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The inflation-unemployment trade-off and the significance of the interest rate: some evidence from the United Kingdom

Abstract

Banking practices of variable loan rates are an important consideration in macroeconomics. This article argues that any empirical study on the inflation-unemployment trade-off requires the inclusion of the real interest rate in the model as any changes in the interest rate affect the capital use by the firms leading to an effect on the level of employment in the economy. To test the validity of this argument an empirical model is developed which includes the real interest rate as one of the explanatory variables in addition to inflation and real wages. The model is estimated using the annual time series data from the United Kingdom for the period from 1961 to 2005. The estimated results indicate that the interest rate variable is indeed significant in explaining the inflation-unemployment trade-off. A Wald test conducted also suggests that exclusion of real interest rate leads to a misspecification problem.

Keywords: bank variable loan rates, Phillips Curve, aggregate supply curve, Great Britain, the United Kingdom, short run, long run.
JEL Classification: E12, E24, E40.

Introduction

The Phillips Curve earned its appellation from A. W. Phillips seminal work in *Economica* (1958, 1961). Though this sometimes-perceptible inverse relationship between unemployment and inflation has intrigued many economists (Snowdon and Vane, 2005). Explanations about why short-run Phillips curves could exist have focused on misperceptions of both the real wage rate and the demand for goods and services. In this paper we show that any empirical test work on the unemployment-inflation trade-off using Phillips Curve requires the inclusion of the real interest rate. Based on earlier works (Gentle and Novak, 1995; Gentle et.al., 2005, 2007) we test our hypothesis using data from the United Kingdom. The theoretical background and graphical analysis are presented in the first section of this paper. The model, its estimation and the discussion of the findings are presented in the second and third sections. The last section presents the summary and conclusion.

1. Theoretical background

New-Keynesians Mankiw (1989, 1993, 2002) and Gordon (1990, 2009) point out that wages and prices can adjust slowly, thus, affecting the macroeconomic fluctuations. The Phillips Curve changes are a macroeconomic fluctuation. Furthermore, Mishkin (2006) notes that the New Keynesians and other Schools of thought agree that unanticipated government policy will have the most effect on the economy; however, the New Keynesians make it very clear that anticipated policy may also affect the economy, specifically making the Short Run Phillips Curve (SRPC) more possible. Mankiw (2006) and Gordon (2009) describe the Phillips Curve as the short-run aggregate supply curve (SRAS). Gordon explains that positive supply shocks cause the SRPC to shift downward and negative supply shocks cause the SRPC to shift upward. In this paper's context we are solely looking at a model where labor inputs are being used in a complementary way with capital. We include real wages (the real cost of labor) and real interest (the real cost of capital) in the model. Business and Consumer confidence uncertainties, characteristic of the New Keynesian model, can also lead to the economy more likely operating on the SRPC (Mankiw, 2006; Gordon, 2009). Using the Phillips Curves in Figure 1, assume that the economy is initially operating at point A on $SRPC_0$. Then the difference between μ_2 and μ_1, an unanticipated inflation creates a money illusion leading the economy to move from point A to point B. When economic agents realize that they did not accurately anticipate the inflation rate, the agents will make an adjustment. At that point the economy shifts to point C on the LRPC. Both temporary misperceptions regarding employees' knowledge of the real wage and entrepreneurs' and managers' knowledge of the real net present value (NPVr) of investment on capital allow the economy to operate on an SRPC. After a period of time, labor agents realize the increase in their cost of living compared to a decline in real wage. Concurrently, entrepreneurs and managers realize the increase in the cost of capital leading to a decrease in the NPVr for capital/labor complementary projects. At the same time, managers and entrepreneurs also realize that an increase in the demand for their products has not been sustained. At this time, the ability of policy makers to use money illusion to operate on $SRPC_0$ is lost. Therefore, the economy comes back to natural unemployment rate on the LRPC, due to some workers opting for unemployment, some capital/labor complementary projects being curtailed, with attendant layoffs and a decrease in aggregate demand that characteristically happens when the real interest rate is increased (Phelps, 1967, 1968; Gentle and Novak, 1995; Gentle et al., 2005, 2008; and Gordon, 2008).

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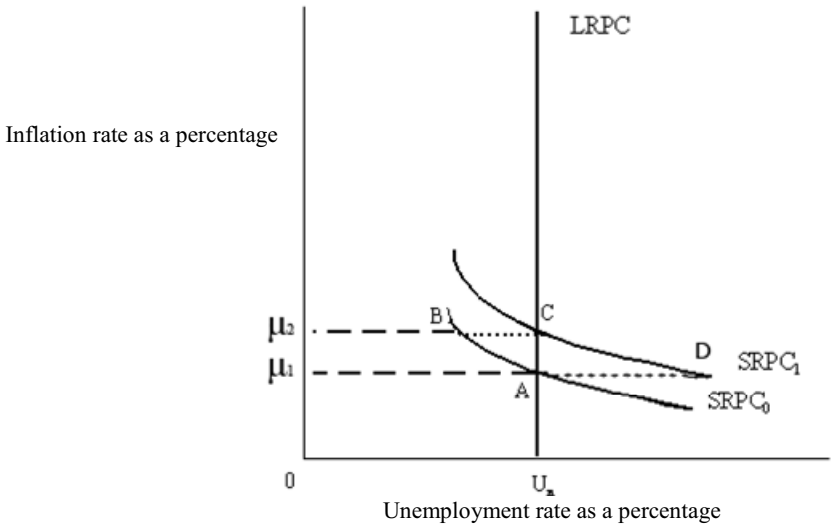

Fig. 1. The Phillips curves

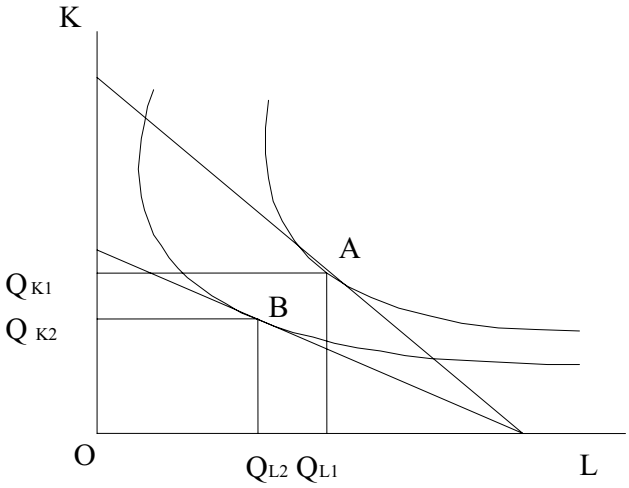

Fig. 2. Effects of real interest rate change on capital (K) and labor (L) use

The isocost curves and isoquants in Figure 2, show the effect of a change in the real interest rate on the capital and labor inputs used by a firm and its output. Suppose initially the firm is operating at point A and demonstrating an increase in the interest rate (the price of capital), *ceteris paribus,* the isocost line will shift inward leading the firm to operate at point B with lower output. An examination of Figure 2 reveals that the firm now reduces both the use of capital inputs, due to the higher cost of capital, and the use of labor input because less complementary capital input is being used due to the lower level of output. Thus, the unemployment rate may increase.

2. Empirical framework

Variable interest rates are common in the United Kingdom (Homer and Sylla, 1996). This analysis is based on the annual time series data from the United Kingdom for the period of 1961-2005 (see Appendix). A detailed historical review of the United Kingdom's economy during those years is beyond the scope of this paper. However, some facts are worth noticing at this point. In 1979, one of the chief aims of Margaret Thatcher's political party was to bring down the inflation rate, by temporarily raising interest rates. In doing so, the British economy was taken onto a Short-Run Phillips Curve (SRPC). The United Kingdom was put through high unemployment for some time as the inflation rate was being tamed. Ultimately, the nation's economy was brought back to the Long-Run Phillips Curve (LRPC) (Dell, 1996; Carlin and Sokice, 2006). The United States was put through some similar high interest rates and higher than normal unemployment during the disinflation policy of Paul Volker, in the early 1980s. Real wage changes are also a factor. This also resulted in some temporary operating on the SRPC as inflation was lowered during the same general time as it was lowered in the United Kingdom (Gordon, 2009). A government policy that purposely puts the country through such a deflationary time, takes the nation onto an SRPC to the right side of the LRPC temporarily, as in the direction of point D of Figure 1. Eventually, the economy will settle back on the LRPC (Gordon, 2009).

The following model provides the conceptual idea on how U_d, deviation of unemployment from its natural rate, relates to inflation rate (μ), real interest rate (r) and real wage (W).

$$U_d = f(\overset{-}{\mu}, \overset{+}{W}, \overset{+}{r}). \quad (1)$$

The coefficient associated with inflation rate is expected to have a negative sign, while the coefficients of real wage and real interest are expected to be of positive signs, *a priori*. Since all the variables in the model are in terms of percentage change, for the sake of consistency, we have also converted the real wage (W) in terms of percentage change in real wage (w). In other words, the real wage (W) has also been converted into growth form. Assuming that all the macroeconomic adjustments are completed in two years for each explanatory variable, their lag is also included. In order to better understand the relationship between the unemployment and its explanatory variables, we developed the following four models.

Model 1: $$U_d = \beta_0 + \beta_\mu \mu + \beta_{\mu_{-1}} \mu_{-1} + \varepsilon_t, \quad (2)$$

Model 2: $$U_d = \beta_0 + \beta_\mu \mu + \beta_{\mu_{-1}} \mu_{-1} + \beta_w w + \beta_{w_{-1}} w_{-1} + \varepsilon_t, \quad (3)$$

Model 3: $$U_d = \beta_0 + \beta_\mu \mu + \beta_{\mu_{-1}} \mu_{-1} + \beta_r r + \beta_{r_{-1}} r_{-1} + \varepsilon_t, \quad (4)$$

Model 4: $$U_d = \beta_0 + \beta_\mu \mu + \beta_{\mu_{-1}} \mu_{-1} + \beta_w w + \beta_{w_{-1}} w_{-1} \beta_r r + \beta_{r_{-1}} r_{-1} + \varepsilon_t. \quad (5)$$

As indicated above, μ, w, and r, respectively, represent the rate of change in the inflation rate, the real wage, and the real interest rate, and ε_t is the random error term. Among all the models mentioned above, equation (2) represents the traditional Phillips Curve and equation (5) represents the model proposed by this paper.

3. Estimation results

Table 1 presents the summary statistics of all the variables used in the estimation of our model. All of variables are in the percentage term. Of interest, the average unemployment rate across the whole sample period is 5.7%; in the meanwhile the mean inflation rate is 6.2%, which is much higher than the macro-control target (2%) set by Britain's central bank currently. The average growth rate (mean and median), the real wage rate and real interest rate are greater compared to the change in other variables in the model.

Table 1. Summary statistics of key variables

	U	μ	w	R
Mean	0.057	0.062	0.089	0.088
Median	0.052	0.047	0.078	0.084
Max	0.118	0.238	0.289	0.149
Min	0.014	0.007	0.021	0.045
Std. dev.	0.033	0.055	0.056	0.030
Num	45	45	45	45

Note: The definitions of key variables are given in the Appendix.

Before estimating the equations mentioned above, Spearman and Pearson correlations are calculated in order to obtain some preliminary knowledge about the relationship between dependent variable and explanatory variables. The calculated correlation coefficients are reported in Table 2. Although the estimated correlation coefficients indicate that the association between unemployment and inflation is negative, they are not statistically significant. In contrast, the real interest rate is positive and statistically significantly correlated with the unemployment rate, which is consistent with our argument. The real wage growth rate, however, is negatively associated with the unemployment rate, which is at odds with our expectation.

Table 2. Correlations of key variables

	U	W	M	R
U	1.000	-0.292*	-0.068	0.338**
W	-0.317**	1.000	0.745***	0.617***
μ	-0.099	0.745***	1.000	0.863***
r	0.332**	0.601***	0.798***	1.000

Note: ***, ** and * indicate the values are significant at 1, 5 and 10% level of significance. The upper triangle presents the Spearman correlation between key variables, while the lower triangle shows the Pearson correlation among key variables. The definitions of key variables are given in the Appendix.

Table 3. Estimation of the models

Variable	Model 1	Model 2	Model 3	Model 4
Constant	0.059***	0.075***	-0.027*	-0.018
	(8.647)	(8.548)	(-1.795)	(-1.057)
μ	-0.297**	0.058	-0.464***	-0.272**
	(-2.657)	(0.369)	(-4.884)	(-2.417)
μ_{-1}	0.282**	0.265**	-0.185**	-0.214**
	(2.496)	(2.252)	(-2.334)	(-2.298)
w		-0.204**		-0.188*
		(-2.262)		(-1.927)
w_{-1}		-0.219*		-0.054
		(-1.832)		(-0.612)
r			-0.159	0.127
			(-0.777)	(0.389)
r_{-1}			1.566***	1.301***
			(6.610)	(3.743)
Adj R^2	0.056	0.119	0.688	0.715
F-stat	2.279	2.446	24.654	18.957
Obs.	44	44	44	44

Note: ***, ** and * indicate the values are significant at 1, 5 and 10% level of significance. The numbers in parentheses are the corresponding t-statistics for estimated coefficients. Models

1, 2, 3, and 4 are different combination of inflation rate, real interest rate, and real wage to explain the unemployment rate. The definitions of key variables are given in the Appendix.

The estimated results of Models 1, 2, 3, and 4 are reported in Table 3. As shown in the table, the contemporaneous effect of inflation is found to be negative and significant in Models 1, 3, and 4. The estimated coefficients suggest that a 1% increase in inflation rate lowers the unemployment by 0.297, 0.464, and 0.272 percent in the traditional (Model 1 and Model 3) and proposed model (Model 4), respectively. When it comes to the lagged term of inflation, such significant negative effect persists and is reinforced in Models 3 and 4; however, it reverses to significant positive in Models 1 and 2. The lagged effect is significantly positive presumably because overtime the agents in the economy change their behavior in accordance with the inflationary condition. The coefficient of wages and its lag carries a theoretically inconsistent sign. Although its lag is not so statistically significant relative to the inflation, the coefficient of contemporaneous effect rejects the null hypothesis at 10% significance level in our proposed model. In a growing economy with the increase in productivity, the demand for labor also may increase leading to higher wages and lower unemployment. In the traditional model both the coefficients of real wage and its lag are negative and significant as well.

The main focus of this study is the coefficient of interest rate. The lagged effect of a change in the interest rate *r* is positive and significant at the conventional level of significance (1%). Its contemporaneous effect, however, is insignificant at 10% level of significance. And these two terms keep positive consistently in the proposed model with respect to Model 3.

Table 4. The significance of different factors in Model 4

Hypothesis	$\beta_i=\beta_{i-1}=0$ (i=μ, w, r)			$\beta_i+\beta_{i-1}=0$ (i=μ, w, r)	
	Wald test	p-value		$\beta_i+\beta_{i-1}$	p-value
μ	5.108**	0.011		-0.485***	0.003
W	3.216*	0.052		-0.242**	0.018
r	24.512***	0.000		1.428***	0.000

Note: ***, ** and * indicate the values are significant at 1, 5 and 10% level of significance.

When we compare the goodness of fit of a traditional model (Models 2, 3, and 4) to the proposed model, we find that in Model 4 (equation 5) inclusion of the real interest rate and the wage growth rate produces highest predictive power (adjusted R^2 = 0.715). We also conducted a Wald test with null hypothesis that real interest rate is redundant variable. The results of this test are reported in Table 4. As seen in Table 4, the estimated F-statistics is 24.512, which is significant at the 1% critical level. This suggests that the exclusion of the interest rate variable would lead to a misspecification problem in the model. This finding further validates our proposition that any estimation of the Phillips Curve should also include the changes in the real interest rate, in addition to any changes in the real wage and inflation rates.

Summary and conclusion

This paper suggests that any analysis of a Phillips Curve should include the real interest rate, as well as inflation and the real wage rate because any changes in the real interest rate influence the labor input mix in the production process, which ultimately affects the level of employment in the economy. In order to justify this argument, an empirical model is developed, which includes the real interest rate as one of the explanatory variables in addition to inflation and real wages. The model is estimated using annual data from the United Kingdom between 1961 and 2005. The estimated result indicates that the interest rate variable is indeed significant in explaining the Phillips Curve. In order to see if the omission of the real interest rate leads to misspecification of the model, a Wald test for redundant variable is conducted. The estimated F-statistics indicates that exclusion of real interest rate indeed leads to a misspecification problem in the model. Significant coefficient of the real interest rate and misspecification problem due to the exclusion of real interest rate does support our proposition that any analysis of the Phillips Curve should include the real interest rate in addition to other variables such as inflation and real wages. Therefore, our research has added some information to what we believe that Robert Gordon (2006, 2009) and Gregory Mankiw (2006) have already been doing research on. The United Kingdom provides an especially interesting study, in view of its significance to the history of thought of Phillips Curve, since A.W. Phillips (1958, 1961) had chosen the United Kingdom as the place for his seminal work.

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Appendix. Data definition and sources

Variable	Definition	Sources
U	Unemployment rate	WDI
R	Nominal interest rate	WDI
μ	Inflation rate	WDI
r	Real interest rate $(R - \mu^e)$[1]	Estimated
W	Real wage rate[2]	WDI
w	Percentage change in W	Calculated
U_n	Natural rate of unemployment[3]	Estimated

Notes: 1. μ^e = expected rate of inflation estimated regressing inflation on its past values. 2. Nominal wage adjusted for changes in the price level. 3. Estimated using following Douglas et al. (1997). WDI = World Development Indicators from the World Bank.