The Relationships between Permanent and Transitory Movements in U.S. Output and the Unemployment Rate

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Abstract

This paper estimates the permanent and transitory movements in U.S. output and the unemployment rate and the relationships between them. The results suggest that permanent movements in U.S. output and the unemployment rate are important for explaining overall fluctuations. Further, the correlation between changes in these series arises in large part due to the relationship between their permanent components.

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1 Introduction

Many macroeconomic time series can usefully be decomposed into two unobserved components. One unobserved component reflects permanent, or trend, movements in the series, while the other captures transitory movements in the series. There may exist important relationships between the unobserved components of two or more different macroeconomic variables. For example, Okun's Law (Okun, 1962) suggests that output and the unemployment rate are related. This paper therefore investigates the relationships between the permanent and transitory movements in U.S. output and the unemployment rate using a bivariate correlated unobserved components model.

The results shed light on a number of important debates. First, regarding the importance of permanent versus transitory movements in real GDP, the results are consistent with the finding by Morley, Nelson and Zivot (2003, hereafter MNZ) that movements in U.S. real GDP are largely permanent. Including the unemployment rate as an additional variable does not qualitatively change the real GDP results from MNZ's univariate model. This result contradicts the claim of Clark (1987) that using unemployment rate data to help identify transitory movements in real GDP should strengthen the case for large transitory movements in real GDP. Second, this paper contributes to the debate about the variability in the natural rate of unemployment[1] by finding support for a variable permanent component in the unemployment rate.

The model also provides estimates of the different relationships between the unobserved components of output and the unemployment rate. Four correlations are of particular interest in

[1] There has been much discussion about the different definitions of the natural rate of unemployment (NRU). This paper equates the NRU with the permanent component of the unemployment rate. For the different sides of the debate on the variability of the NRU, see Weiner (1993), Gordon (1997), Salemi (1999), Grant (2002), and King and Morley (2007).

terms of addressing ongoing debates in the literature. The first two correlations are the "within-series correlations," i.e. those between the innovations to the permanent and transitory components of the same series. The univariate analysis (MNZ) found that for U.S. real GDP these innovations are significantly negatively correlated. Clark (1989) estimated a restricted bivariate model of output and the unemployment rate and concluded that the assumption of zero correlation for the within-series correlation of real GDP was appropriate. The estimate from the unrestricted bivariate model presented here, however, indicates that the MNZ result is robust and is not just a consequence of univariate analysis. The innovations to the permanent and transitory components of the unemployment rate are also negatively correlated. This suggests that the components of the unemployment rate have a similar relationship as those of real GDP.

The third and fourth important correlations involve *cross-series* correlations. The correlation between the transitory components of real GDP and the unemployment rate provides an estimate of the coefficient traditionally associated with Okun's Law. Okun (1962) suggested that a 1% decrease in transitory unemployment corresponds to a 3% increase in transitory real GDP. Traditionally, Okun's coefficient has been estimated by first estimating the unobserved components and then estimating the correlation between the estimated components. In this paper, however, the correlation is directly estimated within the model. The estimated coefficient of -1.4% is smaller in absolute value than is typically found.

Finally, the correlation between the permanent innovations of real GDP and the unemployment rate measures "Okun's coefficient for permanent movements." The coefficient representing the relationship between the unemployment rate and output in the long run is found to be -2.0%, which is closer to what Okun posited for the short run (and equal to modern estimates, Grant, 2002). All of these correlations lend support to a theory of the U.S. economy, such as that of Kydland and Prescott (1982), where permanent shocks move the economy while transitory movements primarily reflect the adjustment of variables to their new steady-state values.

This paper proceeds as follows. Section 2 presents the model. Section 3 presents the results of estimating the model with U.S. data on output and the unemployment rate and discusses sensitivity of the estimates. Section 4 concludes.

2 The Model

Output (*y*) and the unemployment rate (*u*) can each be represented as the sum of a permanent component and a transitory component. The permanent component (τ) is the steady-state level after removing all temporary movements. The transitory component (*c*) embodies all temporary movements and is assumed to be stationary:

$$y_{it} = \tau_{it} + c_{it}, \; i = y \text{ or } u \tag{1}$$

Each of the trend components is assumed to be a random walk[2] to allow for permanent movements in the series:[3]

$$\tau_{it} = \mu_i + \tau_{it-1} + \eta_{it} \tag{2}$$

For output, the model allows for a drift (μ_y) in the permanent component, but the drift for the unemployment rate was insignificant and is not included in the reported models. The

[2] It is possible to specify the permanent component in different ways. Specifying it as a random walk allows for the interpretation of the permanent component as reflecting the steady-state of the economy. Other decompositions and interpretations are possible, and potentially economically useful, such as the one suggested by Lippi and Reichlin (1994). In their model the permanent component is instead specified as an ARIMA process in order to interpret its innovations as productivity changes. Lippi and Reichlin, however, do not explicitly consider the correlation between the permanent and transitory innovations.

[3] Unit root tests (augmented Dickey-Fuller, 1979, using MacKinnon, 1996, one-sided p-values; and Phillips-Perron, 1988), could not reject the presence of a unit root for either series at the 10% level. The unemployment rate is bounded between zero and one, but it can undergo permanent shocks. For example, the random walk will capture frequent structural breaks. Clark (1989) also models the permanent component of the U.S. unemployment rate as a random walk. A discussion of the implications of alternative specifications for the permanent component of the unemployment rate will be presented in section 3.5.2.

final model also includes a one-time structural break in the drift term for real GDP, as discussed below in Section 3.1.[4]

Following MNZ, Clark (1987 and 1989), and Watson (1986), each transitory component is modeled as an autoregressive process of order two (AR(2)).[5]

$$c_{it} = \phi_{1i} c_{it-1} + \phi_{2i} c_{it-2} + \varepsilon_{it} \tag{3}$$

The correlated unobserved components model assumes the permanent and transitory innovations (η_{it}, and ε_{it}) are jointly normally distributed random variables with mean zero and a general covariance matrix (allowing possible correlation between any of the unobserved innovations). The model can be represented in state-space form so that the Kalman filter can be applied for maximum likelihood estimation of the parameters and the components.[6]

3 Results

The data used are the natural log of U.S. real GDP multiplied by 100 (y) and the U.S. civilian unemployment rate (u). The data are quarterly, from 1948:1 – 2005:4.[7] While the estimates presented in Table 1 come from joint estimation, the results for each series are first discussed separately.[8] Figures 1 and 2 present the estimated components of real GDP and the unemployment rate respectively along with the observed series. They are produced using the

[4] Some models, in particular Clark (1987), specify a random walk drift term. Oh and Zivot (2006) find that the results of MNZ are robust to allowing a random walk drift term in a univariate model, but identification of the model is more complicated. For simplicity, a single known structural break is used in this paper to address changing drift, rather than a random walk drift.

[5] Including a third lag does not qualitatively change the results from those presented in Table 1, and a likelihood ratio test indicates that a third lag is not significant.

[6] A discussion of identification of the model as well as the state-space form is available from the author upon request. For other discussions of identification of correlated UC models, see Morley (2007a), MNZ, Schleicher (2003), and the technical appendix of Balke and Wohar (2002).

[7] The data were obtained from FRED II (Federal Reserve Economic Data) from the Federal Reserve Bank of St. Louis, based on the July, 2006, revisions. The unemployment rate is the average civilian unemployment rate over each quarter. The estimated components begin in 1949:1 in the figures below because the program uses a four-quarter training sample to start up the Kalman filter.

[8] The estimation was done in GAUSS 6.0 using the Optmum optimization application. The program is available from the author upon request.

Kalman smoother, which uses all information available in the sample, thus providing a better in-sample fit as compared to the basic Kalman filter which only uses information available at time *t*. In the case of both real GDP and the unemployment rate, using the additional information results in a less variable trend and a more variable transitory component than using the basic filter.

3.1 Is there a Break in the Drift Term for Real GDP?

Perron and Wada (2005) argue that it is important to include a structural break in the drift term in the first quarter of 1973 for U.S. real GDP. Therefore, the last column of Table 1 presents results allowing for this break. While the break in the drift term is statistically significant with a p-value less than 0.0001, including the break in the drift term does not have any qualitative effect on the rest of the results. This finding is consistent with Basistha and Startz's (forthcoming) claim that information from a bivariate model provides enough cross-equation information to estimate the innovation variance-covariance matrix without the pile-up problem that can plague univariate estimates.[9] The baseline model in the discussion that follows includes the break in the drift term for real GDP.

3.2 The Permanent and Transitory Components of Real GDP

The estimates in Table 1 and the estimated permanent component of real GDP presented in Figure 1 clearly indicate something very different from a traditional "textbook" smooth trend. Two key results are immediately evident. First, movements in the permanent component for U.S. real GDP are highly variable. Second, innovations to the permanent component are significantly negatively correlated with innovations to the transitory component, rejecting the restriction of independent components.

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[9] The pile-up problem occurs when the Kalman filter places too little weight on the variance of the permanent innovation (Stock and Watson, 1998).

The estimate of the permanent component, shown in Figure 1, looks very similar to the real GDP series. This result is common to the Beveridge-Nelson (1981) decomposition of U.S. real GDP, and the findings of MNZ and Morley (2007a). The shading in Figure 1 represents the NBER-dated recessions, which appear to correspond to significant negative permanent movements. The transitory movements are the difference between the series and the permanent component. These movements do not correspond to the traditional view of a "cycle," and in particular do not resemble the NBER business cycle. Instead, the results provide some support for models where the economy's movements are driven by real shocks with temporary adjustment to those shocks (e.g. Prescott, 1987, and Kydland and Prescott, 1982).

MNZ tested the restriction of zero correlation between the permanent and transitory innovations in U.S. real GDP in the univariate case, and found that they could reject Clark's (1987) zero-correlation restriction. By contrast, Perron and Wada (2005), found that including a one-time break in the drift of real GDP results in estimates similar to those of Clark. The bivariate model presented here settles the issue by encompassing all of the previous models and implying a significant negative correlation, even after allowing for a one-time structural break in the drift term for real GDP.

3.3 The Permanent and Transitory Components of the Unemployment Rate

Figure 2 presents the estimate of the permanent component of the U.S. unemployment rate along with the unemployment rate series. Similar to real GDP, most of the movement in the U.S. unemployment rate appears to arise from permanent shocks. At the beginning of an NBER-dated recession recession, the unemployment rate starts to rise, but the estimates suggest that the permanent level of the unemployment rate series rises faster in anticipation of future increases in the unemployment rate. The estimates in Table 1 also suggest that movements in the permanent component for the unemployment rate are highly variable. In particular, the standard deviation of the permanent innovation is larger than the standard deviation of the first difference of the series. Moreover, the ratio of the standard deviation of permanent innovations to that of temporary innovations ($\sigma_{\eta u}/\sigma_{\varepsilon u}$) is slightly above one. In addition, the estimates of the autoregressive parameters are relatively small, suggesting that most of the persistence of the unemployment rate is captured in the permanent component. Finally, the estimates indicate that the correlation between permanent and temporary innovations for the unemployment rate is negative, and significantly different from zero, as was also found for real GDP.

3.4 The Relationship between Output and Unemployment: Cross-Series Correlations

The basic connection between output and the unemployment rate comes through Okun's Law (Okun, 1962) which suggests that an increase in transitory output is accompanied by a decrease in transitory unemployment. There is no theoretical reason to believe these two series are cointegrated, nor is there empirical support for cointegration, at least for the U.S.[10] Theories do exist, however, which suggest the existence of additional non-zero correlations between the innovations to the unobserved components of output and the unemployment rate (e.g. Dreze and Bean, 1989). An attractive feature of the model developed in this paper is its ability to consider such relationships between integrated time series even if they are not cointegrated. The following sub-sections will focus on the relationship between the transitory components, i.e. the traditional Okun's coefficient, as well as the relationship between the permanent components.

3.4.1 The Relationship between the Transitory Components

Okun's Law suggests that the *transitory* components of output and the unemployment rate should be negatively correlated. The results presented in the previous two sections, however, indicate that most of the fluctuations in both real GDP and the unemployment rate

[10] The Johansen (1991, 1995) test indicates no cointegration for the data used in this paper.

appear to be due to movements in the *permanent* components. Nevertheless, it is still important to consider the relationship between their transitory components. First, this estimate of Okun's coefficient can be compared with others in the literature. Second, if money is neutral in the long run, it is only the transitory components that can be affected by monetary policy. Understanding the relationship between these components thus remains important for understanding the effects of monetary policy.

Okun (1962) suggested an empirical relationship between output and the unemployment rate which can be represented as:[11]

$$y_t - y_t^* = \lambda(u_t - u_t^*) + v_t \tag{4}$$

where it has become common to interpret ($y_t - y_t^*$) and ($u_t - u_t^*$) as the transitory components of output and the unemployment rate respectively, and v_t represents a random error. In general we expect there to be an inverse relationship between output and the unemployment rate so the estimate of λ should be negative.

In order to compare the results of this paper with more traditional estimates of Okun's coefficient, we must relate the estimated correlations from Table 1 with the regression coefficient (λ) from equation (4). Since we cannot reject the hypothesis that the autoregressive coefficients are the same for GDP and the unemployment rate,[12] we can rewrite (4) by substituting in the innovations to transitory real GDP and transitory unemployment (which are denoted ε_{yt} and ε_{ut} respectively):

$$\varepsilon_{yt} = \lambda\varepsilon_{ut} + (1 - \phi_1 L - \phi_2 L^2)v_t,$$

[11] It is common to assume that all temporary shocks to the unemployment rate also affect real GDP, but there may be additional temporary shocks that affect real GDP but not the unemployment rate. Thus the transitory component of real GDP is in general on the left hand side of the equation. There have been analyses done, however, with the reverse relationship. See Barreto and Howland (1993) for an in-depth discussion of this issue. Reversing the order, however, does not change the main conclusions of the analysis here.

[12] Testing the restriction, based on equation (3), that $\phi_{1y} = \phi_{1u}$ and $\phi_{2y} = \phi_{2u}$, the p-value is 0.20.

where L is the lag operator and where $\phi_1 \equiv \phi_{1y} = \phi_{1u}$ and $\phi_2 \equiv \phi_{2y} = \phi_{2u}$.

Assuming that ε_{yt} and ε_{ut} are jointly normally distributed and that ν_t is an independent normal random variable, we find that $\lambda = \rho_{\varepsilon y \varepsilon u} \cdot \sigma_{\varepsilon y} / \sigma_{\varepsilon u} = -1.4$ (SE: 0.1). This estimate implies that a 1% decrease in transitory unemployment corresponds to a 1.4% increase in transitory real GDP.[13]

Although this estimate is below the 2% consensus estimate (Grant, 2002), it remains within the range of estimates, which vary between 3% (Okun, 1962) and 0.67% (Prachowny, 1993).[14] Previous estimates of Okun's coefficient, however, have in general been based on independently estimated transitory components. In a second step these estimated transitory components are regressed one on the other in order to estimate Okun's coefficient. This traditional method has two drawbacks. First, since the two components are correlated, it is more efficient to jointly estimate the cyclical components. Second, if the measurement error in the independent variable is correlated with the measurement error in the dependent variable, then OLS is biased and inconsistent.[15] Therefore, we should use the estimate of the correlation instead of the correlation of the estimates.

As an example, the univariate MNZ model was applied to simulated data where the true data generating process is the multivariate unobserved components model with the parameter

[13] It is important to note that if the two cycles are not perfectly negatively correlated, then the inverse of λ is not Okun's coefficient in terms of a shock to cyclical GDP affecting the unemployment rate (Barreto and Howland 1993). In the U.S. case, however, we cannot reject the restriction that the temporary innovations to GDP and the unemployment rate are perfectly negatively correlated. Estimating the correlation, the point estimates indicate that a 1% decrease in transitory GDP corresponds to a 0.7% increase in permanent unemployment, which is the same as the inverse of λ.

[14] This value is very similar to what Attfield and Silverstone found for the U.K. For their data, Attfield and Silverstone (1998), find that the series are cointegrated. Exploiting the cointegrating relationship, they find an Okun's coefficient of -1.45. The Johansen (1991, 1995) test, however, indicates no cointegration for U.S. data.

[15] Optimal estimates of the components do not necessarily have the same correlations as the estimates of the correlations. See the discussion of this issue in MNZ, and Oh, Zivot, and Creal (2007), and Morley (2007b).

estimates from the first column of Table 1. Regressing the estimated transitory component of GDP on that of unemployment resulted in a coefficient of -0.08 instead of the true value of -1.4.

3.4.2 The Relationship between the Permanent Components

The relationship between the permanent innovations of output and the unemployment rate can be examined in a way similar to the traditional Okun's coefficient. Let β represent "Okun's coefficient for permanent movements," such that $\beta = \rho_{\eta y \eta u} \cdot \sigma_{\eta y} / \sigma_{\eta u} = -2.0$ (SE: 0.1).[16] If there were no correlation between the permanent innovations of output and the unemployment rate, as was assumed in Clark's (1989) model, then β would be zero. Instead the estimates presented in Table 1 indicate a negative relationship, similar to that of transitory unemployment and output, but almost exactly matching the modern consensus estimate of Okun's coefficient. This is not completely surprising considering the estimates of the model also suggest that most business cycle fluctuations are due to movements in the permanent components of these two series.[17]

3.5 Sensitivity of the Estimates

Two additional features of the U.S. economy need to be considered before concluding. First, does the reduction in the volatility of major macroeconomic variables, known as the "Great

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[16] Note that the Johansen (1991, 1995) test indicates no cointegration for U.S. data. If there were cointegration in this bivariate system, $\rho_{\eta y \eta u}$ would equal one in absolute value. As with the regular Okun's coefficient, this calculation again assumes that all permanent shocks to the unemployment rate also affect real GDP, but there may be additional permanent shocks that affect real GDP but not the unemployment rate. If we were to reverse the relationship, we would have that a 1% decrease in permanent GDP corresponds to a 0.5% increase in permanent unemployment.

[17] If studies that employ trend-cycle decompositions that generate smooth trends mistakenly include permanent movements in the transitory component, it may bias upwards their estimate of Okun's coefficient for the temporary movements. For example, the Hodrick-Prescott (1997, hereafter HP) filter results in a smoother trend component than found here when its smoothing parameter is set to 1600, as is standard for quarterly data. When the HP filter is applied to the data used for this application, the estimated traditional Okun's coefficient is -1.9. Similarly, when the HP filter is applied to simulated data where the true data generating process is the unobserved components model with the parameter estimates from the first column of Table 1 (where we know the coefficient is -1.4), the estimated Okun's coefficient is -2.0.

Moderation" affect the results? Second, what is the impact of alternative specifications for the stationarity properties of the unemployment rate?

3.5.1 The Great Moderation

U.S. output growth appears to have experienced a significant decrease in volatility in the early to mid-1980s. This "Great Moderation," as it has come to be known, was discovered initially by Kim and Nelson (1999) and McConnell and Perez Quiros (2000) and has since been confirmed by many others. It has also been observed in other macroeconomic variables, including the unemployment rate (Sensier and van Dijk, 2004). The consensus in the literature is that the reduction in volatility occurred as a structural break in the first quarter of 1984 for U.S. GDP, and Sensier and van Dijk (2004) give a similar break date for the unemployment rate. In order to capture the volatility reduction in a parsimonious way, two additional "proportional parameters" were added: one for the unemployment rate and one for real GDP. Each parameter is a scalar proportional change in the variances and covariances (holding the within-series correlation constant) for each series. Allowing for this structural break in the first quarter of 1984 does significantly improve the fit of the model, but the results discussed in the previous sections remain the same. The estimates suggest that the two series each experienced essentially the same-sized reduction in the standard deviation of their innovations, approximately 50 percent. Furthermore, we cannot reject the hypothesis that both series experienced the same-sized reduction. Since the Okun's law coefficients depend on the cross-series ratios ($\lambda = \rho_{\varepsilon y \varepsilon u} \cdot \sigma_{\varepsilon y}/\sigma_{\varepsilon u}$), and the estimates suggest these ratios remain unchanged, the Okun's law coefficients appear to be unaffected by the Great Moderation.

3.5.2 Alternative Specifications for the Unemployment Rate

This paper has assumed that the unemployment rate contains a random walk component. This assumption is supported by conventional unit root tests which do not reject the presence of a unit root in the U.S. unemployment rate at the 10% level. As additional support for a variable permanent component for the U.S. unemployment rate, Table 1 shows that the estimates imply a large variance for the innovation to the permanent component of the unemployment rate. Stock and Watson (1998) suggest that if the true variance were very small, the estimate may be biased towards zero. Because the estimated variance is large, these results suggest that it is inappropriate to assume that there is a fixed natural rate of unemployment over the sample.

Nevertheless, alternative specifications might be worth considering. For example, Blanchard and Quah (1989) assume that the unemployment rate is stationary in the main specification of their structural VAR. It may also be that the unemployment rate is stationary once a structural break is taken into consideration. For example, Papell, Murray, and Ghiblawi (2000) find that allowing for a level shift in the U.S. unemployment rate in 1974 (using annual data) results in the rejection of the unit root.

In order to investigate the role of assumptions about the stationarity of the unemployment rate, two partial unobserved components models were estimated. The first model simply assumes that the variance of the permanent innovation to the unemployment rate is zero. Although the distribution is nonstandard, the likelihood ratio test statistic is large (24.94) when compared to the full model. Thus it would seem reasonable to reject the assumption that the unemployment rate follows an unchanging stationary process.

The second partial unobserved components model is similar to the first, but it also allows for a level break at an unknown break date in the unemployment rate. The estimates of this model suggest that there is one significant structural break in the unemployment rate around the first quarter 1975. Further testing indicated that there was no second significant break. Imposing a structural break to capture the level shift in the unemployment rate in the full model improved the fit of the full model by capturing a large outlier, but the remaining estimates (including the large estimated variance for the permanent innovations to the unemployment rate) are remarkably robust to this break. As before, the distribution is nonstandard, but the likelihood ratio test statistic is again large (16.21) when comparing the partial UC model to the full model where both include the level shift in the unemployment rate. Thus it appears that the unemployment rate experiences more frequent permanent movements than can be captured with a structural break.

Despite the evidence against the partial models, it should be noted that the results from estimating the partial models for the U.S. are substantially different from the estimates from the full model. In particular, the results suggest that the unemployment rate and the transitory component of real GDP are almost perfectly negatively correlated, i.e. the transitory component of real GDP is embodied by the unemployment rate. Thus Blanchard and Quah's finding of a large transitory component in real GDP appears to arise from their assumption that the unemployment rate is stationary.[18] Again, however, the results presented in this section suggest that such an assumption is not appropriate for the U.S. data.

[18] An alternative model that finds a large output gap is Basistha and Nelson's (2007) correlated unobserved components model of GDP, inflation, and the unemployment rate. The primary difference between their model and the one presented here is the inclusion of a forward-looking New Keynesian Phillips curve equation. In particular, they reduce the number of shocks by two as compared to a general 3-series model by including the output gap in both the inflation and unemployment rate equations. This reduction in the number of shocks is similar in spirit to the Blanchard and Quah assumption which also reduces the number of shocks.

4 Conclusion

This paper jointly estimates the permanent and transitory movements in U.S. output and the unemployment rate as well as the relationships between them. The estimated components, assuming both series have random walk components, suggest that both real GDP and the unemployment rate have highly variable movements in their permanent components that look similar to the series themselves. In addition, the innovations to the permanent component and the transitory component are negatively correlated for both output and the unemployment rate. This suggests that it would be inappropriate to treat these components as independent. Finally, the negative correlation between the permanent innovations to real GDP and the unemployment rate indicates that real GDP and the unemployment rate are even more strongly linked through their permanent movements than through their transitory movements.

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Table 1: Maximum Likelihood Estimates

Description	**Parameter**	**No Break Estimate (Standard Error)**	**1973 Break Estimate (Standard Error)**
Log likelihood value	*llv*	-277.0406	-268.6080
Real GDP			
S.D. of Permanent Innovation to Real GDP	$\sigma_{\eta y}$	1.4534 (0.1931)	1.4109 (0.1909)
S.D. of Temporary Innovation to Real GDP	$\sigma_{\varepsilon y}$	0.9620 (0.1637)	0.9131 (0.0843)
Correlation between Real GDP Innovations	$\rho_{\eta y \varepsilon y}$	-0.8566 (0.0531)	-0.8484 (0.0474)
Real GDP Drift 1947 – 1972	μ_1	0.8421 (0.0347)	0.9878 (0.0401)
Real GDP Drift 1973 – 2005	μ_2		0.7361 (0.0342)
Real GDP 1st AR parameter	ϕ_{1y}	0.7431 (0.1184)	0.7183 (0.0996)
Real GDP 2nd AR parameter	ϕ_{2y}	-0.2656 (0.1022)	-0.2754 (0.0602)
The Unemployment Rate			
S.D. of Permanent Innovation to Unemployment Rate	$\sigma_{\eta u}$	0.6889 (0.0795)	0.6856 (0.0966)
S.D. of Temporary Innovation to Unemployment Rate	$\sigma_{\varepsilon u}$	0.6462 (0.0472)	0.6434 (0.0224)
Correlation between Unemployment Innovations	$\rho_{\eta u \varepsilon u}$	-0.9666 (0.0096)	-0.9662 (0.0133)
Unemployment Rate 1st AR parameter	ϕ_{1u}	0.6972 (0.0696)	0.7012 (0.0665)
Unemployment Rate 2nd AR parameter	ϕ_{2u}	-0.1737 (0.0347)	-0.1791 (0.0479)
Cross-Series Correlations			
Correlation: Permanent Unemp./Permanent GDP	$\rho_{\eta y \eta u}$	-0.9330 (0.0146)	-0.9609 (0.0209)
Correlation: Permanent GDP/Transitory Unemp.	$\rho_{\eta y \varepsilon u}$	0.9397 (0.0166)	0.9401 (0.0503)
Correlation: Permanent Unemp./Transitory GDP	$\rho_{\eta u \varepsilon y}$	0.8501 (0.0533)	0.9095 (0.0433)
Correlation: Transitory GDP/Transitory Unemp.	$\rho_{\varepsilon y \varepsilon u}$	-0.9562 (0.0212)	-0.9779 (0.0156)

Figure 1: Real GDP and the Estimated Components

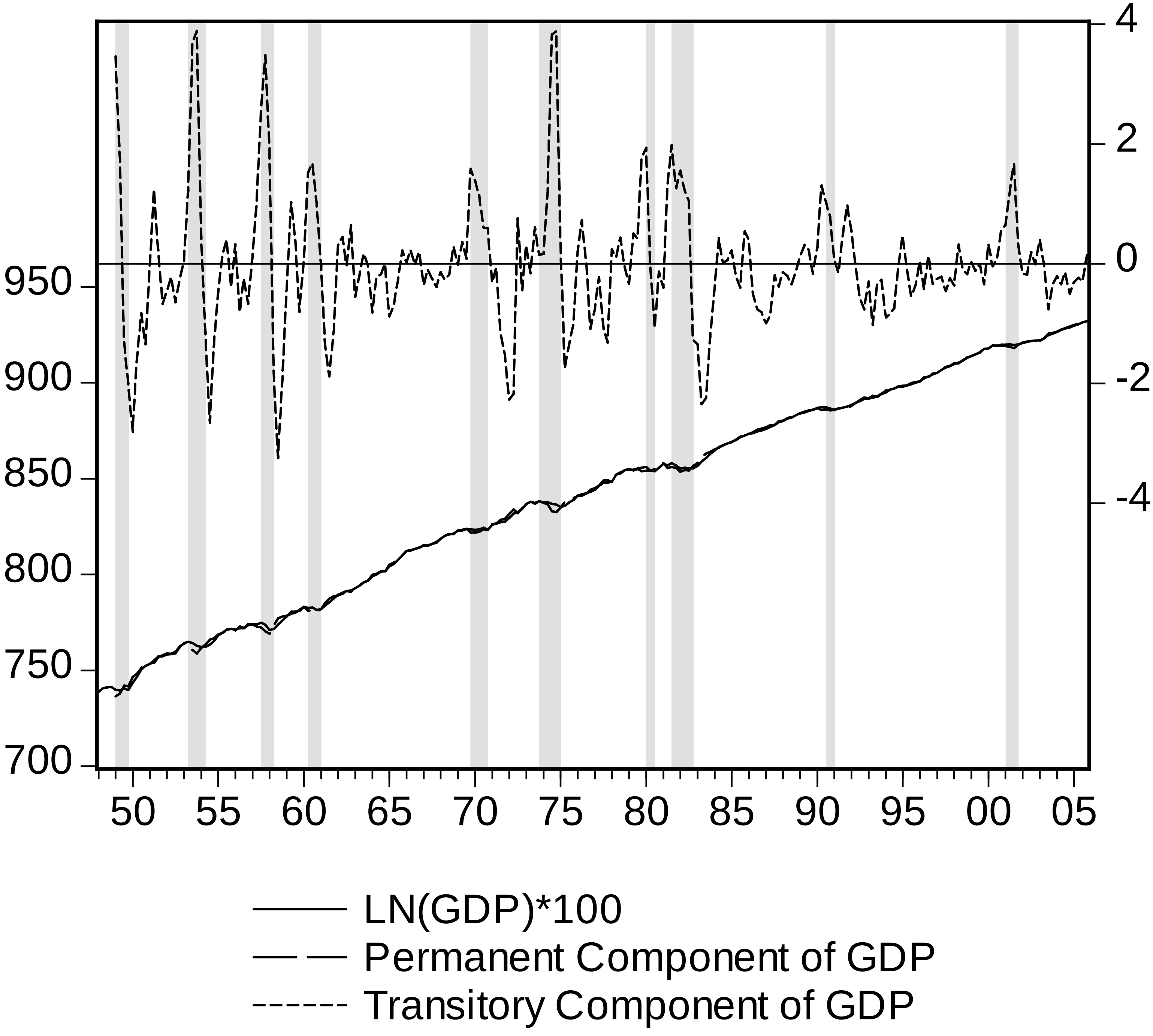

Figure 2: The Unemployment Rate and the Estimated Components