2.259)	2.511 (3.224)
$\hat{\beta}_0$	-9.891^{**} (2.170)	-27.549^{**} (3.275)
$\hat{\beta}_{-1}$	-2.574 (2.473)	-23.438^{**} (3.234)
$\hat{\beta}_{-2}$	-8.676^{**} (2.310)	-5.036 (3.250)
$\hat{\sigma}$	0.173	0.201

Values in parenthesis are Newey-West robust standard errors. * (**) denotes significant at the 10% (5%) level.

Table 14: Unemployment predicted accumulated changes (MS models)

Quarter	UK		US	
	Expansion	Recession	Expansion	Recession
$DURT$	3.05	3.59	1.29	2.71
$DURM$	2.67	4.99	1.35	3.14
$DURW$	2.37	2.50	1.37	2.43

The entries are the expected accumulated reductions (increments) in the unemployment rate, up to the 7th (UK) and 5th (US) quarter, over a four-quarter expansion (recession) when the cyclical component increases (decreases) by one percentage point each quarter, and zero elsewhere.

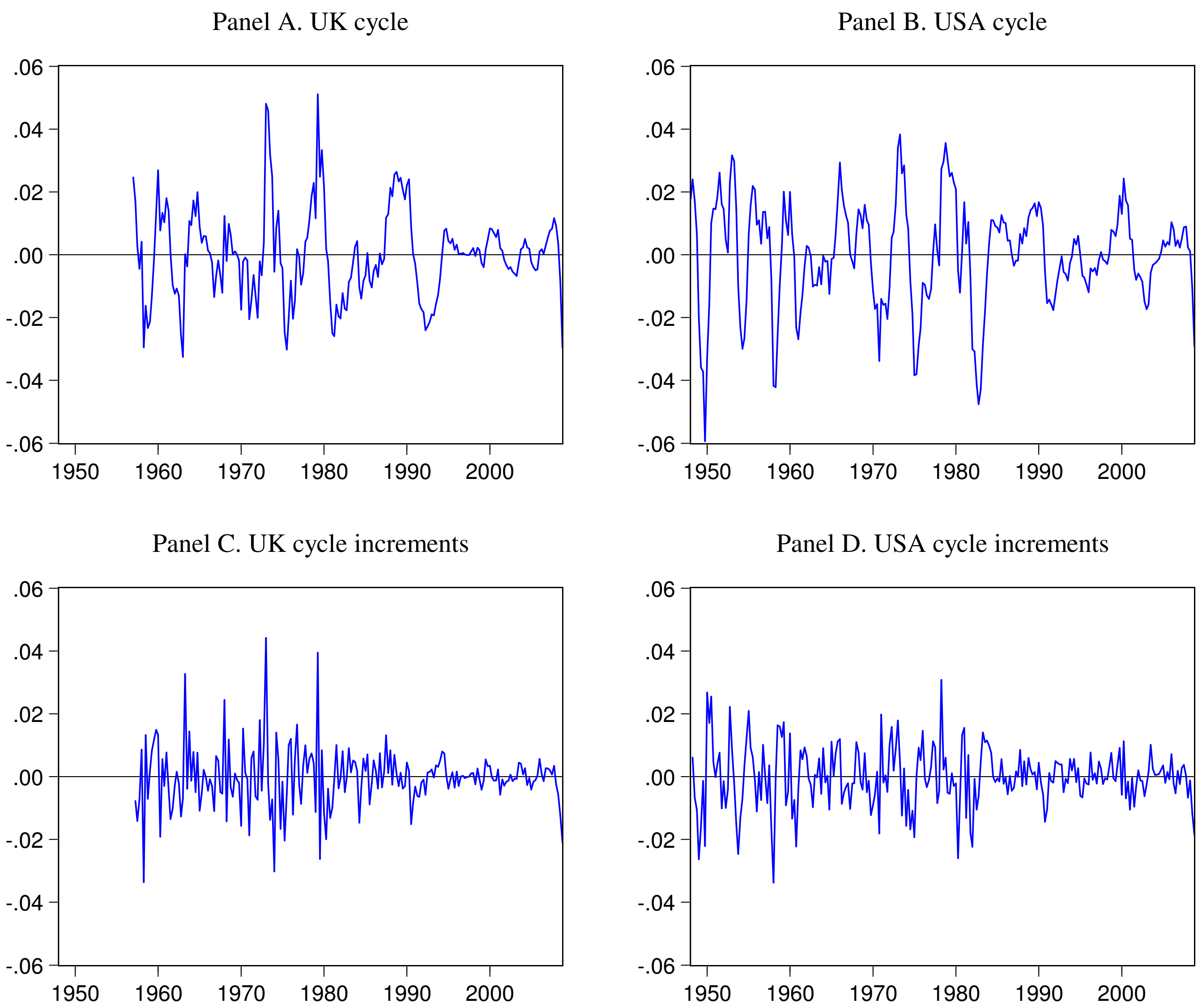

Figure 1: Panels A and B show UK and US cyclical components obtained by subtracting to the logarithm of GDP the trend obtained with the Hodrick and Prescott filter with a smoothing parameter equal to 1600, and panels C and D show their increments.

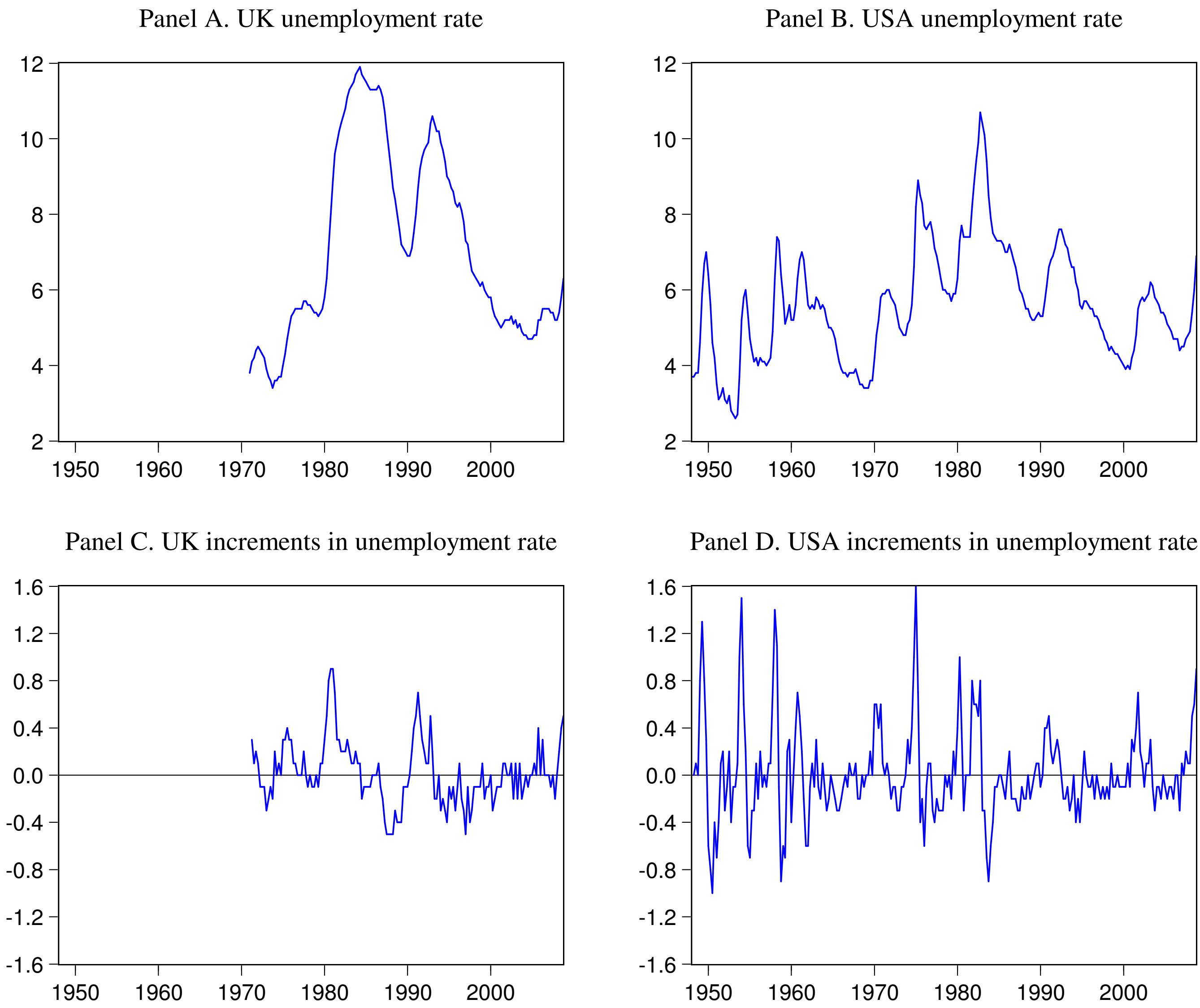

Figure 2: Panels A and B show UK and US percent unemployment rates, and panels C and D their increments.

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