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Abstract

In recent times, inflation targeting has been one of the most successful monetary frameworks in advanced economics. However, critics claim that policy rates have been kept higher than necessary. They claim that central banks did not pursue a symmetric inflation target. If a central bank pursues symmetric inflation and output targets, the optimal monetary policy response is a linear forward-looking Taylor rule (Clarida et,. al 1999). We use the Linex Loss function as outlined in Nobay and Peel (2003) to relax the assumption of symmetric preferences. The presence of asymmetric preferences implies that monetary policy reacts not only to the conditional expectation of inflation and output gap but also to their conditional variances. Non-linear Taylor rules are estimated on UK data from 1995: Q2 and 2003: Q3. The results support the critics. Inflation targeting was indeed pursued with asymmetric preferences. The findings are robust to the Bank of England's ex-ante forecasts, 'real-time' estimates of the output gap, non-linearities in the supply curve, and alternative forecast horizons. Policy rates have been about 30 basis points higher than necessary due to asymmetric preferences.

Key words:*Phillips curve; Taylor Rules; Asymmetric Preferences; Deflationary Bias; GMM estimation; Linex Loss Function; Rational Expectations; Monetary Policy*

JEL Codes: *E31; E52; E6*

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INTRODUCTION

Inflation targeting is optimal monetary policy under quadratic central bank preferences and a linear economic structure (Svensson 1997). It ceases to be optimal monetary policy if the central bank has asymmetric preferences (Nobay and Peel 2003). Monetary policy is tighter than necessary if the central bank is more averse to inflation overshooting its target. Average inflation is consequently lower than desired. Asymmetric preferences lead to *deflationary bias.*

Critics claim that deflationary bias is an accurate description of the inflation targeting experience. They maintain that inflation targeting has swung the pendulum too far in the other direction. Further, they claim that inflation mutters, pundits and mandarins sitting in "anti-inflationary temples" have reneged on their mandate, which was to pursue a symmetric target[1]. And that this has cost jobs, employment, and growth.

We test this proposition for a successful inflation targeting central bank, namely, the Bank of England. The Bank of England has been selected because there is sufficient data to test this hypothesis. While we cover only the Bank of England, this framework can be applied on any inflation targeting central bank. Any central bank with an asymmetric loss function facing a New Keynesian economy sets interest rates according to a non-linear Taylor rule. We estimate forward looking non-linear Taylor rules for the Bank of England during 1995: Q2 - 2003: Q3 to test the null hypothesis of symmetric preferences against the alternative of asymmetric preferences.

These results are in line with previous findings. There is evidence for asymmetric preferences in the period 1995: Q2 - 2003: Q3, which is

[1] Others claim that asymmetric preferences might arise due to the lack of central bank independence. Blinder (1998) claims that *"In most situations the central bank will take far more political heat when it tightens preemptively to avoid higher inflation than when it eases preemptively to avoid higher unemployment."*

robust to controlling for a non-linear supply curve, the bank's own ex-ante forecasts of inflation and real-time data. The critics were right. This means losses in terms of jobs and growth.

Inflation Targeting and Asymmetric Preferences

Inflation targeting, as defined by Svensson, consists of (i) an explicit inflation target as nominal anchor (ii) operational independence and (iii) accountability to the target and transparency in operation. Inflation targeting also implies that price stability is the 'over-riding' concern of monetary policy at least in the medium to long run. This stems from the recognition of a vertical Phillips curve in the medium to long run. Accountability to the target, and transparency in communication and operation aim at shoring up credibility to anchor inflation expectations. Once attained, this reduces the sacrifice ratio, allows costless disinflation, and gives more latitude towards business cycle stabilization.

Although inflation targeting describes a 'targeting rule' it also yields different 'instrument rules' for different economic structures (Svensson 1998). These instrument rules are dependent on 'intermediate targets' due to 'long and variable' lags in monetary policy transmission. By construction inflation forecasts, from sound forecasting models, have a stable relation with inflation. Inflation targeting is therefore inflation 'forecast' targeting, and every variable that carries unique information about inflation becomes a part of the instrument rule. A 'flexible' inflation targeting central bank, can be described as minimizing the expectation of a quadratic loss function given the information set ($\boldsymbol{\Omega}$) that it has.

$$E[L|\boldsymbol{\Omega}] = E\left[\frac{(\pi-\pi^*)^2}{2} + \lambda\frac{y^2}{2}|\boldsymbol{\Omega}\right] \quad (1)$$

This quadratic loss function means that the central bank gives some weight to output stabilization (λ) and that positive and negative deviations of inflation (π) and output gap (y) from their targets ($\pi^*, 0$) are treated equally. These are therefore symmetric preferences. The central bank is free to set its instrument (short term interest rates given by i) to minimize (1). Policy rates typically affect output first, and through output they effect inflation. So policy rates (i) are set in order to ensure the first order condition:

$$\frac{dE[L|\Omega]}{di} = E\left[(\pi - \pi^*)\frac{\partial \pi}{\partial y}\frac{\partial y}{\partial i} + \lambda y \frac{\partial y}{\partial i}|\boldsymbol{\Omega}\right] = 0 \qquad (2)$$

the instrument rule depends on (a) the functional form of central bank preferences, (b) the structure of the economy that links the policy rate to inflation and the output gap and (c) the information set ($\boldsymbol{\Omega}$). A quadratic loss function and a linear economic structure yields linear instrument rules known as the 'Taylor rule'. There is considerable empirical evidence that Taylor rules are useful first approximations of monetary policy conduct. It must be noted that a change in the functional form in (1) will generate quite different instrument rules.

The focus of this thesis will to first demonstrate how asymmetric preferences, (where positive and negative deviations from targets are treated asymmetrically) leads to non-linear Taylor rules, and to test whether this is a plausible description of the Bank of England's historical pursuit of inflation targeting.

The United Kingdom as Case Study

The United Kingdom is an excellent case-study because it was an early adopter of inflation targeting. It has seen many phases of inflation targeting and the Bank of England's remit has evolved over time. The Bank of England also provides us with sufficient data to rigorously test the hypothesis of deflationary bias. Additionally, the Bank of England has also published its actual forecast of inflation since 1993 which can be used to evaluate its policy response. Moreover, the Bank of England is explicit about the short-term interest rate being its chief instrument. The Bank of England turned to inflation targeting when it left the Exchange Rate Mechanism (ERM). The exchange rate target was officially abandoned. The Chancellor of the Exchequer, Norman Lamont, said in October 1992:

> *"I believe we should set ourselves the specific aim of bringing underlying inflation in the UK, measured by the change in retail prices excluding mortgage interest payments, down to levels that match the best in Europe. To achieve this, I believe we need to aim at a rate of inflation in the long term of 2 percent or less…For the remainder of this Parliament, I propose to set ourselves the objective of keeping underlying inflation within a range of 1 percent-4 percent, and I believe by the end of the Parliament we need to be in the lower part of the range."*
>
> —Chancellor of the Exchequer, Norman Lamont, October 1992

It should be noted that right at the outset the target was itself defined asymmetrically. The quotes "2 percent or less" and "we need to be in the lower part of the range" indicated an asymmetric mandate from 1992 to 1997. Additionally, there were still 'monitoring ranges' for money supply growth, but interest rates were not seeking to target money growth. So, what then would serve as intermediate targets? The answer is: forecasts of inflation. Policy rates were now set looking at inflation forecasts itself. All variables were relevant to policy setting, but only indirectly through their contribution to forecasting inflation. In November 1992, Robin Leigh-Pemberton the then Governor made this noticeably clear in a speech:

> *"Experience leads us to believe that monetary policy cannot be conducted with reference to a single target variable. The overriding objective of monetary policy is price stability. Therefore, policy must be conducted with reference to our expectations of future inflation… Consequently, policymakers should make use of every possible variable…as a guide to prospective inflation"*
>
> —Robin Leigh-Pemberton (quoted in Mishkin and Posen 1997).

The rollout of inflation targeting in the UK has been a slow process. From February 1993, the Bank began to publish quarterly editions of the *Inflation Report* where it published its ex-ante forecasts of inflation and rationalize its policy decisions. Even while the Chancellor had the final say on the policy rate, the Bank obtained discretion over the timing of the interest rate change to assuage fears that political interference might seek loose policy just prior to elections. From 1994 onwards, the minutes of policy decision meetings began to be published. In the June of 1995, the remit changed to a point target of "2.5 percent or less" over a long period, while the 1 percent to 4 percent band became a buffer zone. This shift in policy has been captured by econometric evidence which confirms that the Bank of England pursued a target range from 1992-1995 after which it shifted to a point target (Srinivasan et,. al 2006). The timing of this change will prove crucial in the sample selection of this study. It should also be noted that by 1995 the bank carried an asymmetric mandate.

However so far, the Bank of England had only an indirect influence on the interest rate decisions. Following the election of the New Labor government in 1997, the Bank of England was granted *operational independence.* The target was made fully symmetric around 2.5 percent, with a tolerance limit of 1 percent deviations. If inflation went beyond these limits, the Governor would have to write an open letter explaining this failure. Operational independence also implied full control over interest rate decisions. The Monetary Policy Committee was also set up and would decide on policy rates via monthly meetings. The minutes of these meetings are published within 2 weeks. This was hailed as a monumental moment in economic policy in the UK, with many commentators praising the end of politics in monetary policy.

However, right when the Bank completed its transition to inflation targeting, questions were being raised about the preferences of the bank and what they would do with their newfound independence.

The ex-chancellor of the time Kenneth Clarke criticized this approach and he said:

> *"What you are going to see, undoubtedly, is tighter monetary policy than you might otherwise have got from a perfectly responsible chancellor of the exchequer who is prepared to take the broadest possible view of what is in the interests of British industry and commerce and the people who work in it…"*[2]

Clearly Kenneth Clarke was speaking from experience. During his reign as Chancellor, the Bank of England did not have full operational independence. And there were many moments when the Bank of England pressed for a tighter policy that the Chancellor over-ruled. For instance, in June and August of 1996, the Bank put forward the Inflation Report, which predicted inflation to overshoot the target unless rates were raised, to push for a rate hike. The two-year projections showed that inflation would be "a little above 2.5 per cent and rising with the risks more on the upside than the downside". The Chancellor over-ruled and continued to bring down rates, citing other evidence that suggested that inflation was subdued[3].

These incidents show that when the Bank attained operational independence, many commentators had legitimate reasons to believe that monetary policy would become more hawkish than before. By 1997 the Bank satisfied Svensson's criterion for inflation targeting. And by 1997, the critics were already warning of overly tight policy.

The Bank of England Act of 1998 formally recast the primary responsibility of monetary policy to maintain price stability. Pursuit of growth and unemployment concerns was to happen only after this primary objective was secured. There were no further changes until 2003

[2] "Brown gives Bank independence to set interest rates", Elliot and White, The Guardian, May 7th 1997.
[3] "B of E policy rift with Clarke widens", Sebastian Taylor, The Irish Times, August 8th 1996.

when the Bank shifted from targeting Retail Price Inflation to targeting Consumer Price Inflation at 2 percent. However, the structure was largely the same. In 2008, the Bank turned to 'unconventional 'monetary policy to respond to the severity of the Great Recession. Interest rates were lowered to close to zero and open market operations were used to stimulate the economy.

After 2008, interest rate setting was conducted very differently and because data on the CPI targeting period is too short for econometric analysis, we are confined to the RPIX targeting period. However, the starting date is still of concern. Legitimate questions have been asked about including the 1992 to 1995 period. There is evidence for a target range which is not the same as a point target (Martin and Milas 2004, Srinivasan *et. al.*, 2006). Therefore, we exclude the 1992 - 1995 period, and evaluate the Bank's policies only when it was following a point target. We include the 1995 – 1997 period, during which the bank's remit was asymmetric because excluding this would leave us with an exceedingly small sample to make inference. Therefore, this study of inflation targeting focuses on the period 1995 – 2003 where the Bank followed a point RPIX target.

After 1997, the bank repeatedly assuaged concerns by reiterating that it was following asymmetric target. John Vickers, Chief Economist at the Bank of England said in 1998,

> *"There is every indication (e.g. from the 1 percent letter-writing thresholds) that, at least as far as inflation is concerned, losses are symmetric: being 0.6 percent above the target is neither better nor worse than being 0.6 percent below it."*

Dr. Wadhwani then member of the Monetary Policy Committee, in 2001, said:

> *"A critical part of our monetary policy framework is that it specifies a symmetric target -treating deviations above the target*

in the same way as those below the target. If for example, the emphasis were on inflation being 2.5 percent or less, then there would be an incentive for us to drive inflation down, so that the likelihood of breaching the target would be reduced, but at the cost of a detrimental effect on output and employment. A symmetric target potentially permits the highest level of growth that is consistent with the 2.5 percent target."

Therefore, the argument between the Bank and its critics is clear. Both recognized the problems of asymmetric target. There was no dispute that it would be wrong on the Bank's part to have asymmetric preferences. But the Bank said it followed a symmetric target while the critics maintained that it was following an asymmetric target. These are mutually exclusive statements, and it is the task of this paper is to test who was right.

Outline

This working paper is as follows. First we present a literature review on asymmetric loss functions, Taylor rules and previous empirical findings. Then we present the data and methodology. Also included are unit root tests. We also build the general model that will be estimated. The estimation results begin with linear forward-looking versions of the Taylor rule. Then we move onto non-linear Taylor rules that test the hypothesis of asymmetric preferences. Robustness checks are also presented. Then we conclude and summarize. The Appendix examines the Linex Loss.

LITERATURE REVIEW

Optimal Monetary Policy Under Asymmetric Preferences

The asymmetric loss function was given a formal treatment in Nobay and Peel (2003). They use a small game to demonstrate the impact of asymmetric preferences. In a one period, one shot game they assume the central bank has an asymmetric loss function,

$$L = \frac{e^{\alpha(\pi-\pi^*)}-\alpha(\pi-\pi^*)-1}{\alpha^2} + \lambda\frac{y^2}{2} \quad (3)$$

where π is annual inflation, y is the log-linearized 'output-gap', π^* is the inflation target prescribed by the mandate, λ is the weight given to output stabilization as compared to inflation stabilization. If the asymmetry parameter α is positive, positive deviations of inflation from target incur more loss relative to negative deviations of inflation from target. The reverse happens when ɑis negative, and when ɑ tends to zero the function limits to the quadratic loss function. For further examination of the Linex Loss function see the Appendix.

We assume the central bank faces the linear Lucas 'surprise' supply curve (Lucas 1975), where log linearized potential output has been normalized to 0.

$$y = \beta(\pi - \pi^e) + \upsilon \quad (4)$$

The game proceeds as follows. The central bank sets inflation (it has perfect control) after observing the supply shock, and sets it in such a way to balance the goals of inflation and output stabilization. However, inflation expectations of the private sector are set before this. They are set by considering the optimal response of the central bank. Which is given by,

$$\frac{dL}{d\pi} = \frac{e^{\alpha(\pi-\pi^*)}-1}{\alpha} + \lambda\beta(\beta(\pi - \pi^e) + \upsilon) = 0 \quad (5)$$

We apply 2nd order Taylor series approximation to get,

$$\frac{dL}{d\pi} = (\pi - \pi^*) + \alpha\frac{(\pi-\pi^*)^2}{2} + \lambda\beta(\beta(\pi - \pi^e) + \upsilon) = 0 \quad (6)$$

The private sector has rational expectations and uses (6) to set its expectations. We apply expectations on (6) and impose $\pi^e = E(\pi)$ to get:

$$E(\pi) = \pi^* - \alpha \frac{E(\pi-\pi^*)^2}{2} \qquad (7)$$

assuming inflation to be normally distributed with variance σ_π^2, we now get:

$$E(\pi) = \pi^* - \alpha \frac{\sigma_\pi^2}{2} \qquad (8)$$

Thus, under asymmetric preferences we find that optimal monetary policy does not keep average inflation at target. It is capable of causing deflationary bias, even though there are other factors at play. For instance, having α>0 will not by itself lead to deflationary bias if the central bank is targeting an output level above potential. Another complication could arise if there were additionally asymmetric preferences on output as well, so the net effect on average inflation could well be mixed.

The essential point is that under asymmetric preferences, optimal policy keeps tabs on the conditional second moments. If the forecasted variance of inflation is positive, then an inflation-averse (α>0) central bank will act prudently by keeping expected inflation below target to minimize loss.

This also points to the role of uncertainty in bringing out the consequences of asymmetric preferences. Moreover, it also implies that to test the hypothesis of asymmetric preferences, we only need to see if the central bank's reaction factors in the conditional variance of inflation. However, this simple model has no role for instruments like interest rates, so we need to build a more general model to allow us to test the hypothesis of asymmetric preferences.

Taylor Rules

The most popular way to evaluate monetary policy is to estimate Taylor rules. While there maybe numerous factors and deliberations that could have determined policy rates at any point in time; this rule demystifies monetary policy response to developments in the economy by reducing it to a few parameters. The original rule was applied on U.S data, and describes policy interest rate (i_t) setting as a simple linear function of current deviation of inflation from target i.e. the current inflation gap ($\pi_t - \pi^*$) and deviation of current output (y_t) from its long run potential (y^*). Further when inflation and output are at target policy rates are kept so that 'real' policy rates are aligned with the natural rate of real interest rate (r*). Deviations from the rule are captured by the residual and are known as 'policy shocks'.

$$i_t = r^* + \pi^* + \varphi_1(\pi_t - \pi^*) + \varphi_2(y_t - y^*) + v_t \tag{9}$$

While the original rule was devised as a rule of thumb that could be both descriptive and prescriptive (Taylor 1993), it has been found to be the optimal monetary policy when a central bank with quadratic loss function responds to an economic structure with adaptive expectations (Svensson 1997). In Svensson's model transmission lags ensure that inflation effects inflation two periods ahead, and the central bank sets interest rates looking at current inflation and output gap because are optimal predictors of inflation two periods ahead.

Extensions of the Taylor rule include taking care of the fact that central banks are also believed to smoothen policy rate changes, slowly bringing actual policy rate to its desired levels over time. Thus, actual policy rate is modelled as an autoregressive process that follows,

$$i_t = \delta_1 i_{t-1} + (1 - \delta_1) i_t^d + v_t \tag{10}$$

where desired policy rate is determined by the Taylor rule.

$$i_t^d = r^* + \pi^* + \varphi_1(\pi_t - \pi^*) + \varphi_2(y_t - y^*) \tag{11}$$

which gives the following reduced form for policy rate,

$$i_t = \delta_1 i_{t-1} + (1-\delta_1)(r^* + \pi^* + \varphi_1(\pi_t - \pi^*) + \varphi_2(y_t - y^*)) + v_t \quad (12)$$

The lagged policy rate is also useful in mopping up excess serial correlation. However, these models are still unrealistic because typically central banks do not have information about current inflation and output when they set the policy rate. Therefore, they are usually estimated using lags of inflation and output gap.

Also there is a likelihood that central banks might consider other variables when setting interest rates. The general form of backward looking Taylor rules is:

$$i_t = A(L)i_t + \big(1 - A(L)\big)(r^* + \pi^* + B(L)(\pi_t - \pi^*) + C(L)(y_t - y^*) + D(L)(x_t - x^*)) + v_t \quad (13)$$

Where $A(L), B(L), C(L), D(L)$ are polynomials in the lag operator such that:

$$A(L) = B(L) = C(L) = D(L) = 0$$

And $x_t - x^*$ could represent any other variable that could help the central bank predict inflation such as exchange rates or monetary aggregates. Models like (13) can fit the data well (Kozicki 1999, Nelson 2001, Taylor 1999, Orphanides 1997). However backward-looking specifications are restrictive in that they are optimal rules only for a narrow class of models. Only a few economic structures can give rise to reaction functions like (13).

A way forward was developed in Clarida, Gali and Gertler (1997) who nest (13) within a broader class of forward-looking Taylor rules.

$$i_t = \delta_1 i_{t-1} + (1-\delta_1)(r^* + \pi^* + \varphi_1 E(\pi_t - \pi^* | \boldsymbol{\Omega}_{t-1}) + \varphi_2 E(y_t - y^* | \boldsymbol{\Omega}_{t-1})) + v_t \quad (14)$$

(14) implies that the central bank sets interest rates after forecasting inflation and output gap. In practice (14) is estimated by substituting actual values of inflation in place of expectations and the forecast errors go into the residual term. The Generalized Method of Moments (GMM) uses information available to the central bank when it set the interest rates, that must be orthogonal to the composite error term, to estimate the parameters. Therefore, all lags of inflation and output gap are utilized in generating a forecast of inflation, to which monetary policy responds. This improved forward-looking Taylor rule has been shown to be optimal monetary policy for a wide class of models. Forward looking Taylor rules seem to fit the behavior of the Federal Reserve (Clarida, Gali and Gertler 1998, 1999, 2001).

The central bank may not aim at the forecast of current inflation, because of transmission lags. It may aim at inflation a few periods ahead. Alternative forecast horizons can be added:

$$i_t = \delta_1 i_{t-1} + (1-\delta_1)(r^* + \pi^* + \varphi_1 E(\pi_{t+k} - \pi^* | \boldsymbol{\Omega}_{t-1}) + \varphi_2 E\big(y_{t+j} - y^* | \boldsymbol{\Omega}_{t-1}\big)) + v_t \quad (15)$$

Here k is the target horizon for inflation i.e. the time it takes for policy rates to effect inflation. Similarly j is the target horizon for output.

Econometric Evidence

While theoretical examinations of asymmetric preferences have been diverse, empirical testing of asymmetric preferences has largely relied on the framework offered by Nobay and Peel (2003).This approach has the advantage that it is tractable and it allows us to test the direction and magnitude of the asymmetry parameter. Table 1 summarizes the past findings made on UK data. Almost all studies find evidence of asymmetric preferences.

Ruge Murcia (2003) shows that a central bank with asymmetric loss function responds to uncertainty by being 'prudent' and this can counteract inflation bias. When the central bank is targeting the natural rate of unemployment, the average inflation becomes a function of the conditional variance of unemployment rates, similar to what was given in (8). Ruge Murcia (2004) tests this proposition and confirms that there the Bank of England did have 'recession avoidance 'preferences. This implies asymmetry on unemployment in the loss function.

Table 1: Empirical Evidence for Asymmetric Preferences

Authors	Period	Innovation	Inference	Asymmetry?
Martin and Milas (2004a)	1992-2000	Policy rule that responds differently to (expected) inflation in 'inner' and 'outer' ranges.	Inner range is 1.4 percent to 2.6 percent and monetary reaction is larger when expected inflation is outside this.	Yes, on inflation.
Gascoigne and Turner (2003)	1992-2003	Models policy rate changes as functions of inflation and growth.	Larger probability of interest rate hike when growth is higher.	Yes, on growth.
Boinet and Martin (2005)	1992-2003	Taylor rules with with different reaction for different thresholds of inflation.	Policy rates respond to Inflation gaps only when it's a outside 2.3 percent - 2.7 percent (target zone).	Yes, on inflation.
Srinivasan et,. al (2006)	1995-2003	Used Actual Forecasts of BoE.	Inflation aversion detected that is not robust to use of Actual Forecasts, indicating 'forecast bias'.	No.
Cuckierman et,. al (2008)	1992-2005	Derives the Taylor rule under joint Recession and Inflation Avoidance preferences; tests to see which is dominant.	Inflation Avoidance Dominates Recession Avoidance, Taylor rule is convex in inflation.	Yes, on inflation.

Similarly Cuckierman and Gerlach (2003) show that asymmetric preferences that favor positive output gaps over negative output gaps lead average inflation to be an increasing function of the variance of shocks to output. Evidence for 22 developed economies in the period before 2000 shows that this is indeed the case. This suggests that inflation bias in advanced economies could have arisen due to asymmetric preferences on output.

Not all tests of asymmetric preferences have been conducted using the Linex Loss function A different approach is outlined in Surico (2007a) who demonstrates that a central bank with asymmetric preferences responds to a New Keynesian economy by means of a non-linear Taylor rule. The estimated non-linear Taylor rule for the United States shows that in the pre-Volker era monetary policy had recession avoidance preferences, which does not exist in the post-Volker era. This can account for inflationary bias in monetary policy during this period. Surico also tests for non-linearities in the Phillips curve and comes up with the conclusion that these are insignificant.

Surico (2007b) tests a similar model on European data while explicitly controlling for non-linearities in the economic structure by adding a cross-product term in the reduced form solution for interest rates. Srinivasan *et. al.* (2006) use the Linex Loss function to demonstrate inflation-averse preferences and thus deflationary bias for the United Kingdom. However, this finding disappears when they use the actual ex-ante forecast of inflation. The authors conclude that the deflationary arose due to bias in the forecasts and not asymmetric preferences on inflation.

Identification Issues

The jump from an asymmetric reaction function to asymmetric preferences is not simple. In fact, asymmetric preferences may not be the sole reason for asymmetric monetary policy reactions. Non-linear Taylor rules can also arise due to non-linearities in the economic structure. So, when a central bank with symmetric preferences is facing a convex aggregate supply, then its optimal response is to react harder to inflation overshoots. This is the essence of Minford and Srinivasan (2009) who show that the testing the hypothesis of asymmetric preferences suffers from such an identification problem.

Identification of the asymmetry parameter via the non-linear Taylor rule assumes that the central bank has rational ex-ante forecasts which the GMM seeks to replicate in estimation. Inference can be biased if the actual forecasting models of the bank were biased. A central bank with asymmetric preferences will, with upward biased ex-ante forecasts of inflation, respond tighter than required. However, the GMM, generating only unbiased forecasts, may not capture this phenomenon. This problem is resolved in Srinivasan *et. al.* (2006), by using actual ex-ante forecasts of inflation as robustness' check.

Identification is further complicated by the fact that non-linear Taylor rules might be observed a historical policy evaluation even without there being any such biases. Inferring demand pressure intel economy requires accurate estimates of the 'output-gap' but estimates from conventional statistical filters are sensitive to the sampling period. Historical policy evaluation working with hindsight and future realizations of output might arrive at a different estimate of output gap than what could have been possibly known at the time. Even if policy makers were adhering to asymmetric, policy evaluation could misleadingly display evidence for asymmetric preferences due to hindsight bias. This problem is resolved by using a real-time dataset as a check.

DATA AND METHODOLOGY

Data and Sources

The entire dataset has been described has been described in Table 2. The estimations will be on the 1995Q2 - 2003Q3 period. The actual policy instrument has not been identical during this period, so we proxy it by using the Nominal 3-Month Treasury Bill Yield (T90). This short-term interest rate closely tracks the developments in the numerous policy instruments. The inflation gap (RPIX)is measured by the difference between actual annual RPIX inflation and the official target of 2.5 percent.The output gap (GAP) is measured by log linearizing real GDP and then applying the Hodrick Prescott filter. The smoothening parameter is taken to be 1600 as convention. We subtract the Bank's ex-ante forecast of RPIX inflation from the target value of 2.5 percent, to obtain the i-period ahead forecast of inflation gap (FORE[i]).

Other relevant variables that have been used to create model generated forecasts have been the old Sterling Effective Exchange Rate (SEEX), the HP filtered cycles of unemployment rate (UNEMP) and the spread between 10 year nominal and inflation indexed bonds (SPREAD). The SEEX captures the openness of the British economy, the UNEMP is used to forecast the GAP and the SPREAD is a proxy for market inflation expectations.

Table 2: Variables used in Estimation

Variable	Description
T90	3 Month Treasury Bill Yields, Seasonally Adjusted
RPIX	Annual Inflation in Retail Price Index (Excluding Mortgage Payments) minus the Target (2 .5 percent)
GAP	HP filtered cycles from Chained Real GDP Seasonally Adjusted
FORE(i)	i periods ahead forecast of inflation made at time t minus the target (2.5 percent)
UNEMP	HP filtered cycles from registered unemployment rate, Seasonally Adjusted
SEEX	Sterling Effective Exchange Rate (IMF-Old)
SPREAD	Difference between nominal and indexed 10 year T-bill yields

Unit Root Tests

Before estimation we conduct Augmented Dickey Fuller Tests. This involves running the following regression on every variable, in the 1995: Q2 – 2003: Q3 period.

$$\Delta x_t = \beta \Delta x_{t-1} + \sum_i^n \rho_i \Delta x_{t-i} + \varepsilon_t \tag{16}$$

It should be noted that unit root tests have low power i.e. they fail to distinguish between unit root and near unit root processes. Thus, these tests are biased towards unit root processes. Additionally, there is large theoretical support for the stationarity of interest rates and annual inflation rates. De-trending procedures like the HP filter remove the unit root. However, it is always good practice to display unit root tests.

The following stylized facts emerge during 1995:Q2 to 2003:Q3. The policy rate (T90) has been on average a little over 5 percent per annum, with little variation around that. The inflation deviation (RPIX) around 2.5 percent per annum has been on average close to zero. Also, the variation has been very small. The actual ex-ante forecast of inflation (deviations) has also been close to zero, with little variation. The output gap has been on average, by construction, close to zero. These stylized facts by themselves do lend support to the claim that inflation targeting was conducted with asymmetric preferences. However, that average inflation was close to zero does not go against the idea either. Average inflation is determined by a whole host of other factors like the nominal interest rate target, natural real interest rate, and output target.

We perform unit root tests on all variables and the results are presented in Table 3. The p-values are MacKinnon p-values for Augmented Dickey Fuller unit root tests using 3 lags. The squared terms of output and inflation gap as well as their cross-product terms are also included. The results show that in 1995: Q2 – 2003: Q3, all variables were stationary except GAPSQUARE and RPIXSQUARE. The results lend support to the estimations in the next segment.

Table 3: Unit Root Tests

Period	Mean	St.Dev	P-Value
T90	5.381	1.142	0.8
RPIX	0.012	0.366	0.5
GAP	-0.043	0.465	0.18
FORE(0)	0.003	0.376	0.56
SEEX	100.719	7.870	0.1
UNEMP	6.185	1.162	0.08
SPREAD	3.150	0.642	0.39
RPIXSQUARE	0.130	0.115	0.04
GAPSQUARE	0.211	0.235	0.014
CROSSPRODUCT	-0.016	0.179	0.06
FORESQUARE	0.137	0.154	0.3143
CROSSPRODUCT_FORE	-0.025	0.190	0.16

Univariate De-trending

One of the core issues in applied macroeconomic work is the issue of separating potential output from actual output. Potential output is that portion of actual output that depends on real factors, which the difference i.e. the cyclical component depends on monetary or transitional factors. Monetary policy should respond very differently to changes in the cyclical components as compared to changes in potential output. In short run macroeconomics, monetary policy is interested in the 'output gap' or the cyclical component only. The conventional wisdom entails that the nature of the economy is such that this component is mean reverting even if persistent overtime. Our assumptions about the nature of the economy lead us to methods that help distinguish actual from potential output.

One simple way to simply regress the log of output on time, and the residuals thus obtained are treated as the cyclical components. Here we are assuming that the potential output grows at a constant pace. One might relax this assumption by introducing a squared term in the regression of log of output on time. This would allow potential output to have uniform increase or decrease in its growth. Developing on this idea Hodrick and Prescott (1991, 1997) develop a method that allows the growth rate to smoothly increase or decrease. If log linearized actual output (y_t) can be written as the sum of potential output (g_t) and cyclical deviations (c_t), then we have

$$y_t = g_t + c_t \tag{17}$$

The Hodrick and Prescott Filter selects the trend $\{g_t\}_{t=1}^{T}$ by the following minimization:

$$\{g_t\}_{t=1}^{T} = argmin[\sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=1}^{T}[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})^2]] \tag{18}$$

Here λ is known as the smoothening parameter and its value governs the ratio of the variation in the cyclical component vis-à-vis the variation in the growth of potential output. Hodrik and Prescott prescribed a value of 1600 for the smoothening parameter for quarterly data. They arrive at this figure by employing the following rules of thumb. The HP filter is easy to compute, is intuitive and has been found to work well with mainstream macroeconomic models. The cyclical components it yields correspond well to what academicians and policy makers expect to see in cyclical components. Therefore, it has been widely popular in academic and policy circles. However, there are serious problems with it. These are summarized in Hamilton (2017). For starters, it can be shown that the HP filter yields optimal disaggregation of trend and deviation only if the series is an I(2) process among other conditions. But if the series were generated by such a data generating process then its cyclical components would all be white noise.

Moreover, a large number of papers have questioned the assumption that potential output grows smoothly. Starting with Nelson and Plosser (1982) we see papers demonstrating that shocks to potential growth explain a larger amount of variation in actual output. In other words, there seems to be a unit root in GDP. If this is true, then application of the HP filter has serious ramifications. De-trending with the HP filter on a random walk generates spurious 'cycles' (Hamilton 2017). In this paper we have gone ahead with the HP filter. It was a recognized and influential method of de-trending at the Bank of England during the period concerned. HP estimates were and still are important inputs into policy making. In comparison, it is more unlikely that estimates from other models like the unobserved component models would have been more influential (or correct). That is because unobserved component models give output gap with little persistence. The HP filter is in comparison a much more plausible thumb rule.

The HP filter makes use of the entire sample. This gives it a lot of hindsight, which policymakers in real time would not have. Partly this problem can be resolved by using a one-sided HP filter. In this study we instead offer robustness check using a real-time dataset.

The General Model

This is a simpler version of the model presented in Surico (2007b). We describe the loss function of the central bank as:

$$L_t = \left\{ \lambda \frac{e^{\alpha(\pi_t - \pi^*)} - \alpha(\pi_t - \pi^*) - 1}{\alpha^2} + \lambda \frac{e^{\gamma y_t} - \gamma y_t - 1}{\gamma^2} + \frac{\mu_a}{2}(i_t - i^*)^2 + \frac{\mu_b}{2}(i_t - i_{t-1})^2 \right\} \quad (19)$$

Here i_t is the policy rate at time 't'. The weights given to different objectives are: μ_b for smoothening interest rate movements, μ_a for interest rate stabilisation, λ for inflation stabilisation and 1 for output stabilization. The targets: π^* for inflation, i^* for the policy rate and 0 for output gap.

The asymmetry parameters: α for inflation and γ for output gap. The information set availableto the central bank includes all information at time t-1; shocks at time t are unknown to the centralbank just as they are to the private sector. The optimal interest rate at any given time is given by,

$$i_t^o = argmin\, E_{t-1}L_t \tag{20}$$

The structure of the economy is given by,

$$\pi_t = \theta E_t\pi_{t+1} + \frac{ky_t}{1-\tau ky_t} + \varepsilon_t^s \tag{21}$$

$$y_t = E_t y_{t+1} - \varphi(i_t - E_t\pi_{t+1} - r^*) + \varepsilon_t^d \tag{22}$$

(21) is a forward-looking supply curve and (22) is a forward-looking Investment-Saving (IS) curve. Thus, the central bank is able to impact output in the same period by raising policy rates. By effecting output-gaps, it can impact inflation in the same period. Since policy rates at time "t" have control over losses only at time "t" there are no transmission lags whatsoever. This is consistent with the evidence found in Brzoza-Brzezina *et. al.* (2013). Therefore, the dynamic optimization problem for the central bank breaks down into one-period-problems. Differentiating,

$$\frac{dE_{t-1}L_t}{di_t} = E_{t-1}\left\{\begin{matrix} \lambda \frac{e^{\alpha(\pi_t-\pi^*)}-1}{\alpha}\frac{k}{(1-\tau ky_t)^2}[-\varphi] + \frac{e^{\gamma y_t}-1}{\gamma}[-\varphi] \\ +\mu_a(i_t - i^*) + \mu_b(i_t - i_{t-1}) \end{matrix}\right\} = 0 \tag{23}$$

The second order Taylor series approximation is applied to the non-linearities in inflation andoutput gap around target values.

$$E_{t-1}\left\{\begin{matrix} \lambda[(\pi_t-\pi^*) + \alpha(\pi_t-\pi^*)^2]\frac{k}{(1-\tau ky_t)^2}[-\varphi] + [y_t + \gamma {y_t}^2][-\varphi] \\ +\mu_a(i_t - i^*) + \mu_b(i_t - i_{t-1}) \end{matrix}\right\} = 0 \tag{24}$$

First order Taylor series approximation is applied to the non-linearities in the Phillips curve.

$$E_{t-1}\left\{\begin{matrix} \lambda[(\pi_t-\pi^*) + \alpha(\pi_t-\pi^*)^2][k - 2k^2\tau y_t][-\varphi] + [y_t + \gamma {y_t}^2][-\varphi] \\ +\mu_a(i_t^o - i^*) + \mu_b(i_t^o - i_{t-1}) \end{matrix}\right\} = 0 \tag{25}$$

Which on re-arranging gives us the optimal rule,

$$i_t^o = \rho i_{t-1} + (1-\rho)\begin{bmatrix} i^* + \frac{\lambda k \varphi}{\mu_a} E_{t-1}(\pi_t - \pi^*) + \frac{\varphi}{\mu_a} E_{t-1} y_t \\ + \frac{\alpha \lambda k \varphi}{\mu_a} E_{t-1}(\pi_t - \pi^*)^2 + \frac{\varphi \gamma}{\mu_a} E_{t-1} {y_t}^2 \\ + \frac{2\lambda k^2 \tau \varphi}{\mu_a} E_{t-1}(\pi_t - \pi^*) y_t \end{bmatrix} \quad (26)$$

$$\rho = \frac{\mu_b}{\mu_a + \mu_b} \quad (27)$$

And given that actual policy is optimal policy plus monetary disturbances/policy shocks and let the policy rate target be the sum of the real policy target and inflation target.

$$i_t = i_t^o + v_t \quad (28)$$

$$i^* = r^* + \pi^* \quad (29)$$

We get the reduced form solution for actual policy rate,

$$i_t = \rho i_{t-1} + c_0 + c_1 E_{t-1}(\pi_t - \pi^*) + c_2 E_{t-1} y_t + c_3 E_{t-1}(\pi_t - \pi^*)^2 + c_4 E_{t-1} {y_t}^2 + c_5 E_{t-1}(\pi_t - \pi^*) y_t + v_t \quad (30)$$

Equation (30) is estimated via GMM, which allows us to use actual value of inflation and output gap as regressors alongside many instruments from time "t-1". This works because actual inflation and actual output gap are related to their optimal forecasts via forecast errors.

$$\pi_t = E_{t-1}\, \pi_t + \xi_t^{\pi} \quad (31)$$
$$y_t = E_{t-1}\, y_t + \xi_t^{y} \quad (32)$$

We plug in actual values in the place of expected values to get,

$$i_t = \rho i_{t-1} + c_0 + c_1(\pi_t - \pi^*) + c_2 y_t + c_3(\pi_t - \pi^*)^2 + c_4 {y_t}^2 + c_5(\pi_t - \pi^*)y_t + e_t \qquad (33)$$

And e(t) consists of the policy shock alongside a combination of forecast errors of inflation and output gap. So, we are ensured for any variable Z^j in the central bank's information set $\boldsymbol{\Omega}_{t-1}$.

$$E\left(e_t Z_{t-i}^j\right) = 0, \forall \text{ i } \in \mathbf{N} \text{ and } \forall Z^j \in \boldsymbol{\Omega}_{t-1} \qquad (34)$$

The next segment estimates (33) and presents the coefficients. The interest will be regarding c_3 which contains the asymmetry parameter. Since $c_3 = \alpha c_2$, we can identify the value of alpha as long as c_2 is not zero. Since this is always found to be true in all estimations, we can simply test $H_0: \alpha = 0$ by testing $H_0: c_3 = 0$. This will tell us if the Bank of England had asymmetric preferences or not.

ESTIMATION RESULTS

Linear Taylor Rules

We first set all three asymmetry parameters to zero in (33) and estimate linear Taylor rules. Table 4 presents the results. Three lags of the regressors, unemployment HP cycles, effective exchange rates and interest rate spread were used as instruments. The model fit is excellent with all variables significant and the signs in the right direction. The results with model generated inflation forecasts and actual forecasts give almost identical results. We set the inflation target to 2.5, to find the inflation deviations before running the regression.

There is no serial correlation in the residuals (the Achumby Chungwa test at lag 1), which allows us to make inferences. And so we find that all coefficients are significant at 1 percent level of significance. The long run multiplier for inflation is well above 1. The root mean square is low, the J-test tells us that the overriding moment conditions are valid. The first stage Shea Partial R2s are above 0.5 and close to the actual Partial R2s. The coefficients on both models are almost identical, leading weight to the results and compensating for the smallness of the sample.

Table 4: Linear Taylor Rule Estimates

Model 1: $\boldsymbol{i_t = \rho i_{t-1} + c_0 + c_1 E_{t-1}(\pi_t - \pi^*) + c_2 E_{t-1} y_t + e_t}$		
	Model Generated	Actual Inflation Forecasts
ρ	0.85*	0.87*
c_0	0.55*	0.60*
c_1	0.18*	0.25*
c_2	0.43*	0.45*
RMSE	0.33	0.33
AC Test P-Value	0.717	0.06
J Test P-Value	0.99	0.99

Note: * is significance at 1 percent level, ** is significance at 5 percent level, *** is significance at 10 percent level. The instruments used were 3 lags of regressors, dependent variable, Sterling Effective Exchange Rate, HP-detrended unemployment rate, Spread between 10 yr nominal and indexed Government Bonds.

Non-Linear Taylor Rules

We now estimate a non-linear Taylor rule after allowing for asymmetric preferences both in inflation and output. However, we still restrict the non-linearity in the Phillips curve to zero. The results are presented in table 5. Both model generated forecasts and actual forecasts give the similar results. There is no serial correlation, collectively the instruments are strong and the model fit is excellent. Once again, all variables are highly significant, but the most important finding is that there is clear evidence for *both inflation-averse and expansion-avoidance preferences.* But to be able to correctly identify asymmetric preferences we need to control for non-linearities in the Phillips curve.

This is what we do next. We estimate the full model without any restrictions this time. The estimation is presented in Table 6. The model fit is again excellent, all regressors are significant at the 1 percent level. The model generated forecasts and actual forecasts give identical results. Even after controlling for non-linearities in the supply curve we still see evidence for asymmetric preferences. The cross product term is positive and significant, hinting at a convexity in the economy that contributes to deflationary bias.

Table 5: Non-Linear Taylor Rule Estimates

Model 2: $\boldsymbol{i_t = \rho i_{t-1} + c_0 + c_1 E_{t-1}(\pi_t - \pi^*) + c_2 E_{t-1} y_t + c_3 E_{t-1}(\pi_t - \pi^*)^2 + c_4 E_{t-1} {y_t}^2 + e_t}$		
	Model Generated Forecasts	Actual Inflation Forecasts
ρ	0.96*	0.94*
c_0	-0.2*	0.06***
c_1	0.34*	0.38*
c_2	0.36*	0.34*
c_3	1.1*	0.12**
c_4	0.81*	0.72*
RMSE	0.29	0.30
AC Test P-Value	0.48	0.06
J Test P-Value	0.99	0.99

Note: * is significance at 1 percent level, ** is significance at 5 percent level, *** is significance at 10 percent level. The instruments used were 3 lags of regressors, dependent variable, Sterling Effective Exchange Rate, HP-detrended unemployment rate, Spread between 10 yr nominal and indexed Government Bonds.

Table 6: Controlling for Non-Linear Phillips Curve

Model 3: $i_t = \rho i_{t-1} + c_0 + c_1 E_{t-1}(\pi_t - \pi^*) + c_2 E_{t-1} y_t + c_3 E_{t-1}(\pi_t - \pi^*)^2 + c_4 E_{t-1} {y_t}^2 + c_5 E_{t-1}(\pi_t - \pi^*) y_t + e_t$		
	Model Generated Forecasts	Actual Inflation Forecasts
ρ	0.95*	0.93*
c_0	-0.08*	0.11*
c_1	0.43*	0.48*
c_2	0.46*	0.46*
c_3	1.06*	0.27*
c_4	0.83*	0.78*
c_5	0.60*	0.51*
RMSE	0.28	0.29
AC Test P-Value	0.92	0.20
J Test P-Value	0.99	0.99

Note: * is significance at 1 percent level, ** is significance at 5 percent level, *** is significance at 10 percent level. The instruments used were 3 lags of regressors, dependent variable, Sterling Effective Exchange Rate, HP-detrended unemployment rate, Spread between 10 yr nominal and indexed Government Bonds.

Robustness Checks

Table 7 and 8 show results with alternative forecasts horizons. Only with the actual forecasts, the asymmetry on inflation seems to disappear. But that estimated model has serial correlation and thus untrustworthy standard errors. Therefore, we stick to the story thus established. Table 9 deals with 'real-time bias' using output gap estimates from a 'real time dataset' compiled by the Bank of England. These are used alongside its forecasts of growth to construct a time series which will be used for HP-filter de-trending (Figure 1).

We show sub-sample stability of the asymmetry parameters estimated in Model 2. The rolling windows technique is used to study the in-sample stability of the asymmetry parameters. Because the sample is small and instruments many, we use as small a rolling window as possible. The 95 percent confidence interval for this estimate is always above zero, indicating strong evidence in favor of asymmetric preferences (Figure 2 and 3). The robustness checks confirm that there is compelling evidence for asymmetric preferences.

Table 7: Alternate Forecast Horizons (+1 Inflation)

Model 4: $\boldsymbol{i_t = \rho i_{t-1} + c_0 + c_1 E_{t-1}(\pi_{t+1} - \pi^*) + c_2 E_{t-1} y_t + c_3 E_{t-1}(\pi_{t+1} - \pi^*)^2 + c_4 E_{t-1} {y_t}^2 + e_t}$		
Obs = 33	Model Generated Forecasts	Actual Inflation Forecasts
ρ	0.94*	0.94*
c_0	0.19*	0.23*
c_1	0.44*	0.14*
c_2	0.51*	0.46*
c_4	0.31*	-0.05
RMSE	0.30*	0.21*
AC Test P-Value	0.26	0.29
J Test P-Value	0.14	0.01

Note: * is significance at 1 percent level, ** is significance at 5 percent level, *** is significance at 10 percent level. The instruments used were 3 lags of regressors, dependent variable, Sterling Effective Exchange Rate, HP-detrended unemployment rate, Spread between 10 yr nominal and indexed Government Bonds.

Table 8: Alternate Forecast Horizons (+2 Inflation, +1 Output Gap)

Model 5: $\boldsymbol{i_t = \rho i_{t-1} + c_0 + c_1 E_{t-1}(\pi_{t+2} - \pi^*) + c_2 E_{t-1} y_{t+1} + c_3 E_{t-1}(\pi_{t+2} - \pi^*)^2 + c_4 E_{t-1} {y_{t+1}}^2 + e_t}$		
Obs = 33	Model Generated Forecasts	Actual Inflation Forecasts
ρ	0.94*	0.95*
c_0	0.02	0.07*
c_1	0.29*	0.19*
c_2	0.43*	0.29*
c_4	1.07*	0.02
c_4	0.51*	0.54*
RMSE	0.31	0.31
AC Test P-Value	0.33	0.04
J Test P-Value	0.99	0.99

Note:* is significance at 1 percent level, ** is significance at 5 percent level, *** is significance at 10 percent level. The instruments used were 3 lags of regressors, dependent variable, Sterling Effective Exchange Rate, HP-detrended unemployment rate, Spread between 10 yr nominal and indexed Government Bonds.

Table 9: Real Time Output Gap Estimates

Model 6: $i_t = \rho i_{t-1} + c_0 + c_1 E_{t-1}(\pi_{t+2} - \pi^*) + c_2 E_{t-1} y_{t+1} + c_3 E_{t-1}(\pi_{t+2} - \pi^*)^2 + c_4 E_{t-1} {y_{t+1}}^2 + e_t$		
Obs = 33	Model Generated Forecasts	Actual Inflation Forecasts
ρ	0.94*	0.95*
c_0	0.02	0.07*
c_1	0.29*	0.19*
c_2	0.43*	0.29*
c_4	1.07*	0.02
c_4	0.51*	0.54*
RMSE	0.31	0.31
AC Test P-Value	0.33	0.04
J Test P-Value	0.99	0.99

Note: * is significance at 1 percent level, ** is significance at 5 percent level, *** is significance at 10 percent level. The instruments used were 3 lags of regressors, dependent variable, Sterling Effective Exchange Rate, HP-detrended unemployment rate, Spread between 10 yr nominal and indexed Government Bonds.

Figure 1: Real Time vs Conventional Output Gap Estimates

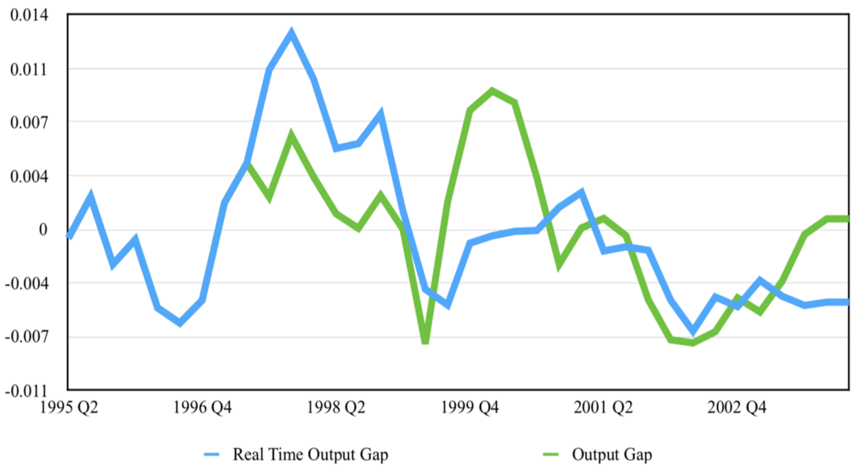
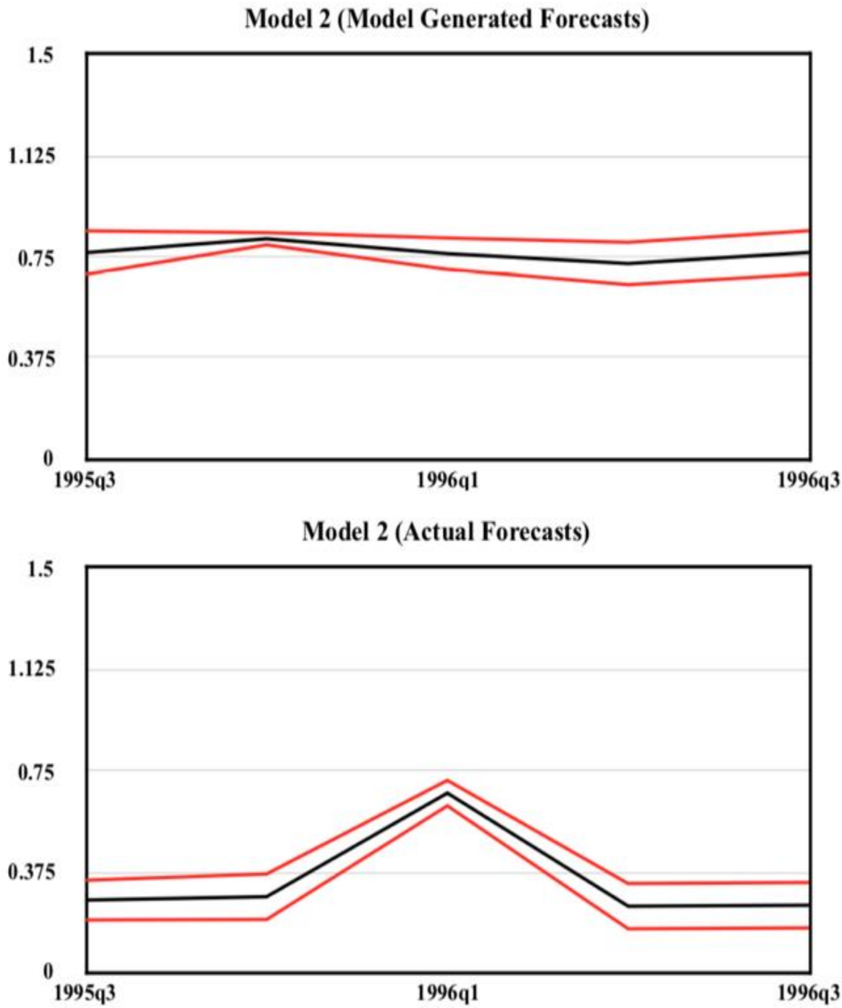
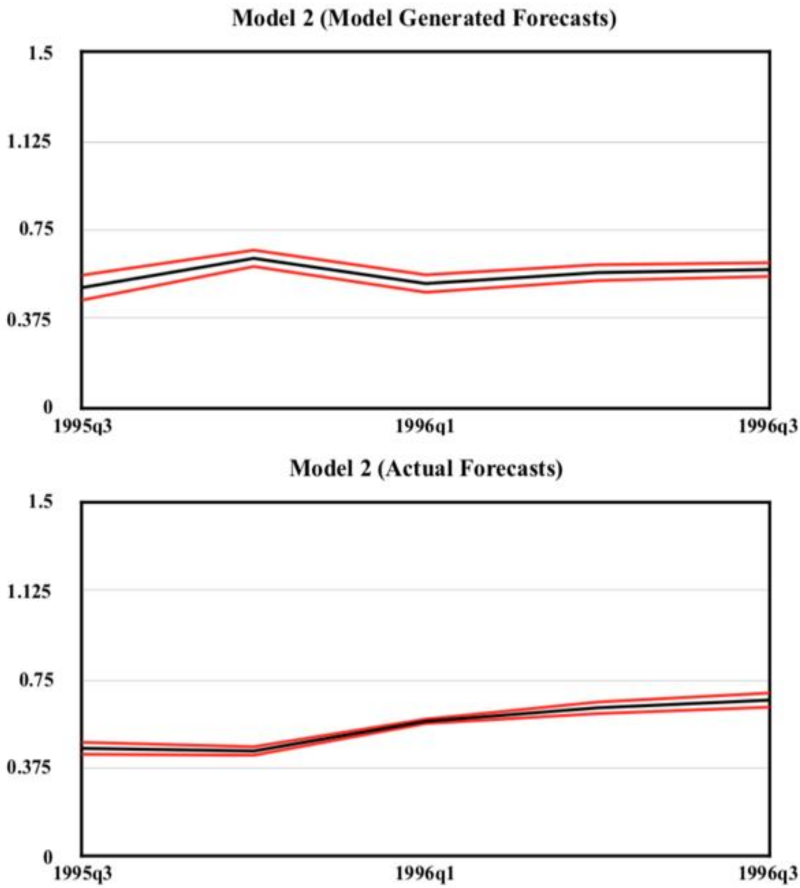


Figure 2: Model 2 Sub-Sample Stability of Asymmetry Coefficient



c_3

Figure 3: Model 2 Sub-Sample Stability of Asymmetry Coefficient c_4



CONCLUSION

Inflation targeting is the most popular regime today. It has demonstrated much success in the last 30 years. Inflation targeting is composed of the holy trinity of an explicit inflation target, central bank independence and deep-rooted accountability and transparency mechanisms. With freedom comes responsibility. With the freedom to set policy rates as it deems fit, the central bank must necessarily be made accountable to its mandate. This is because central bank preferences bear heavily on actual inflation and growth outcomes. Thus, accountability is an important link in the chain of events that will lead to the success of inflation targeting.

The Bank of England is known as a successful inflation targeting central bank. And notwithstanding its notable credentials, it too seems to have failed to fully live up to its mandate. The mandate was to target inflation at 2.5 percent, with equal treatment of inflation overshoots and undershoots. The evidence suggests that the Bank of England has preferred inflation undershoots to overshoots and negative output-gaps to positive output-gaps. This has meant that policy has been unduly restrictive and that interest rates have been higher than necessary. This means losses in terms of growth and jobs.

In order to find out how much restrictive has policy been we take our estimates from Model 2(Model Generated Forecasts) and simulate the path of interest rates had there been symmetric preferences on inflation and output. It turns out that policy rates would have been about 30 basis points lower under symmetric preferences. Given that policy was excessively tight for about 8years - we can safely say that this implies a large loss in terms of employment and growth.

To eliminate asymmetric preferences, we need institutional reform. For starters, we need to pay close attention to the details of the mandate itself. Many central banks carry asymmetric mandates. This can be easily rectified by changing the mandate. Further Nobay and Peel (2003) suggest a combination of a lower target and a Walsh contract to eliminate the effect of asymmetric preferences. This approach induces sufficient incentives on the central bank to prevent it from following overly restrictive monetary policy. These avenues should be explored.

APPENDIX

We write the quadratic loss function as,

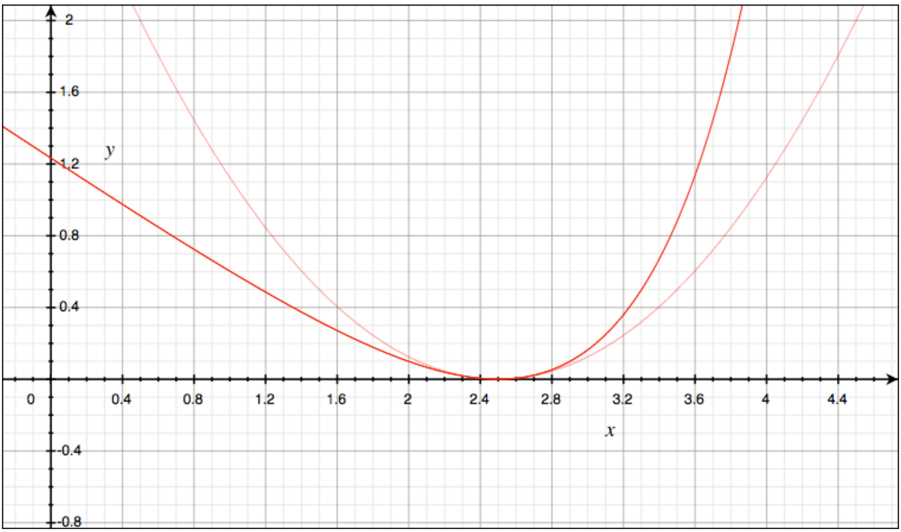
$$y = \frac{(x - x^*)^2}{2} \tag{35}$$

and the Linex Loss function as,

$$y = \frac{e^{\alpha(x-x^*)} - \alpha(x - x^*) - 1}{\alpha^2} \tag{36}$$

I set the values of x^* to be 2.5 and the asymmetry parameter α to be 1.5 and then plot values that satisfy (35) and (36) in Figure 4. The dark red line is (36) and the light red line is (35). The asymmetry can be clearly depicted. For instance, asymmetric loss function registers approximately double the loss when x = 3.6, which is barely 1 unit deviation above 2.5. Similarly, the asymmetric loss function registers about half the loss when x = 1.2 which is again barely more than one unit deviation below target.

Figure 4: Linex Loss Function



Something interesting happens to the asymmetric loss function when ɑ tends to zero. However it isn't itself defined at zero, but only limits to the quadratic case. Taking limits gives us,

$$\lim_{\alpha\to 0} y = \lim_{\alpha\to 0} \frac{e^{\alpha(x-x^*)}-\alpha(x-x^*)-1}{\alpha^2} \tag{37}$$

if we substitute the value of ɑ = 0, we get the indeterminate form 0/0. Thus we use L'Hospital's rule and differentiate the numerator and denominator by ɑ to get,

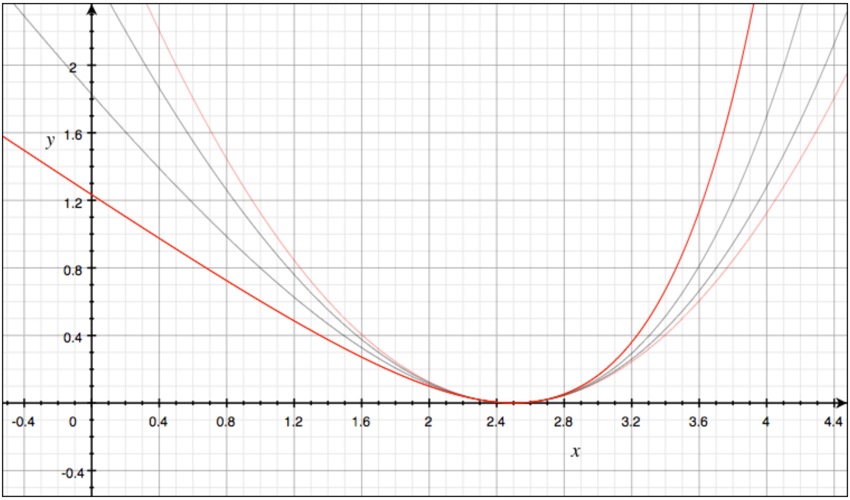
$$\lim_{\alpha\to 0} y = \lim_{\alpha\to 0} \frac{(x-x^*)e^{\alpha(x-x^*)}-(x-x^*)}{2\alpha} \tag{38}$$

This too takes on an indeterminate form if we substitute ɑ = 0. So we once again apply L'Hospital's rule to get,

$$\lim_{\alpha\to 0} y = \lim_{\alpha\to 0} \frac{(x-x^*)^2 e^{\alpha(x-x^*)}}{2} = \frac{(x-x^*)^2}{2} \tag{39}$$

Thus testing the null hypothesis Ho: ɑ = 0 against the alternative Ha: ɑ ≠ 0 the same as testing the null of symmetric preferences against the alternative of asymmetric preferences. This can be demonstrated graphically also. Figure 5 shows how the function rolls over as α falls to 0, and becomes similar to quadratic loss (grey lines).

Figure 5: Linex Loss Function



REFERENCES

Boinet, V., And C. Martin (2008), "Targets, Zones, And Asymmetries: A Flexible Nonlinear Model of Recent UK Monetary Policy", *Oxford Economic Papers*, 60(3), 423-439.

Brzoza-Brzezina, M., K. J. otłowski and A. Miśkowiec (2013), "How Forward-Looking Are Central Banks? Some Evidence From Their Forecasts", *Applied Economics Letters*, 20(2), 142-146.

Clarida, R., J. Gali, and M. Gertler (1999), "The Science of Monetary Policy: A New Keynesian Perspective", *Journal Of Economic Literature*, 37(4), 1661-1707.

Clarida, R., J. Gali and M. Gertler, (2000), "Monetary Policy Rules and Macroeconomic Stability: Evidence And Some Theory", *The Quarterly Journal Of Economics*, 115(1), 147-180.

Clarida, R., J. Galı and M. Gertler (1998), "Monetary Policy Rules In Practice: Some International Evidence", *European Economic Review*, 42(6), 1033-1067.

Cukierman, A., and A. Muscatelli (2008), "Nonlinear Taylor Rules and Asymmetric Preferences in Central Banking: Evidence from The United Kingdom And The United States", *The BE Journal Of Macroeconomics*, 8(1).

Gascoigne, J. and P. Turner (2004), "Asymmetries in Bank of England Monetary Policy." *Applied Economics Letters*, 11(10), 615-618.

Gerlach, S. and G. Schnabel (2000), "The Taylor Rule And Interest Rates In The EMU Area." *Economics Letters*, 67(2), 165-171.

Hamilton, J. D. (2018), "Why You Should Never Use The Hodrick-Prescott Filter." *Review Of Economics And Statistics*, 100(5), 831-843.

Judd, J. P. and G. D. Rudebusch (1998). "Taylor's Rule And The Fed: 1970-1997." *Economic Review - Federal Reserve Bank Of San Francisco*, (3), 3.

Kozicki, S. (1999), "How Useful Are Taylor Rules For Monetary Policy?", *Economic Review-Federal Reserve Bank Of Kansas City*, 84(2), 5.

Kydland, F. E. and E. C. Prescott (1990), "Business Cycles: Real Facts And A Monetary Myth", *Real Business Cycles: A Reader*, 383.

Lucas, R. E. (1973), "Some International Evidence On Output-Inflation Tradeoffs." *The American Economic Review*, 63(3), 326-334.

Martin, C., and C. Milas (2004), "Modelling Monetary Policy: Inflation Targeting In Practice", *Economica*, 71(282), 209-221.

Minford, P., And N. Srinivasan (2008), "Are Central Bank Preferences Asymmetric? A Comment", *Economic Notes*, 37(1), 119-126.

Mishkin, F. S. and K. Schmidt-Hebbel (2001), "One Decade Of Inflation Targeting In The World: What Do We Know And What Do We Need To Know?", *National Bureau Of Economic Research*, W8397.

Molodtsova, T., A. Nikolsko-Rzhevskyy and D. H. Papell (2008), "Taylor Rules With Real-Time Data: A Tale Of Two Countries And One Exchange Rate", *Journal Of Monetary Economics*, 55, S63-S79.

Nelson, C. R. and C. R. Plosser (1982), "Trends And Random Walks In Macroeconomic Time Series: Some Evidence and Implications", *Journal of Monetary Economics*, 10(2), 139-162.

Nelson, E. (2003), "UK monetary Policy, 1972-97: A Guide Using Taylor Rules", *Central Banking, Monetary Theory and Practice: Essays in Honour of Charles Goodhart*, 1, 195.

Orphanides, A. (2001), "Monetary Policy Rules Based On Real-Time Data", *American Economic Review*, 91(4), 964-985.

Orphanides, A. and S.V. Norden (2002), "The Unreliability of Output-Gap Estimates in Real Time", *Review Of Economics and Statistics*, 84(4), 569-583.

Robert Nobay, A. and D.A. Peel (2003), "Optimal Discretionary Monetary Policy in a Model of Asymmetric Central Bank Preferences", *The Economic Journal*, 113(489), 657-665.

Ruge-Murcia, F. J. and L. Dudley (2001), "Inflation Targeting Under Asymmetric Preferences", *International Monetary Fund, Research Department,* 1-161*.*

Srinivasan, N., V. Mahambare and M. Ramachandran (2006), "UK Monetary Policy Under Inflation Forecast Targeting: Is Behaviour Consistent With Symmetric Preferences?", *Oxford Economic Papers*, 58(4), 706-721.

Surico, P. (2007), "The Fed's Monetary Policy Rule And US Inflation: The Case Of Asymmetric Preferences", *Journal of Economic Dynamics and Control*, 31(1), 305-324.

Surico, P. (2007), "The Monetary Policy of the European Central Bank", *The Scandinavian Journal Of Economics*, 109(1), 115-135.

Svensson, L. E. (1997), "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets", *European Economic Review*, 41(6), 1111-1146.

Taylor, M. P. and E. Davradakis (2006), "Interest Rate Setting and Inflation Targeting: Evidence of a Nonlinear Taylor Rule for the United Kingdom", *Studies in Nonlinear Dynamics and Econometrics*, 10(4).

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