MONETARY POLICY AND ALTERNATIVE MEASURES OF INFLATION: EMPIRICAL EVIDENCE FOR THE UK

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Abstract. *The issue of which measure of inflation ought to be targeted by policymakers has been extensively analysed, but the equally important issue of which inflation rate is actually targeted by policymakers in practice has been given much less attention. The paper addresses this question, using data for the UK, a country where differences among the alternative measures are especially marked. We estimate simple Taylor-like monetary policy rules, using several different measures of inflation. We find that plausible models can be obtained for each of the different measures, suggesting that it may not matter which is used in empirical analysis. Models using the RPI measure of inflation have a slight empirical advantage which reflects the ability better to explain monetary policy in more turbulent circumstances.*

Key words: *inflation target, measures of inflation, Bank of England*

1. Introduction

The issue of which measure of inflation should be targeted by policymakers has been extensively analysed. There are several aspects in this debate, including whether it is better to target core or headline inflation rates (Aoki, 2001), whether the policy should target consumer prices or just domestic prices (Kirsanova et al., 2006), and whether policymakers should respond to inflationary shocks or just to induced "second-round" changes in domestic wages and prices (Batini et al., 2003). Most studies conclude that policymakers should target the inflation rate over which they have most control, in practice a core inflation rate from which volatile items have been removed (Nessen, Soderstrom, 2001). Other authors consider the merits of targeting domestic wages rather than prices, often concluding that this would be superior (Erceg et al., 2000, Mankiw, Reis, 2003). The debate has been given substance by Kozicki's (1999) demonstration that alternative measures of inflation can imply very different policy rates.

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However, another important question, considering which inflation rate is *actually* targeted by policymakers in practice, has been given much less attention. This may reflect the trend to publicly announce which inflation rate Central Banks are targeting. However, such announcements do not resolve the issue: officially targeting a particular rate of inflation does not necessarily imply that a monetary policy rule that includes this particular rate will outperform alternatives, not least because policymakers may seek to target inflation over a longer horizon than that of short-term monetary policy decisions.

This paper investigates this issue. We consider the case of the UK, a country where differences among alternative measures are especially marked, reflecting the openness of the economy and the importance of the housing market. We estimate simple Taylor-like monetary policy rules using several different measures of inflation. We consider eight alternative measures which reflect the theoretical debate by differing along the headline / core, overall / domestic and price / wage dimensions. These diverse measures of inflation are clearly distinct, with some low and even negative correlations among them. Despite this, we find that a plausible policy rule can be estimated for each measure of inflation. This rather surprising result suggests that, from the perspective of empirical models of monetary policy, it may not matter which measure of inflation is used. Models using the headline Retail Price Index (RPI) fit the data best. This appears to be due to their ability better to explain the policy rate in periods of turbulence such as 2001–2002 and not because of a superior ability to explain monetary policy in more tranquil circumstances.

The paper is structured as follows. Section 2 provides some general background about the phenomenon of inflation targeting, Section 3 outlines the simple theoretical model used to guide our empirical models. Section 4 describes our data, Section 5 develops the theoretical model into a form suitable for empirical estimation, presents and discusses our results. Section 6 concludes the paper.

2. Background

The issue of the optimal monetary policy framework has often been raised in the light of the recent global financial crisis. Having in mind the usual primary goals of any central bank – monetary and financial stability, – this paper is based on the former – the monetary stability issue.

The easiest way to describe monetary stability would be to say that it is achieved when the country's inflation is kept at a low level. However, such a definition is quite imprecise and vague, since it does not really specify what is meant by the "low" level of inflation. Since the early 1990s, a more explicit way of announcing the goal of monetary stability has become implementing a certain inflation target – a precise number, or a range of numbers targeted by a central bank.

With New Zealand as a pioneer, followed shortly by the UK in the end of 1992, the trend of inflation targeting implementation took off, making it 27 inflation targeting

countries (including both developed and developing economies) in total to this day (Hammond, 2011). This paper focuses on the case of the UK, however. Currently, the Bank of England characterises itself as following a specified inflation target: "The inflation target of 2% is expressed in terms of an annual rate of inflation based on the Consumer Prices Index (CPI). The remit is not to achieve the lowest possible inflation rate. Inflation below the target is therefore judged to be just as bad as inflation above the target. The inflation target is therefore symmetrical" (Bank of England, 2014).

The inflation target in the UK has not always been the same, though. According to Bean (2003), on the introduction of the inflation targeting regime in the UK, the Bank of England committed to target RPIX inflation, which is the measure excluding the effect of mortgage payments from the retail price index inflation. The range for the target was set to be 1–4%; however, the goal was to bring the inflation rate down to 2.5% or less by 1997. Therefore, the officially targeted inflation measure in the UK was RPIX until the end of 2003, and CPI onwards.

Broadly speaking, inflation targeting means that a central bank has to adjust the Bank Rate in such a way that the inflation target is not missed. The whole idea might sound fairly straightforward and simple; however this is far from reality. Amongst other problems, like choosing the point versus range target, and setting an appropriate target level, the primary focus of this paper is the choice of a *measure* of inflation to target.

Although the worldwide trend among inflation targeting central banks, where the Bank of England is not an exception, is to target headline CPI, inflation can be measured in a number of other ways. Consider core inflation which excludes the most volatile prices from the headline CPI basket. Core inflation alone contains a number of different measures in itself (each excluding different components) – Clark (2001) distinguishes at least five different ones. Domestic inflation, disregarding the influence of foreign prices on the domestic economy (or the so-called "imported inflation"), and unit wage costs inflation are yet the other alternative measures for an inflation target. Finally, "no central bank would be satisfied by looking at only one price index when formulating monetary policy. Because inflation measures differ in methodology, sector coverage, inherent biases, and idiosyncratic noise, examination of a variety of these indicators has been needed to gain insight into the underlying inflation process" (Whitesell, 2005). So what is the reason behind such a worldwide solidary choice of CPI, probably the most volatile[1] (at least in theory) measure of all just mentioned?

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[1] The reason a central bank should not be satisfied with targeting a volatile measure of inflation is another goal of monetary policy – financial stability. Monetary policy makers are usually reluctant to change the Bank Rate frequently, whereas setting a volatile measure of inflation as a target would imply that with every change in inflation the Bank Rate would need to be adjusted. Therefore, in theory, monetary policy makers are most likely to be interested in setting the least volatile measure of inflation as a target in order to make the Bank Rate as stable as possible.

In order to answer this question, let us consider inflation targeting from two perspectives as defined by Bernanke (2003): a certain *monetary policy framework* and *a way of communication* to a broad public. Talking about the monetary policy framework side of the process, the benefits of the inflation targeting regime are thought to be brought by a stronger monetary policymakers' response to inflation. In other words, policymakers' response to inflation increases when a central bank implements an inflation target since they become more concentrated on keeping inflation at a stable targeted level. This in turn means that following shocks the economy gets back to equilibrium much faster than it would should the response to inflation have been weaker, i.e. without an inflation target (Sorensen, Whitta-Jacobsen, 2010). At the same time, inflation targeting helps anchor private agents' inflation expectations. Once expectations are anchored, they do not change when the economy is hit by a shock, and an economy moves back to its equilibrium right in the next period after the shock. This is where the communication part of an inflation target comes in. Without an explicit inflation target it would be difficult, if possible at all, to anchor private agents' inflation expectations at a particular level, whereas the central bank, which has a publicly announced official inflation target, is likely to succeed, assuming it has a good and credible reputation among the public, of course.

So, the inflation targeting process is twofold: the monetary policy framework part increases the monetary policy makers' response to inflation, whereas communication to the public via inflation targeting aims to anchor private agents' inflation expectations. Both of those factors reduce the economy's recovery time following shocks; however, the latter is extremely important considering the reason behind choosing CPI as a targeted measure. CPI is the most broadly available measure of inflation and probably the easiest for private agents to understand. Its easy access and simplicity, therefore, push the majority of central banks to select this particular measure for their official inflation targets. In addition, due to the objective to anchor inflation expectations, policy makers cannot change the measure of targeted inflation every time the economic situation requires a response to something other than the official measure.

Knowing a somewhat twofold effect of inflation targeting, it is clear why the choice of CPI as a targeted measure of inflation is so common. However, this still does not answer the question of whether it is really CPI which is being targeted by central banks, and whether any other plausible models using other measures of inflation can be found to fit the data better or at least as well as the ones with CPI inflation. It is the primary goal of this paper.

3. Theoretical model

Empirically, policy rules with a response to the lagged output gap but a possibly forward-looking response to inflation work best in our data. To motivate such a policy rule, we analyse optimal monetary policy in a simple macroeconomic model similar to that analysed by Clarida et al. (1999). Aggregate supply is given by the New Keynesian Phillips Curve (Gali and Gertler, 1999):

$$\pi_t = \beta E_t \pi_{t+1} + \lambda x_t + u_t, \tag{1}$$

where π is the inflation rate, x is the output gap, and u_t is a supply shock, where $u_t = \rho_\pi u_{t-1} + \varepsilon_{\pi t}$ and ε_π is a white noise error term. In modelling the aggregate demand, we incorporate habit persistence in household utility functions (Fuhrer, 2000) by assuming that

$$x_t = \theta x_{t-1} + (1-\theta) E_t x_{t+1} - \varphi(i_t - E_t \pi_{t+1} - \rho) + g_t, \tag{2}$$

where i is the nominal policy rate, ρ is the equilibrium real interest rate, and g_t is an aggregate demand shock; here, $g_t = \rho_y g_{t-1} + \varepsilon_{yt}$, where ε_y is a white noise error term[2]. Policymakers have the loss function:

$$\Lambda = E_t \sum_{j=0}^{\infty} \beta^j [\frac{1}{2}(\pi_{t+j} - \pi^*)^2 + \frac{\alpha}{2} x_{t+j}^2], \tag{3}$$

where π^* is the inflation target. Policymakers act under discretion, choosing the output gap. The first-order condition is

$$x_t = -\frac{\lambda}{\alpha}(\pi_t - \pi^*), \tag{4}$$

and we can also show that $E_t \pi_{t+1} = \rho_\pi \pi_t$ (Clarida et al., 1999). Substituting (4) into (2) and solving for the interest rate, the optimal monetary policy rule is:

$$i_t = \rho + (1 + \frac{\lambda(1-\rho_\pi(1-\theta))}{\alpha\varphi\rho_\pi})(E_t\pi_{t+1} - \pi^*) + \frac{\theta}{\varphi} x_{t-1} + \frac{1}{\varphi} g_t. \tag{5}$$

This is an optimal policy rule with a backward-looking response to output and a forward-looking response to the inflation gap, $(\pi - \pi^*)$. To obtain a more flexible model, we use $E_t \pi_{t+1} = \rho_\pi \pi_t$ to express the policy rule as

$$i_t = \rho + (1 + \frac{\lambda(1-\rho_\pi(1-\theta))}{\alpha\varphi\rho_\pi})\rho_\pi^{k-1}(E_t\pi_{t+k} - \pi^*) + \frac{\theta}{\varphi} x_{t-1} + \frac{1}{\varphi} g_t, \tag{6}$$

where k is an integer.

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[2] It is possible to incorporate inflation persistence using a "hybrid" New Keynesian Phillips Curve. However, as Clarida et al. (1999) discuss, the analysis of optimal monetary policy becomes more complex in this case.

4. Data

We use the UK data for the period 1993Q4–2007Q4, obtained from the Office of National Statistics (ONS). Stable policy rules have previously been estimated for this sample period (Mihailov, 2006; Martin, Milas, 2010). There is also a strong evidence of a change in the monetary policy rule in the UK (and other developed economies) from the summer of 2007 as Central Banks faced the unprecedented challenge of the Global Financial crisis (Martin, Milas, 2013). A model of monetary policy in this period would require a detailed analysis of the stability of the financial system and solvency of the banking sector, which is beyond the scope of this paper.

i is the official policy rate (Bank Rate), whereas the output gap, x, is measured as the proportional deviation of GDP from its underlying Hodrick–Prescott trend. We use eight alternative measures of inflation. These can be categorised as being headline, core, domestic, and wage inflation measures. They are all expressed as annual rates of change of the underlying price indices. We use four alternative measures of headline inflation: (1) CPI, (2) RPIX, (3) RPI and (4) the targeted rate defined as RPIX from 1993Q4 to 2003Q4 and CPI thereafter; as explained below, this corresponds to the inflation rate used in the specification of the inflation target. CPI and RPI are the main measures of consumer prices. They have a similar coverage but differ in construction as CPI is a HICP measure based on a geometric average, whereas RPI is based on an arithmetic average. RPIX is the RPI index with some housing-related components removed. We have a single measure for each of the other categories. For core inflation we use (5) CPIX which is the CPI index with food and energy components removed. For domestic inflation, we use (6) the GDP deflator. For wage inflation, we use the annual rate of change of (7) unit wage costs, constructed by subtracting the growth in output per worker the annual rate of change of an index of nominal wages. Finally, we also consider (8) the first principal component of the previous seven measures.

The UK had an inflation target throughout our sample. The target was announced in late 1992 as a range of between 1–4% for the annual increase in RPIX inflation, with the aim of being below 2.5% in the medium term (Bernanke et al., 1999). In May 1997, the target was clarified as being a 2.5% point target. In November 2003, the target was changed to be a 2% annual increase in the Consumer Price Index (CPI), an alternative headline measure more closely aligned to the measure used in the Eurozone. The empirical model in (6) includes the inflation gap, $(\pi - \pi^*)$. To construct inflation gaps for our alternative measures of inflation, we assume an inflation target of 2.5% for RPIX inflation and 2% for other measures. The inflation gap for the officially targeted inflation rate is defined as the RPIX inflation gap for 1993Q4–2003Q4 and the CPI inflation gap thereafter. Table 1 summarises the time series properties of our alternative measures of the inflation gap.

TABLE 1. **Key features of alternative measures of the inflation gap, UK 1993Q4–2007Q4**

a) Descriptive statistics								
	Official measure	RPIX	CPI	RPI	CPIX	GDP deflator	Wage costs	PC
Mean	-0.05	0.10	-0.19	0.21	-0.44	0.53	-0.11	2.51
St. dev.	0.40	0.44	0.61	0.85	0.81	0.81	1.41	1.11
b) Correlations								
	Official measure	RPIX	CPI	RPI	CPIX	GDP deflator	Wage costs	PC
Official measure	1.00	0.88	0.77	0.53	0.60	0.38	0.13	0.79
RPIX	0.88	1.00	0.77	0.69	0.57	0.53	0.27	0.88
CPI	0.77	0.77	1.00	0.54	0.70	0.40	0.07	0.87
RPI	0.53	0.69	0.54	1.00	0.33	0.26	0.36	0.67
CPIX	0.60	0.57	0.70	0.33	1.00	0.50	0.00	0.79
GDP deflator	0.38	0.53	0.40	0.26	0.50	1.00	-0.01	0.70
Wage costs	0.13	0.27	0.07	0.36	0.00	-0.01	1.00	0.03
PC	0.79	0.88	0.87	0.67	0.79	0.70	0.03	1.00

Prepared by the authors using data from the ONS (Office for National Statistics).

The average gap is smallest for the officially targeted rate, reflecting the apparent success of inflation targeting over the pre-2007 period (although there have been deviations from the target since). RPI is the most volatile headline measure, while domestic and wage-based inflations are also volatile. But surprisingly, the CPIX inflation is more volatile than CPI and RPIX. This reflects the early 1990s; the CPIX inflation has been the most stable measure since 2000. It is also striking that correlations among different measures are often small and in some cases negative. This mainly reflects the split between headline rates and domestic and wage-based inflation measures, which evolve rather differently. Wage-based inflation is especially disconnected from the other measures – this is reflected in a low weighting in the principal component.

5. Results

We made two adjustments to the optimal policy rule in (6) in our empirical estimates. First, we assume the *ad-hoc* adjustment of the nominal policy rate in order to account for the well-documented phenomenon of interest rate smoothing. Second, we found, after some experimentation, that the data preferred a model with the second, rather than the first, lag of the output gap. Our empirical model is, therefore,

$$i_t = \mu i_{t-1} + (1-\mu)\{\omega_0 + \omega_1(E_t \pi_{t+k} - \pi^*) + \omega_2 x_{t-2}\} + v_t, \tag{7}$$

where $\omega_0 = \rho$, $\omega_1 = (1 + \dfrac{\lambda(1-\rho_\pi(1-\theta))}{\alpha\varphi\rho_\pi})\rho_\pi^{k-1}$, $\omega_2 = \dfrac{\theta}{\varphi}$ and $v_t = \dfrac{1}{\varphi}g_t$.

The estimates of (7) were obtained by GMM using four lags of the explanatory variables as instruments, the Newey–West correction to the covariance matrix and iterative updating of the weighting matrix. P-values for the J-statistics, reported below, suggest that the null hypothesis of no relationship between instruments and equations error is not rejected. For each measure of the inflation gap, we estimated policy rules for alternative values of k, reporting the model with the best fit.

Our estimates of $i_t = \mu i_{t-1} + (1 - \mu)\{\omega_0 + \omega_1(E_t \pi_{t+k} - \pi^*) + \omega_2 x_{t-2}\} + v_t$ are presented in Table 2.

TABLE 2. **Estimation results, UK 1993Q4–2007Q4**

	Official measure	RPIX	RPI	CPI	CPIX	GDP deflator	Wage costs	PC
ω_0	4.79 (0.18)	4.91 (0.33)	4.41 (0.56)	5.21 (0.30)	5.73 (0.52)	4.39 (0.75)	4.65 (0.68)	1.57 (1.33)
ω_1	1.96 (0.98)	2.70 (0.93)	2.19 (1.12)	1.02 (0.43)	1.35 (0.61)	1.30 (0.71)	2.35 (1.19)	1.28 (0.51)
ω_2	2.40 (0.75)	2.03 (0.59)	2.68 (1.57)	2.10 (0.45)	2.08 (0.59)	3.84 (1.59)	2.92 (1.29)	2.14 (0.58)
μ	0.89 (0.05)	0.87 (0.06)	0.93 (0.04)	0.87 (0.05)	0.90 (0.03)	0.93 (0.03)	0.92 (0.04)	0.88 (0.04)
k	0	1	0	0	3	-1	4	2
S. E.	0.31	0.32	0.28	0.32	0.32	0.30	0.30	0.32
J-stat	0.43	0.45	0.53	0.54	0.64	0.59	0.68	0.74

Prepared by authors, using data from ONS (Office for National Statistics) and eViews.

Notes:
1. J-test is the p-value for the test of exogeneity between instruments and equation errors.
2. Estimation by GMM using the Newey–West correction to the covariance matrix and iterative updating of the weighting matrix. The instrument set comprises the first four lags of the explanatory variables.

Perhaps surprisingly, given the diversity revealed in Table 1, we obtain plausible policy rules for each measure of the inflation gap, with all estimates consistent with *a priori* expectations. However, alternative measures of inflation lead to markedly different policy rules. Estimates of ω_1, the response to the inflation gap, vary between 1.02 and 2.70. Estimates of ω_2, the response to the output gap, lie between 2.03 and 3.84. Estimates of the interest rate smoothing effect μ vary between 0.87 and 0.93. The values of k range from -1 to 4, suggesting that policymakers consider a narrow horizon for inflation; this is consistent with the alternative specification estimated in the previous literature. Models using core and wage-based inflation are associated with higher values of k, suggesting a more forward-looking policy.

Using the standard error to discriminate, the model with RPI inflation is the best model in terms of the goodness of fit. Models using other measures of headline inflation perform relatively poorly, being dominated by models with domestic and wage inflation. However, the margins involved are rather small. To analyse this further, we divide the sample into periods of "turbulence" in 1997–1998 and 2001–2002 and periods of "calm" in the remainder of the sample. Comparing correlations between the policy rate and the fitted values of the policy rate from the models reported in Table 2, we find that the fitted value from the RPI model is more closely correlated with the policy rate than other models in periods of turbulence than in periods of calm. This is especially apparent in 2001–2002 when the RPI model is able to "explain" the depth of the cut in the policy rate better than other models. This suggests that a superior fit derives from a superior ability to explain the policy rate in periods of turbulence. However, this conclusion is based on one episode and so may not to be robust. No model is able to explain the rise in policy rates in 1997–1998: this may reflect a monetary policy shock engineered to give credibility to the newly independent Bank of England.

6. Conclusions

This paper has addressed the issue of which inflation rate is *actually* targeted by the policymakers as opposed to which measure of inflation is formally announced to be targeted. This issue has been addressed by estimating simple empirical monetary policy rules for the UK, using a range of alternative measures of the inflation rate. We find that a plausible policy rule can be estimated for each measure of inflation. The model using RPI inflation fits the data best, but the margin is rather small and may reflect a single episode.

Our findings suggest that, from the perspective of empirical models of monetary policy, it may not matter which measure of inflation is used. While this provides some support for an existing empirical literature that has used a variety of alternative measures, it does present something of a puzzle, since the measures of inflation we consider are rather diverse with some measures being only weakly or even negatively correlated.

Our conclusions should be treated with some caution, though. Our estimates are robust to alternative specifications within the same sample, through varying the value of k. However, they are not always robust to alternative sample dates. Reducing the sample length exacerbates issues around relatively few observations, and estimates can become unstable if the policy rate or inflation rates become non-stationary in a short sample. Extending the sample after 2007 introduces instability due to the well-documented collapse in the weight on inflation in empirical monetary policy rules in the financial crisis. We would argue that our results are plausible but also feel that some healthy scepticism might be appropriate.

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