The Phillips Curve: Forward-Looking Behavior and the Inflation Premium

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Abstract: We use the inflation premium—the difference between nominal and real interest rates—as a proxy for expected inflation in the context of the New Keynesian Phillips Curve. Using data from inflation-indexed and nominal bonds we estimate a forward-looking Phillips curve for the United Kingdom over the period 1985-2004. The proposed model describes UK inflation dynamics considerably better than does the standard hybrid New Keynesian Phillips Curve under the assumption of rational expectations. In contrast with the findings in the rest of the literature we find that there still exists a tradeoff between inflation and the stance of the real economy, regardless of the empirical measure used. This relationship also persists in the period since the UK adopted inflation targeting as a framework for monetary policy.

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Key words: Phillips curve, inflation expectations, inflation premium, tradeoff between inflation and aggregate demand, real and nominal bonds.

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1. Introduction

"The connection between price inflation and real economic activity has been a central focus of interest to macroeconomists for much of the last century. It has likewise been a, if not *the*, central issue in the making of monetary policy." [1]—Benjamin M. Friedman.

Estimation of the Phillips curve tradeoff between inflation and output (or unemployment) is of considerable interest to both macroeconomists and policymakers. Following Gali and Gertler (1999) much work on this topic has been done within the framework of the New Keynesian Phillips Curve (NKPC), in which inflation is a function of expected future inflation, past inflation, and a measure of the "stance" of the real economy.[2] Expected future inflation is notoriously difficult to measure directly. Commonly, realized future inflation is used as a proxy; rational expectations are invoked, and estimation is conducted by the Generalized Method of Moments (GMM) or other instrumental variable method. To the extent that realized inflation does not closely track expectations, this procedure will have low power for achieving accurate estimates. To the extent that the assumption of short-run rational expectations fails, the procedure is biased.

We reassess the question of a short-run tradeoff between inflation and the real economy by proposing an alternative measure of expected inflation. By making use of unique data available for the United Kingdom during the period 1986-2004—the availability of both nominal and real yield curves over the last 20 years—we argue that the inflation premium is a useful proxy for expected inflation. The inflation premium is calculated as the difference between the nominal and real yield for a given maturity, and it is a market-based measure of inflation expectations with three attractive properties: (1) it is forward looking, (2) it is updated frequently (basically daily), and (3) it is easily available.[3]

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[1] These are the opening sentences written by Friedman in the introduction to Solow and Taylor (2001).
[2] The measures used vary widely, from traditional measures of the output gap, to output gap measures based on a general equilibrium model, and to measures of real marginal costs and labor shares.
[3] Scholtes (2002).

The relatively thick market for index-linked gilts in the UK makes possible the calculation of real rates, although data is not available for as short a maturity as is true for nominal bonds. The inflation premium measure is probably as good a measure of expected inflation as is possible to construct from existing markets. There is no a priori reason why realized inflation or the inflation premium should necessarily be the superior measure. Our results suggest that for the purpose of estimating the NKPC, the inflation premium is the better measure.

We begin by estimating the standard hybrid NKPC under the assumption of rational expectations using the inflation premium as an instrument. Using this approach, among others, Balakrishnan and Lopez-Salido (2002) have found that during the period in question for the United Kingdom there ceased to be any connection between inflation and the real economy. Our findings are completely in accord with the previous literature that estimated a NKPC for the UK over the period since 1985: future inflation plays a predominant role in explaining inflation dynamics and regardless of what proxy of the stance of the real economy one uses, there is no tradeoff between inflation and the real economy.

Next we hypothesize that economic agents adopt the inflationary expectations of the financial market as their own, or at least that the inflation premium is a useful proxy for inflationary expectations. Using the inflation premium we find that over the last 20 years there has been a consistent tradeoff between inflation and the stance of the real economy, regardless of which measure of the stance we use. This relationship remains intact even after 1992 when the Bank of England adopted inflation targeting as the framework for monetary policy.

The structure of the paper is as follows. Granger causality tests between the inflation premium and realized inflation are presented in section 2, together with a brief history of UK's experience with index-linked bonds. Section 3 introduces the basic formulation of the NKPC, and reviews the existing literature on NKPC, focusing on the studies for the United Kingdom. We also summarize the issues with GMM estimation of the NKPC as reported in the recent literature. In section 4, we present estimates of the forward-looking Phillips curve for the UK over the period 1986-2004 and conduct a robustness check of our results. Section 5 concludes.

2. Inflation-linked securities and inflation expectations

The United Kingdom has the longest experience among large, industrial countries with issuing index-linked securities. Her Majesty's Treasury first started issuing index-linked gilts in March 1981, the reasons behind this action being "to reinforce belief in the government's anti-inflation policy, to reduce the cost of funding by saving the inflation risk premium and to improve monetary control by increasing the flexibility of funding."[4] By 2003 the inflation-uplifted amount outstanding in the inflation-linked gilt market (about £78 billion) was more than 25% of the size of the total outstanding debt stock (£280 billion). As emphasized by Scholtes (2003), "Apart from the UK Treasury, no other major government issuer currently has a sufficient number of outstanding index-linked bonds to permit estimation of a well specified real yield curve."

The Bank of England uses a methodology based on cubic smoothing splines[5] in order to fit nominal and real yield curves to observed nominal and real bond yields, and publishes the entire yield curve data for any given business day since 1985. This provides almost 20 years worth of data on both spot and instantaneous forward nominal rates ($i_t^{s,M}$ and $i_t^{f,M}$) and real rates ($r_t^{s,M}$ and $r_t^{f,M}$) for any given maturity.[6] For example, with maturity measured in quarters, $i_t^{s,4}$ represents the interest rate on a loan contracted at time t that matures at $t+4$, and , $i_t^{f,4}$ represents the interest rate locked in at time t on an overnight loan that occurs at time $t+4$. Assuming that one has information on both the nominal rate (i_t^M) and the real rate (r_t^M) for a given maturity, one can calculate the inflation

[4] See Deacon, Derry and Mirfendereski (2004), p. 130.
[5] The methodology used by the Bank of England in order to fit the yield curves is described in detail in Anderson and Sleath (2001).
[6] In practice, the shortest available maturity is different for nominal and real spot rates. Nominal spot rates are available starting from a maturity of 1 month, while real spot rates are only available with considerable gaps in the series starting with a maturity of 25 months. The BOE states that: "we only provide data at maturities where we think the curve can be fitted so that it is stable and meaningful. … This is usually a problem at short maturities where we require more information because we expect the short end of the yield curve to exhibit the greatest amount of structure." (See http://www.bankofengland.co.uk/statistics/yieldcurve/main.htm, Notes on the Bank of England Yield Curves).

premium ($\pi_t^{p,M}$), as the difference between the nominal and the real interest rate. Since nominal rates incorporate inflation expectations, this inflation premium can be thought of as an approximation for the average expected annual inflation rate over the lifetime of the bond.[7] Thus, for the United Kingdom inflation expectations proxies can be calculated as the spot or forward inflation premiums ($\pi_t^{p,s,M}$ and $\pi_t^{p,f,M}$).

The relevance of the inflation premium as a market based measure of inflation expectations is emphasized by Cedric Scholtes, of the Bank of England, who points out that inflation expectation proxies derived from index-linked bonds have the advantages of being "forward-looking, timely, and frequently updated for a range of maturities."[8] Using the inflation premium as a proxy for inflation expectations is equivalent to allowing for the possibility that economics agents follow heuristics in the formation of expectations, a possibility clearly acknowledged by the Governor of the Bank of England, Mervyn King, who states that "Rational optimizing behavior is in many situations too demanding, and actual decisions may reflect the use of heuristics."[9] The inflation premium also fulfills the two basic requirements for a useful rule of thumb: It is easy to compute and it is frugal in its data requirements.

What is the empirical evidence regarding the information content of the inflation premium about future inflation? Scholtes (2002) has shown that the two-year inflation premium is more closely related to two-year-ahead inflation than survey based measures of expectations.[10] Using data on UK real and nominal bonds, Risa (2001) found that for medium maturity bonds, most of the variability in the difference between nominal and real yields is driven by changes in expected inflation. Our results are consistent with previous findings. Figures 1 and 2, present realized inflation and the spot inflation premium calculated as the difference between the nominal and real spot rate for a

[7] The inflation premium is only an approximation for expected inflation because the premium may include a time varying risk factor (see Ang and Bekaert (2005), Risa (2001) or Evans (1998)).
[8] See Scholtes (2002).
[9] Mervyn King (2005).
[10] Barclay Basix collects information on survey inflation forecasts in the UK. However, this information is not readily available to the public.

maturity of 4 years (16 quarters).[11] We chose the maturity of 16 quarters, because it is the shortest maturity for which the real rate is available without any missing values from January 1985 to December 2004. Figure 1 includes the quarter-to-quarter inflation rate, while Figure 2 includes the inflation rate since the corresponding period of the previous year. In both cases, there is a striking positive relationship between the actual inflation rate and the spot inflation premium.

To get an initial idea about the direction of "causality" we conducted Granger causality tests. In the test equations the inflation rate (inflation premium) is regressed on four of its own lags[12] and four lags of the inflation premium (inflation rate). The results of these tests are presented in Table 1, both for quarterly and annual inflation rate, for the period since the 1st quarter of 1986 to the 4th quarter of 2004. We cannot reject the null hypothesis that realized inflation does not Granger cause the spot or forward inflation premium. However, we can always reject at 1% significance levels the null hypothesis that the inflation premium, an approximation for expected inflation, does not Granger cause realized inflation.

[11] For the forward inflation premium the figures look very similar.
[12] Changing the number of lags does not influence the conclusion of this analysis.

3. Common Formulation and Literature Review

Since the influential paper by Gali and Gertler (1999) the hybrid specification of the New Keynesian Phillips curve (NKPC) has been widely used as a description of pricing behavior in macroeconomic models derived from micro-foundations. The widespread expression for the hybrid NKPC[13] is given by equation (1) and under the assumption of rational expectations, (2), one obtains the estimation equation presented in equation (3):

$$\pi_t = \gamma^b \pi_{t-1} + \gamma^f E_t \pi_{t+1} + \lambda x_t + \varepsilon_t \tag{1}$$

$$\pi_{t+1} = E_t \pi_{t+1} + \eta_{t+1} \tag{2}$$

$$\pi_t = c + \gamma^f \pi_{t+1} + \gamma^b \pi_{t-1} + \lambda x_t + v_t, v_t = \varepsilon_t - \gamma^f \eta_{t+1} \tag{3}$$

where $\gamma^b, \gamma^f, \lambda$ depend on underlying structural parameters.[14] π_t represents the quarter-to-quarter inflation rate and the variable x_t is a particular measure of aggregate demand pressures on inflation. For example, it can be a proxy of the output gap, computed as the deviation of RGDP from trend output (based on a quadratic trend or Hodrick-Prescott filter) or theory-based measures of potential output (see Nelson and Nikolov (2003)). In recent years, various authors argued that real marginal costs are not proportional to the output gap, and thus the focus shifted towards using labor (wage) share based measures of x_t (see Woodford (2001), Balakrishnan and Lopez-Salido (2002), Batini et al. (2000), Kara and Nelson (2002)). Another option is to use the unemployment rate, or the deviation of the unemployment rate from an estimate of the natural rate of unemployment as in the classical Phillips curve.

Since π_{t+1} is not observable at time t, equation (3) is usually estimated by the Generalized Method of Moments estimator (GMM) with correction of the covariance

[13] The pure forward-looking version of the NKPC is obtained by imposing the restriction $\gamma^b = 0$.

[14] These structural parameters are the inter-temporal discount factor, the degree of price stickiness, the degree of "backwardness" in price setting, the curvature of the production function and the elasticity of demand. For a detailed derivation of equation (1) see Gali and Gertler (1999).

matrix for high-order serial correlation. The instrument set typically includes four to six lags of inflation, the measure of the stance of the real economy, the spread between long-term and short-term interest rates, wage inflation, commodity prices, import and export prices, real exchange rate, etc. [15]

Variants of equation (3) have been estimated for a variety of countries (including the UK) and for a variety of periods. The empirical findings regarding estimates of the parameters of interest for the United Kingdom are often contradictory. They can be summarized based on the conclusions reached regarding the importance of the variables in equation (3).

With respect to the driving variable, x_t, Batini et al. (2000) find that over the period 1972-1999 there was a stable relationship between inflation and the labor share (as a measure of real marginal costs), but not between inflation and the output gap. Neiss and Nelson (2002) find a stable relationship both between inflation and unit labor costs (another proxy for real marginal costs) and between inflation and output gap for the period 1961-2000. The difference arises because of the alternative definitions of the output gap. Neiss and Nelson (2002) construct the output gap in a manner consistent with dynamic general equilibrium models, while Batini et al. (2000) employ measures of detrended output. In addition, Balakrishnan and Lopez-Salido (2002) and Kara and Nelson (2002), find that the relationship between marginal cost (or unit labor cost) and inflation disappeared in the mid-1980s. Thus, in the context of the NKPC for the United Kingdom the literature generally finds that during the last 20 years there has been no tradeoff between inflation and the stance of the real economy, especially in the case when the later is approximated by detrended output.

Most of the literature emphasizes one common point, namely that forward-looking behavior as captured by the coefficient on future inflation in the NKPC equation plays a major role in determining inflation dynamics for the United Kingdom. The estimates of

[15] The average total number of instruments included in such estimations is around twenty (in some cases even forty).

γ^f are highly significant and range between 0.6 and close to one.[16] For example, Balakrishnan and Lopez-Salido (2002) report estimates of γ^f ranging from 0.657 to 0.963, depending on the exact specification of the estimation equation and the measure of the marginal cost that is used.

The existing literature also points out various additional variables to be included in the estimation equation (3). Batini et al. (2000) focus on the influence of current and expected employment growth rates on inflation, while Kara and Nelson (2002) stress the role of the real exchange rate and Balakrishnan and Lopez-Salido (2002) call attention to the importance of other variables that capture the openness of the UK economy. In contrast, Neiss and Nelson (2002) find that there is no evidence supporting the importance of open-economy factors on inflation, and thus proceed in their estimation without including them.

However, there are two aspects not frequently addressed in these papers: how well does the NKPC actually fit the data, and whether GMM is an appropriate estimation methodology. Noticeable exceptions are Bårdsen et al. (2004) and Mavroeidis (2005). Their papers emphasize the drawbacks of using GMM estimation with a large number of instruments and a general correction of the covariance matrix for serial correlation. If the structural error term ε_t is an i.i.d random variable, the error term v_t in equation (3) will follow an MA(1) process, $\text{cov}(v_t, v_{t-1}) = -\gamma^f \sigma_\varepsilon^2$. This first-order negative serial correlation in the error term does not affect the validity of the conventional GMM estimation procedure that uses lagged variables as instruments, since lagged inflation will not be correlated with v_t. As long as the included lagged variables are relevant for the prediction of π_{t+1}, they can serve as instruments. However, the GMM residual obtained from estimating the hybrid specification of the NKPC usually exhibits higher order serial correlation (see Gali et al. (2001)). This higher order serial correlation can have two

[16] In a pure forward-looking NKPC the coefficient on future inflation takes the interpretation of the intertemporal discount factor. Consequently some papers impose the restriction this coefficient takes the value of 0.99 (see for example Neiss and Nelson (2002) and Nelson and Nikolov (2004)).

possible causes, as emphasized by Mavroeidis (2005) and Bårdsen et al. (2004). First, it can be a symptom of omitted dynamics from the model, implying that the model is mis-specified and leading to biased and inefficient estimates of the underlying coefficients. Second, it can arise if the structural error term, ε_t is itself autocorrelated. For example, if ε_t is serially correlated up to order q, v_t will follow an $MA(q+1)$ process. This case automatically invalidates the estimation method used by Gali et al. (2001) and others, since it is incorrect to include lags of inflation that lie within the autocorrelation horizon of the error term into the instrument set. Mavroeidis (2005) and Bårdsen et al. (2004) concluded that the NKPC is most probably mis-specified, and warned researchers against adopting the NKPC too easily as a model of inflation dynamics. Their paper evaluates the NKPC against a family of encompassing models and clearly rejects the NKPC as a model of UK inflation, in favor of a model more in line with the traditional backward looking Phillips curve.

One of the notable exceptions to making the assumption of rational expectations is presented in Roberts (1995). Roberts uses survey based measures of one-year-ahead expected inflation (the Livingston and Michigan Surveys), and finds a statistically significant coefficient on the output gap and unemployment rate. He concludes that actual future inflation is a worse proxy for inflation expectations than are surveys.

4. Data and Estimation Results

The data used in this paper covers the period 1985:Q1-2004:Q4. We limited the sample to this period, since our interest is in the role of the inflation premium as a proxy for expected inflation, and yield curve estimates are only available starting with 1985. We define the driving variable x_t alternatively as the output gap (calculated based on a Hodrick-Prescott filter, gap^{hp}, quadratic trend, gap^{qt}, or an estimate of potential output published by the OECD, gap^{OECD}) or an unemployment measure (the unemployment rate, u, or the gap between the unemployment rate and the non-accelerating wage rate of unemployment as published by the OECD[17], gap^{u}). For estimation purposes we calculate the inflation rate, π_t, as the annualized quarter-to-quarter percentage rate of change[18] in the Retail Price Index (RPI). We use two different inflation premiums: $\pi_t^{p,s}$—the difference between the spot nominal and real yields for a maturity of 4 years (16 quarters) and $\pi_t^{p,f}$—the difference between the 4-year forward nominal and real yields. The choice of a maturity of 4-years is dictated by the availability of the data. (See footnote 6.) We would have preferred a one-quarter maturity if it had been available. It is notable how well the forward-looking premium works given the imperfect maturity match. The data source for the yields is the Bank of England's own estimates of the yield curve.[19]

We consider three different specifications of a forward-looking Phillips curve, based on three alternative proxies for expected inflation, $E_t\pi_{t+1}$, in equation (1). The first specification makes the standard assumption of rational expectations, and uses the inflation premium as an instrument. The second and third specifications use the inflation premium as a proxy for expected inflation, with the spot premium in the second

[17] The estimate of the non-accelerating wage rate of unemployment and potential output comes from the OECD Economic Outlook publication.

[18] Specifically, $\pi_t = \left[\ln\left(RPI_t\right) - \ln\left(RPI_{t-1}\right)\right] \times 4 \times 100$.

[19] Estimates of both the spot and forward yield curves for each business day since January 1985 are available on the Bank of England website, www.bankoflengland.co.uk/yields/.

specification and the forward premium in the third. Since a proxy may be subject to measurement error we instrument, including the forward inflation premium as an instrument in the second specification and the spot inflation premium as an instrument in the third. Specifically we estimate equations[20] (4)-(6) by two-stage least squares (2SLS) using a Newey-West correction of the standard errors:

$$\begin{aligned} &\pi_t = c + \gamma^f \pi_{t+1} + \gamma^b \pi_{t-1} + \lambda x_t + v_t \\ &instruments = \left[\pi_{t-1}, x_{t-1}, \pi_t^{p,s}, \pi_t^{p,f} \right] \end{aligned} \tag{4}$$

$$\begin{aligned} &\pi_t = c + \gamma^f \pi_t^{p,s} + \gamma^b \pi_{t-1} + \lambda x_t + \xi_t \\ &instruments = \left[\pi_{t-1}, x_{t-1}, \pi_{t-1}^{p,s}, \pi_t^{p,f} \right] \end{aligned} \tag{5}$$

$$\begin{aligned} &\pi_t = c + \gamma^f \pi_t^{p,f} + \gamma^b \pi_{t-1} + \lambda x_t + \omega_t \\ &instruments = \left[\pi_{t-1}, x_{t-1}, \pi_t^{p,s}, \pi_{t-1}^{p,f} \right] \end{aligned} \tag{6}$$

We use 2SLS and a parsimonious instrument set in order to avoid the problems of using GMM estimation with many instruments. The *F*-statistics from the first-stage regressions are at least 30, with an associated *p*-value of zero.

Tables 2A and 2B present the results from estimating equations (4)-(6) for the UK over the period 1985:Q2-2004:Q3 under the restriction $\gamma^b + \gamma^f = 1$[21]. This restriction implies that the joint effect of expected inflation and past inflation is reflected one for one in current inflation and that there is no long-run tradeoff between inflation and aggregate demand pressures. Table 2A uses various measures of the output gap, while table 2B uses the unemployment rate and the deviation of unemployment from the natural rate as the driving variable. The columns with the heading (1) present the results from

[20] Since the RPI data is not seasonally adjusted we also include in the estimation equations and instrument sets quarterly dummy variables and a dummy for the second quarter of 1990 when the coverage of the RPI changed.

[21] The unrestricted and restricted estimation results are very similar and the null hypothesis that $\gamma^b + \gamma^f = 1$ is only rejected in about one fourth of the results. Given that imposing the restriction does not affect the fit of the model, we have focused our attention on the restricted results.

estimating equation (4). A variety of measures of the stance of the real economy produce similar results: in the standard formulation of the NKPC the major role is played by future inflation, the estimate of γ^f being 0.77. The coefficient on future inflation is quite precisely estimated, a 95% confidence interval is (0.6, 0.9). One interpretation is that about 60-90% of economic agents have forward-looking behavior. Lagged inflation has a much smaller, but not negligible, effect, and the economics stance variable has no statistically significant impact on inflation and enters with the wrong sign. Looking at the results of the Breusch-Godfrey *LM* test, the standard hybrid specification of the NKPC seems to suffer from misspecification, since the residuals exhibit high order serial correlation. As argued by Mavroeidis (2005) and Bårdsen et al. (2004) the residual high order serial correlation can be a symptom of omitted dynamics from the model, implying that the model is mis-specified and leading to biased and inefficient estimates of the underlying coefficients.

Columns (2) and (3) of Tables 2A and 2B present the results from estimating equations (5) and (6), in which the inflation premium is used as a direct measure of inflation expectations and not just as an instrument. The results are strikingly different from the previous ones. The estimates of γ^f are still highly significant and in the range of 0.72-0.84. A typical 95% confidence interval for γ^f is of the same range as under the standard assumption of rational expectations. The interesting finding is that when expected inflation is approximated by the spot or forward inflation premium there appears to be a clear and consistent relationship between inflation and the stance of the real economy. As suggested by theory, an increase in the output gap—an increase in RGDP relative to its potential level—leads to an acceleration in the inflation rate, while an increase in the unemployment rate leads ceteris paribus to a lower inflation rate. When we use gap^{qt} or gap^{OECD} as driving variables, ceteris paribus a 100 basis point increase in the output gap will increase the inflation rate by about 0.16-0.29 basis points. Similarly, a 100 basis point increase in the unemployment rate (or in the deviation of the unemployment rate from the natural rate) will decrease the inflation rate by about 0.24-0.37 basis points.

The proposed alternative formulations of a forward-looking Phillips curve fits the UK data considerably better than (or at least as well as) the standard hybrid NKPC. Furthermore, investigating the residuals from estimating equations (5) and (6) there is no sign of misspecification that could be detected as high-order residual serial correlation.

The last line in Tables 2A and 2B presents the results for a Hausman test for the endogeneity of the inflation premium measures. When future inflation is used as a proxy for expected inflation, the New Keynesian Phillips curve has to be estimated by 2SLS since future inflation is correlated with the error term v_t in equation (4). However, the inflation premium may be econometrically exogenous since it is determined at time t. Alternatively, since the inflation premium is a proxy it may include measurement error which would require an instrumental variable approach. We conduct a Hausman test for the null hypothesis that π_t^{ps} (π_t^{pf}) is exogenous by adding the current level of the inflation premium to the instrument set.[22] The results are mixed: We reject the null hypothesis that the forward inflation premium is exogenous but we do not reject the null hypothesis that the spot inflation premium is exogenous at 5% significance level.

Given that there is some evidence in favor of the use of the spot inflation premium in an OLS regression, we present such results in Table 3. The results are quite similar to the 2SLS results, which is unsurprising given the results of the Hausman test.

In the following we conduct a robustness check of our results. We consider three different scenarios. First, we estimate by OLS a restricted ($\gamma^b + \gamma^f = 1$) Phillips curve that only uses explanatory variables that are given as of time t. We stipulate a parsimonious estimation equation in which inflation depends on its own lag, the lagged value of the spot or forward inflation premium and the lag of the output gap or

[22] The test statistic is calculated as the difference in the 2SLS estimates of the coefficients on π_t^{ps} (π_t^{pf}) when π_t^{ps} (π_t^{pf}) is excluded from the instrument set and when π_t^{ps} (π_t^{pf}) is included in the instrument set, divided by the square root of the difference between the corresponding estimated variances of the two coefficients. For details see, Hausman (1978).

unemployment measure[23]. Even though the explanatory variables are all lagged values this specification can still be interpreted as a forward-looking Phillips curve since $\pi_{t-1}^{p,s}$ and $\pi_{t-1}^{p,f}$ are forward-looking proxies for expected inflation derived from inflation linked securities. The OLS results in Table 4 are almost identical to the 2SLS estimates included in Tables 2A-2B, reinforcing the validity of our estimation. With all possible measures of aggregate demand pressures we find evidence of a statistically significant tradeoff between the stance of the real economy and inflation. Finally, even though the model is based on only lagged variables, it fits quarter-to-quarter fluctuation in the inflation rate quite well, the adjusted R^2 being in the neighborhood of 82%.

Second, we investigate whether the tradeoff between inflation and the real economy persisted in the period since 1992 when the UK adopted inflation targeting as the framework for monetary policy. In order to see if the relationship between inflation and the real economy changed after the UK adopted inflation targeting, we estimate the restricted version of equation (5) and (6) over two sample periods, 1985:Q2-1992:Q3 and 1992:Q4-2004:Q3. The results from this exercise are presented in tables 5A and 5B. The last line of these tables includes the result of the Chow test for stability of the coefficients across the pre- and post- inflation targeting samples. We tested for structural break in the slope coefficients γ^f and θ. No matter which measure of the real economy we employ, we do not reject the null hypothesis that γ^f and θ stayed unchanged with the implementation of inflation targeting. There are no major differences in the dynamics of inflation in the pre- and post- inflation targeting periods, although the fit of the model is slightly worse after 1992. Except in the case when we use the HP-filter based output gap, the tradeoff between inflation and the real economy persists even in the period since the UK adopted inflation targeting. This finding is consistent with the Bank of England Act (1998) that clarifies that even though the major goal of monetary policy is to achieve price stability, monetary policy should also support the economic policy of the government, namely high and stable levels of growth and employment.

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[23] Changing the number of included lags leaves the results largely unaffected. The estimation equation also includes quarterly dummy variables.

As a last robustness check we consider alternative maturities for the calculation of the inflation premium. In our analysis so far, the spot (forward) inflation premium was calculated as the difference between the 4-year (16-quarter) nominal and real spot (forward) yields. To ascertain that our results are not conditional on this particular maturity, we experimented with a variety of maturities, up to 15 years. The results obtained from this experiment are qualitatively identical to our previous results. For example, Tables 6A and 6B present the estimated coefficients when the inflation premiums are calculated for a maturity of 10 years. As before, the results indicate that about 30% of economic agents have backward-looking expectations and 70% have forward-looking expectations as denoted by the coefficient on the inflation premiums. Furthermore, we obtain a statistically significant tradeoff between inflation and the real economy whenever we use the inflation premium as a proxy for expected inflation.

5. Conclusions

We compare estimates of a NKPC based on using the inflation premium as a measure of inflationary expectations with traditional estimates that use realized future inflation. The model that allows for inflation expectations to be approximated by the inflation premium fits UK inflation dynamics considerably better than the standard NKPC under the assumption of rational expectations. Forward-looking behavior, as captured by the coefficient on the inflation premium, is a major determinant of inflation dynamics, the estimated coefficient being about 0.7-0.8.

When the inflation premium is used as a measure of expected inflation we are able to estimate a well specified forward-looking Phillips curve. We find that regardless of the proxy that is used for the stance of the real economy, even during the last 20 years there still exists a tradeoff between inflation and the real economy. The findings in the previous literature regarding the disappearance of a tradeoff between inflation and the stance of the real economy after the mid-1980s are conditional on the assumption of rational expectations. This relationship also persists in the period of explicit inflation targeting in the UK, emphasizing the need for policy makers to take this tradeoff into account when making monetary policy decisions. Furthermore, while the hybrid NKPC appears to be misspecified as reflected in the residual high-order serial correlation, our proposed estimation equations do not suffer from the same problem.

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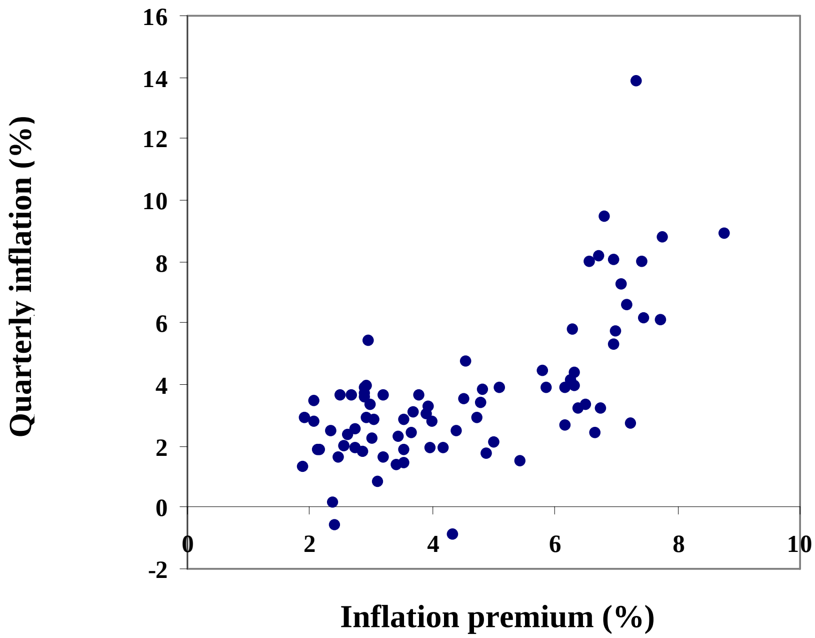

Figure 1: UK quarterly inflation ($\pi_{1,t}$) and spot inflation premium ($\pi_t^{p,s,16}$), 1985-2004

$$\pi_t^{p,s,16} = i_t^{s,16} - r_t^{s,16}; \pi_{1,t} = \left[\ln(RPI_t) - \ln(RPI_{t-1})\right] \times 4 \times 100$$

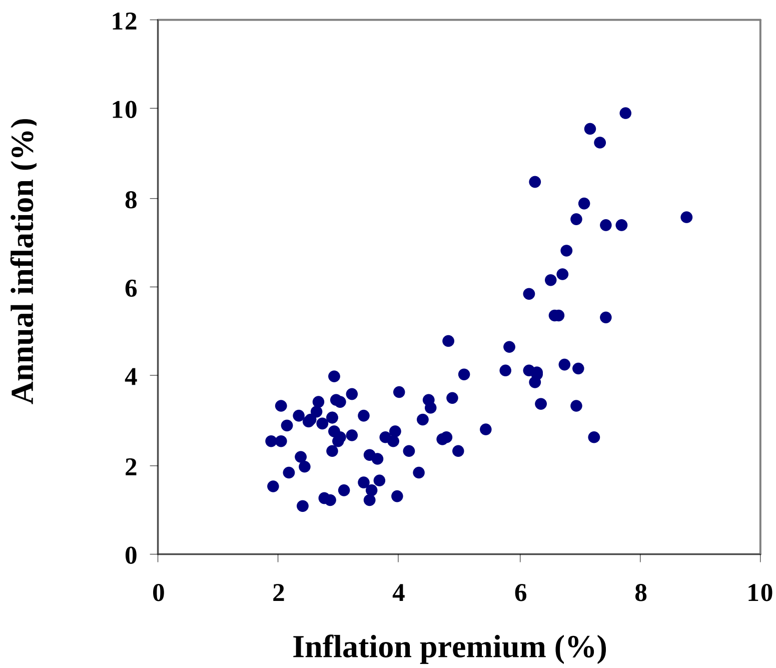

Figure 2: UK annual inflation ($\pi_{4,t}$) and spot inflation premium ($\pi_t^{p,s,16}$), 1985-2004

$$\pi_t^{p,16} = i_t^{16} - r_t^{16}, \pi_{4,t} = \left[\ln(RPI_t) - \ln(RPI_{t-4})\right] \times 100$$

TABLE 1: Granger causality tests between inflation and the inflation premium

Test equations:

$$\pi_t = \alpha + \sum_{i=1}^{4} \phi_i \pi_{t-i} + \sum_{i=1}^{4} \theta_i \pi_{t-i}^{p,j,16} + \varepsilon_{1,t}$$

$$\pi_t^{p,j,16} = \beta + \sum_{i=1}^{4} \delta_i \pi_{t-i}^{p,j,16} + \sum_{i=1}^{4} \gamma_i \pi_{t-i} + \varepsilon_{2,t}$$

$$where: \pi_t = \pi_{1,t} \text{ or } \pi_{4,t} \text{ and } j = s \text{ or } f.$$

Null Hypothesis:	F-Stat.	Conclusion
Annual inflation $\pi_t^{p,s,16} = i_t^{s,16} - r_t^{s,16}; \pi_t^{p,f,16} = i_t^{f,16} - r_t^{f,16}; \pi_{4,t} = \left[\ln(RPI_t) - \ln(RPI_{t-4})\right] \times 100$		
$\pi_{1,t}$ does not Granger Cause $\pi_t^{p,s,16}$ $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$	0.32 <0.86>	Inflation does not Granger cause the spot inflation premium
$\pi_{1,t}$ does not Granger Cause $\pi_t^{p,f,16}$ $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$	0.50 <0.73>	Inflation does not Granger cause the forward inflation premium
$\pi_t^{p,s,16}$ does not Granger Cause $\pi_{1,t}$ $\theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$	7.40 <0.00>	The spot inflation premium Granger causes inflation
$\pi_t^{p,f,16}$ does not Granger Cause $\pi_{1,t}$ $\theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$	4.78 <0.00>	The forward inflation premium Granger causes inflation
Quarterly inflation $\pi_t^{p,s,16} = i_t^{s,16} - r_t^{s,16}; \pi_t^{p,f,16} = i_t^{f,16} - r_t^{f,16}; \pi_{1,t} = \left[\ln(RPI_t) - \ln(RPI_{t-1})\right] \times 4 \times 100$		
$\pi_{1,t}$ does not Granger Cause $\pi_t^{p,s,16}$ $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$	0.36 <0.83>	Inflation does not Granger cause the spot inflation premium
$\pi_{1,t}$ does not Granger Cause $\pi_t^{p,f,16}$ $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$	0.61 <0.66>	Inflation does not Granger cause the forward inflation premium
$\pi_t^{p,s,16}$ does not Granger Cause $\pi_{1,t}$ $\theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$	7.85 <0.00>	The spot inflation premium Granger causes inflation
$\pi_t^{p,f,16}$ does not Granger Cause $\pi_{1,t}$ $\theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$	4.35 <0.00>	The forward inflation premium Granger causes inflation

Note: The equations were estimated over the sample 1986:Q1-2004:Q4; the number of observations is N=76. Changing the number of included lags in the test equations, anywhere between 2 and 12 lags, does not influence the conclusion of the Granger Causality test. *p*-values are given in angle brackets, <…>.

TABLE 2A: Restricted 2SLS ($\gamma^f + \gamma^b = 1$) estimation of a forward looking Phillips curve using output gap measures as the driving variable

		HP Output gap (gap_t^{hp})			QT output gap (gap_t^{qt})			OECD output gap (gap_t^{OECD})		
		(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}		0.23 (2.86)***	0.26 (3.04)***	0.25 (3.31)***	0.24 (2.95)***	0.28 (3.46)***	0.26 (3.38)***	0.24 (3.07)***	0.26 (3.08)***	0.24 (3.14)***
π_{t+1}^e	π_{t+1}	0.77 (9.52)***	–	–	0.76 (9.34)***	–	–	0.76 (9.53)***	–	–
	π_t^{ps}	–	0.74 (8.74)***	–	–	0.72 (8.77)***	–	–	0.74 (8.88)***	–
	π_t^{pf}	–	–	0.75 (9.76)***	–	–	0.74 (9.41)***	–	–	0.76 (9.85)***
x_t		-0.10 (-0.77)	0.45 (3.50)***	0.56 (3.89)***	-0.09 (-1.15)	0.16 (1.99)**	0.27 (3.27)***	-0.08 (-1.13)	0.20 (2.79)***	0.29 (4.07)***
Adj. R^2		0.73	0.79	0.78	0.74	0.79	0.78	0.74	0.79	0.79
SSR		223.97	172.75	180.82	220.47	180.67	183.30	218.95	176.48	177.93
BG LM test (4)		33.90 <0.00>	4.00 <0.41>	1.65 <0.80>	34.31 <0.00>	4.28 <0.39>	1.48 <0.83>	35.30 <0.00>	3.46 <0.48>	0.99 <0.91>
Hausman test for endogeneity of π_t^p		–	1.44 <0.15>	3.36 <0.00>	–	1.63 <0.10>	2.97 <0.00>	–	1.86 <0.06>	2.89 <0.00>

TABLE 2B: Restricted 2SLS ($\gamma^f + \gamma^b = 1$) estimation of a forward-looking Phillips curve using unemployment measures as the driving variable

		Unemployment rate (u_t)			Unemployment gap (gap_t^u)		
		(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}		0.28 (3.52)***	0.16 (2.29)**	0.25 (2.84)***	0.27 (3.38)***	0.19 (2.70)***	0.19 (2.28)**
π_{t+1}^e	π_{t+1}	0.72 (9.15)***	–	–	0.73 (9.03)***	–	–
	π_t^{ps}	–	0.84 (11.95)***	–	–	0.81 (11.37)***	–
	π_t^{pf}	–	–	0.75 (8.55)***	–	–	0.81 [9.89]***
x_t		0.05 (0.87)	-0.30 (-3.96)***	-0.24 (-2.81)***	0.11 (1.24)	-0.30 (-3.05)***	-0.37 (-3.36)***
Adj. R^2		0.74	0.81	0.78	0.75	0.80	0.79
SSR		214.46	156.10	181.24	214.11	166.95	173.72
BG LM test (4)		41.27 <0.00>	3.12 <0.54>	0.91 <0.92>	39.81 <0.00>	1.50 <0.83>	0.13 <0.99>
Hausman test for endogeneity of π_t^p		–	1.59 <0.11>	3.35 <0.00>	–	1.74 <0.08>	3.34 <0.00>

Estimated in EViews by 2SLS. Standard errors were calculated by using a Newey-West heteroskedasticity consistent coefficient covariance matrix. Sample covers 1985:Q2-2004:Q3. Columns (1) use as instruments: $\pi_{t-1}, \pi_t^{ps}, \pi_t^{pf}, x_{t-1}$. Columns (2) use as instruments $\pi_{t-1}, \pi_{t-1}^{ps}, \pi_t^{pf}, x_{t-1}$. Columns (3) use as instruments $\pi_{t-1}, \pi_t^{ps}, \pi_{t-1}^{pf}, x_{t-1}$. The line BG LM test (4) presents the results of the Breusch-Godfrey *LM* test for fourth order serial correlation in the residuals. *t*-statistics are reported in parenthesis, (…), and *p*-values in angle brackets, <…>. * (**, ***) Indicates that the parameter is significant at the 10% (5%, 1%) level.

TABLE 3: Restricted OLS ($\gamma^f + \gamma^b = 1$) estimation of a forward-looking Phillips curve that uses the inflation premium as a measure of forward looking expectations

	Output Gap						Unemployment rate			
	gap_t^{hp}		gap_t^{qt}		gap_t^{oecd}		u_t		gap_t^{u}	
π_{t-1}	0.29 (3.14)***	0.33 (4.16)***	0.31 (3.47)***	0.33 (4.09)***	0.30 (3.21)***	0.31 (3.93)***	0.19 (2.56)**	0.31 (3.59)***	0.22 (2.70)***	0.25 (2.88)***
π_t^{ps}	0.71 (7.69)***	–	0.69 (7.62)***	–	0.70 (7.57)***	–	0.81 (11.30)***	–	0.78 (9.79)***	–
π_t^{pf}	–	0.67 (8.33)***	–	0.67 (8.24)***	–	0.69 (8.68)***	–	0.69 (7.99)***	–	0.75 (8.65)***
x_t	0.41 (2.73)***	0.49 (3.16)***	0.15 (1.70)*	0.24 (2.97)***	0.18 (2.26)**	0.26 (3.64)***	-0.31 (-4.13)***	-0.24 (-2.99)***	-0.32 (-3.51)***	-0.38 (-3.69)***
Adj. R^2	0.79	0.79	0.78	0.78	0.79	0.79	0.81	0.79	0.80	0.79
SSR	172.38	178.79	180.38	181.91	175.96	176.48	155.86	179.77	166.64	172.36
BG LM test (4)	1.00 <0.41>	0.69 <0.60>	1.01 <0.40>	0.59 <0.67>	0.89 <0.47>	0.71 <0.59>	0.77 <0.55>	0.43 <0.79>	0.44 <0.78>	0.33 <0.85>

Estimated in EViews by OLS, with Newey-West correction of the standard errors for autocorrelation. Sample covers 1985:Q2-2004:Q3. The line BG LM test (4) presents the results of the Breusch-Godfrey *LM* test for fourth order serial correlation in the residuals. *t*-statistics are reported in parenthesis, (…), and *p*-values in angle brackets, <…>. * (**, ***) Indicates that the parameter is significant at the 10% (5%, 1%) level.

TABLE 4: Restricted OLS ($\gamma^f + \gamma^b = 1$) estimation of a forward-looking Phillips curve that uses only lagged variables

	Output Gap						Unemployment rate			
	gap_{t-1}^{hp}		gap_{t-1}^{qt}		gap_{t-1}^{oecd}		u_{t-1}		gap_{t-1}^{u}	
π_{t-1}	0.19 (2.06)**	0.22 (2.53)**	0.24 (2.92)***	0.23 (2.80)***	0.22 (2.53)**	0.20 (2.64)***	0.13 (1.78)*	0.26 (2.84)***	0.16 (2.17)**	0.18 (2.09)**
π_{t-1}^{ps}	0.81 (8.55)***	–	0.76 (8.95)***	–	0.78 (9.21)***	–	0.87 (12.34)***	–	0.84 (11.60)***	–
π_{t-1}^{pf}	–	0.78 (8.71)***	–	0.77 (9.38)***	–	0.80 (10.87)***	–	0.74 (8.19)***	–	0.82 (9.70)***
x_{t-1}	0.50 (3.40)***	0.58 (3.79)***	0.20 (2.20)**	0.30 (3.53)***	0.23 (2.97)***	0.33 (4.81)***	-0.33 (-4.39)***	-0.25 (-3.15)***	-0.34 (-2.91)***	-0.40 (-3.11)***
Adj. R^2	0.81	0.81	0.80	0.81	0.81	0.82	0.83	0.80	0.81	0.81
SSR	159.50	162.81	168.59	163.74	161.03	154.22	145.56	167.35	156.97	158.97
BG LM test (4)	4.89 <0.30>	3.93 <0.41>	6.45 <0.17>	3.99 <0.41>	4.03 <0.40>	1.63 <0.80>	0.26 <0.99>	4.91 <0.30>	2.36 <0.67>	2.36 <0.67>

Estimated in EViews by OLS, with Newey-West correction of the standard errors for autocorrelation. Sample covers 1985:Q2-2004:Q3. The line BG LM test (4) presents the results of the Breusch-Godfrey *LM* test for fourth order serial correlation in the residuals. *t*-statistics are reported in parenthesis, (…), and *p*-values in angle brackets, <…>. * (**, ***) Indicates that the parameter is significant at the 10% (5%, 1%) level.

TABLE 5A: Restricted 2SLS ($\gamma^f + \gamma^b = 1$) estimation of a forward-looking Phillips curve using output gap measures as the driving variables before and after the adoption of inflation targeting

	Output gap											
	gap_t^{hp}				gap_t^{qt}				gap_t^{oecd}			
	(1)		(2)		(1)		(2)		(1)		(2)	
	Pre-IT	Post-IT	Pre-IT	Post-IT	Pre-IT	Post-IT	Pre-IT	Post-IT	Pre-IT	Post-IT	Pre-IT	Post-IT
π_{t-1}	0.32 (5.82)***	0.32 (2.73)***	0.30 (5.20)***	0.39 (3.26)***	0.34 (6.13)***	0.29 (2.35)***	0.32 (5.50)***	0.36 (2.94)***	0.34 (2.51)***	0.22 (1.71)*	0.32 (2.30)**	0.29 (2.20)**
π_t^{ps}	0.68 (12.23)***	0.68 (5.69)***	–	–	0.66 (12.08)***	0.71 (5.87)***	–	–	0.66 (11.92)***	0.78 (6.10)***	–	–
π_t^{pf}	–	–	0.70 (12.05)***	0.60 (4.95)***	–	–	0.68 (11.96)***	0.64 (5.20)***	–	–	0.68 (4.85)***	0.71 (5.40)***
x_t	0.47 (3.02)**	0.31 (1.06)	0.53 (3.13)***	0.30 (0.96)	0.24 (2.45)**	0.29 (1.81)*	0.29 (2.90)***	0.26 (1.54)	0.21 (2.27)**	0.32 (2.61)**	0.26 (2.26)**	0.33 (2.56)**
Adj. R^2	0.84	0.67	0.84	0.62	0.83	0.68	0.83	0.62	0.83	0.70	0.83	0.64
SSR	63.01	76.10	63.14	88.55	65.79	73.78	65.44	87.52	66.92	70.45	66.60	84.80
BG LM test (4)	3.51 <0.48>	6.59 <0.16>	3.85 <0.43>	3.00 <0.56>	3.93 <0.42>	5.84 <0.21>	4.37 <0.35>	2.06 <0.72>	3.92 <0.42>	5.23 <0.26>	4.36 <0.36>	1.11 <0.89>
Chow test	0.15 <0.85>		0.27 <0.76>		0.07 <0.93>		0.06 <0.93>		0.42 <0.66>		0.08 <0.92>	

TABLE 5B: Restricted 2SLS ($\gamma^f + \gamma^b = 1$) estimation of a forward-looking Phillips curve using unemployment measures as the driving variables before and after the adoption of inflation targeting

	Unemployment rate							
	u_t				gap_t^u			
	(1)		(2)		(1)		(2)	
	Pre-IT	Post-IT	Pre-IT	Post-IT	Pre-IT	Post-IT	Pre-IT	Post-IT
π_{t-1}	0.26 (3.06)***	0.21 (1.86)*	0.24 (2.97)***	0.26 (1.99)**	0.27 (3.47)***	0.22 (1.86)*	0.25 (3.37)***	0.26 (2.01)**
π_t^{ps}	0.74 (8.83)***	0.79 (6.86)***	–	–	0.73 (9.50)***	0.78 (6.64)***	–	–
π_t^{pf}	–	–	0.76 (9.23)***	0.74 (5.76)***	–	–	0.75 (10.22)***	0.74 (5.65)
x_t	-0.30 (-2.10)**	-0.26 (-2.76)***	-0.29 (-1.85)*	-0.30 (-2.90)***	-0.28 (-2.13)**	-0.34 (-2.61)***	-0.29 (-2.08)**	-0.40 (-2.62)***
Adj. R^2	0.83	0.71	0.81	0.66	0.82	0.71	0.82	0.66
SSR	66.86	67.44	71.12	78.27	67.02	67.45	70.14	78.68
BG LM test (4)	3.71 <0.45>	5.37 <0.25>	4.14 <0.39>	0.43 <0.98>	4.03 <0.40>	5.26 <0.26>	4.22 <0.34>	0.42 <0.98>
Chow test	0.21 <0.81>		0.01 <0.99>		0.07 <0.93>		0.31 <0.74>	

Estimated in EViews by 2SLS. Columns with the heading (1) use as instruments $\pi_{t-1}, \pi_{t-1}^{ps}, \pi_t^{pf}, x_{t-1}$, while columns with the heading (2) use as instruments $\pi_{t-1}, \pi_t^{ps}, \pi_{t-1}^{pf}, x_{t-1}$. Standard errors were calculated by using a Newey-West heteroskedasticity consistent coefficient covariance matrix. Columns with the heading Pre-IT were estimated over the sample 1985:Q2-1992:Q3 and cover the period before the UK adopted inflation targeting. Columns with the heading Post-IT were estimated over the sample 1992:Q4-2004:Q4 and cover the period after the UK adopted inflation targeting. The line BG LM test (4) presents the results of the Breusch-Godfrey *LM* test for fourth order serial correlation in the residuals. The line Chow test presents the results of the F-test for H_0 that the slope coefficients are the same for the Pre-IT and Post-IT samples. *t*-statistics are reported in parenthesis, (…), and *p*-values in angle brackets, <…>. * (**, ***) Indicates that the parameter is significant at the 10% (5%, 1%) level.

TABLE 6A: Restricted 2SLS ($\gamma^f + \gamma^b = 1$) estimation of a forward looking Phillips curve using output gap measures as the driving variable—Alternative maturity for the term premium (10 years)

		HP Output gap (gap_t^{hp})			QT output gap (gap_t^{qt})			OECD output gap (gap_t^{OECD})		
		(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}		0.26 (3.30)***	0.26 (3.64)***	0.32 (4.92)***	0.26 (3.26)***	0.27 (3.64)***	0.30 (4.53)***	0.26 (2.42)***	0.25 (2.52)**	0.28 (2.92)***
π_{t+1}^e	π_{t+1}	0.74 (9.43)***	–	–	0.74 (9.37)***	–	–	0.74 (6.97)***	–	–
	π_t^{ps}	–	0.74 (10.34)***	–	–	0.73 (9.61)***	–	–	0.75 (7.72)***	–
	π_t^{pf}	–	–	0.68 (10.26)***	–	–	0.70 (10.61)***	–	–	0.72 (7.41)***
x_t		-0.10 (-0.79)	0.58 (3.94)***	0.77 (3.85)***	-0.08 (-1.14)	0.26 (3.10)***	0.42 (4.27)***	-0.08 (0.86)	0.29 (3.33)***	0.42 (4.30)***
Adj. R^2		0.74	0.79	0.78	0.74	0.79	0.78	0.74	0.79	0.78
SSR		217.56	173.69	188.82	216.56	178.23	185.86	216.02	173.05	182.90
BG LM test (4)		36.17 <0.00>	1.71 <0.79>	1.37 <0.85>	35.71 <0.00>	1.56 <0.82>	0.51 <0.97>	36.18 <0.00>	1.30 <0.86>	0.57 <0.97>

TABLE 6B: Restricted 2SLS ($\gamma^f + \gamma^b = 1$) estimation of a forward-looking Phillips curve using unemployment measures as the driving variable—Alternative maturity for the term premium (10 years)

		Unemployment rate (u_t)			Unemployment gap (gap_t^u)		
		(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}		0.29 (2.76)***	0.24 (2.38)**	0.40 (4.20)***	0.28 (2.69)***	0.16 (1.56)	0.23 (2.78)***
π_{t+1}^e	π_{t+1}	0.71 (6.88)***	–	–	0.72 (6.92)***	–	–
	π_t^{ps}	–	0.76 (7.62)***	–	–	0.84 (7.94)***	–
	π_t^{pf}	–	–	0.60 (6.29)***	–	–	0.77 (7.33)***
x_t		0.05 (0.60)	-0.27 (-3.16)***	-0.23 (-2.44)**	0.11 (1.02)	-0.41 (-3.59)***	-0.53 (-4.06)***
Adj. R^2		0.75	0.80	0.76	0.75	0.81	0.79
SSR		213.07	168.86	204.55	212.39	162.41	178.10
BG LM test (4)		40.88 <0.00>	0.96 <0.92>	2.38 <0.67>	39.85 <0.00>	1.29 <0.86>	0.56 <0.97>

Estimated in EViews by 2SLS. Standard errors were calculated by using a Newey-West heteroskedasticity consistent coefficient covariance matrix. Sample covers 1985:Q2-2004:Q3. As a robustness test the inflation premiums are calculated for a maturity of 10 years (40 quarters). Columns (1) use as instruments: $\pi_{t-1}, \pi_t^{ps}, \pi_t^{pf}, x_{t-1}$. Columns (2) use as instruments $\pi_{t-1}, \pi_{t-1}^{ps}, \pi_t^{pf}, x_{t-1}$. Columns (3) use as instruments $\pi_{t-1}, \pi_t^{ps}, \pi_{t-1}^{pf}, x_{t-1}$. The line BG LM test (4) presents the results of the Breusch-Godfrey *LM* test for fourth order serial correlation in the residuals. *t*-statistics are reported in parenthesis, (…), and *p*-values in angle brackets, <…>. * (**, ***) Indicates that the parameter is significant at the 10% (5%, 1%) level.