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Edward Nelson

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Edward Nelson, Bank of England and CEPR

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Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

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ABSTRACT

UK Monetary Policy 1972–97: A Guide Using Taylor Rules*

In the period from the floating of the exchange rate in 1972 to the granting of independence to the Bank of England in 1997, UK monetary policy went through several regimes, including: the early 1970s, when monetary policy was subordinate to incomes policy as the primary weapon against inflation; Sterling M3 targeting in the late 1970s and early 1980s; moves in the late 1980s toward greater exchange rate management, culminating in the UK's membership of the ERM from 1990 to 1992; and inflation targeting from October 1992. This Paper estimates simple interest rate reaction functions, or 'Taylor rules', for different UK monetary policy regimes. The inflation targeting regime that began in 1992 appears to be the only period that is characterized by the 'Taylor principle', namely a greater than one for one response of interest rates to fluctuations in inflation, a feature stressed in Goodhart (1992). In contrast to the US case, the early 1980s disinflation in the UK appears best characterized as an increase in the intercept of the authorities' interest rate rule rather than by an increased systematic response of monetary policy to inflation.

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Edward Nelson
Monetary Policy Committee
MPC Unit HO-3
Bank of England
Threadneedle Street
London EC2R 8AH
Tel: (44 20) 7601 5692
Fax: (44 20) 7601 3550
Email: ed.nelson@bankofengland.co.uk

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NON-TECHNICAL SUMMARY

In the period from the floating of the exchange rate in 1972 to the granting of independence to the Bank of England in 1997, UK monetary policy went through several regimes, including the early 1970s, when monetary policy was subordinate to incomes policy as the primary weapon against inflation; targeting of a monetary aggregate (sterling M3) in the late 1970s and early 1980s; moves in the late 1980s toward greater exchange rate management, culminating in the UK's membership of the ERM from 1990 to 1992; and inflation targeting from October 1992.

This Paper estimates simple interest rate reaction functions, or 'Taylor rules', for different UK monetary policy regimes in the period 1972–97. It is not claimed that policy makers actually adhered to a Taylor rule during any part of this period. Rather, the Taylor rule estimates provided here can be regarded as a simple (two or three parameter) characterization of developments in UK monetary policy. Under this interpretation, changes in the estimated Taylor rule coefficients across regimes reflect different policy responses over time to inflation or to output relative to potential.

A natural question is what interest there is in characterizing UK monetary policy in periods where it is non-optimal, such as in 1972–90 (to judge by the generally unfavourable inflation outcomes over that period). A major reason is that a quantitative characterization of policy behaviour helps to recover the structural parameters describing price, wage, and output determination in the economy. For example, the historical decomposition of euro area inflation over 1973–98 by Smets and Wouters (2001) with an estimated structural model requires the specification of a monetary policy rule, so that estimation can disentangle policy-rule parameters from the behavioural parameters that describe private pricing and spending decisions. In a full system estimation exercise such as undertaken in that paper, it may not be feasible to model all the historical breaks in policy regime, so information about the quantitatively most important breaks in policy behaviour is useful. The estimates in the present Paper indicate which are the quantitatively most important shifts in policy and so can aid future work on structural modelling of the UK economy.

For the sample periods covering the 1970s, I find that the estimated long-run response of the nominal interest rate to inflation was well below unity. This is a violation of what Woodford (2001) calls the 'Taylor principle' – namely that monetary policy should ensure a greater than one for one response of interest rates to fluctuations in inflation (relative to target), which tends to ensure that inflation is on target on average. In addition, the real interest rate was permitted to be negative for most of the 1970s. These results suggest that UK monetary policy failed to provide a nominal anchor in the 1970s. Control of inflation was delegated to devices other than monetary policy, notably income policy (direct controls on wages and prices).

In the 1980s, control of inflation in the UK was more successful and, consistent with this, the estimates suggest a tighter monetary policy. This tightening was manifested in an increase in the average prevailing level of real interest rates, and a high degree of responsiveness to foreign interest rates, rather than in an increase in the estimated response to the domestic inflation rate. This is contrast to studies of the early 1980s disinflation in the US (e.g. Clarida, Galí and Gertler, 2000; Judd and Rudebusch, 1998). In contrast to the US case, the early 1980s disinflation in the UK appears best characterized as an increase in the intercept of the authorities’ interest rate rule rather than by an increased systematic response of monetary policy to inflation.

The estimates in this Paper suggest that the long-run response of nominal interest rates to inflation remained below unity until the period of inflation targeting, 1992–7. For this most recent period, the long-run estimated responses of the UK nominal interest rate to inflation and the output gap are remarkably close to the values of 1.5 and 0.5 respectively, associated with the baseline version of the Taylor rule in Taylor (1993).

1. Introduction

In the period from the floating of the exchange rate in June 1972 to the granting of operational independence to the Bank of England in May 1997, UK monetary policy went through several regimes. These included the period in the 1970s when monetary policy was considered subordinate to incomes policy as the government's primary weapon against inflation; an emphasis on monetary targeting in the late 1970s and early 1980s; moves from 1987 toward greater management of the exchange rate, culminating in the UK's membership of the Exchange Rate Mechanism (ERM) from 1990 to 1992; and inflation targeting from October 1992.[1]

Taylor (1993) showed that US monetary policy is well described by a rule whereby the short-term nominal interest rate responds positively to inflation and the output gap. There has subsequently been an explosion of theoretical and empirical work on Taylor rules, including econometric estimates of rule coefficients for the US by Clarida, Galí, and Gertler (2000) and Judd and Rudebusch (1998).

This paper provides estimates for the UK of the Taylor rule for several different monetary policy regimes over 1972–1997. It is not claimed that policymakers actually adhered to a Taylor rule during any part of this period; rather, the Taylor rule estimates provided here can be regarded as a simple (two or three parameter) characterization of developments in UK monetary policy. Under this interpretation, changes in the estimated Taylor rule coefficients across regimes reflect different policy responses over time to inflation or to output relative to potential.

Estimates of Taylor-style monetary policy reaction functions on quarterly UK data include those of Broadbent (1996), Clarida, Galí, and Gertler (CGG) (1998), and Adam, Cobham, and Girardin (2001). The present work departs from these studies in several ways. I split my estimation period into six distinct policy regimes, and estimate Taylor rules for each regime except the ERM period. By contrast, previous studies have estimated rules over samples (e.g. 1981–1995 for Broadbent, 1979–1990 for CGG), which, I argue, do not correspond to valid estimation periods because they include more than one policy regime.[2] Additionally, my longer sample allows a detailed examination of monetary policy behaviour both during the 'Great Inflation' of the 1970s, and under inflation targeting (1992 onward). Finally, I estimate both backward-looking and forward-looking Taylor rules, and compare them as descriptions of UK policy behaviour.

Charles Goodhart's career and research are intertwined with the subject matter of this paper in three respects. First, for half of the overall period considered here—namely, the period up to 1985—Goodhart was involved in UK monetary policy in his capacity as Chief Monetary Adviser to the Bank of England. Secondly, as discussed in Section 2 below, the Taylor rule literature can be regarded as a response, both theoretical and empirical, by the monetary economics profession to criticisms that Goodhart made in the 1970s and 1980s of the state of monetary analysis. Thirdly, the period described here, 1972–1997, witnessed an evolution of UK monetary policy that culminated in the creation of the Monetary Policy Committee, on which Goodhart served as an External member, and thus one of the nine individuals who made decisions on monetary policy in the United Kingdom. The years 1997–2000, during which Goodhart served as an MPC member, are outside the period I study,[3] but the estimates I provide of pre-1997 reaction functions can be compared with the type of interest rate rule that Goodhart laid out as desirable (see Goodhart, 1992, and Section 2 below).

For the sample periods covering the 1970s, I find that the estimated long-run response of the UK nominal interest rate to inflation was well below unity. Moreover, the real interest rate was permitted to be negative for most of this period. These results suggest that UK monetary policy failed to provide a nominal anchor in the 1970s. In the 1980s, control of inflation was more successful and, consistent with this, the estimates suggest a tighter monetary policy. This tightening was manifested in an increase in the average prevailing level of real interest rates, and a high degree of responsiveness to foreign interest rates, rather than in a stronger response to inflation. Indeed, the estimates in this paper suggest that the long-run response of nominal interest rates to inflation remained below unity until the inflation targeting period 1992–1997. For that period, the long-run responses of the UK nominal interest rate to inflation and the output gap are remarkably close to the values of 1.5 and 0.5 found by Taylor (1993) to be a good description of recent US monetary policy, and close to the recommendation for UK monetary policy made by Goodhart (1992).

A natural question before proceeding is what interest there is in characterizing UK monetary policy in periods where it is non-optimal, such as the 1972–1990 period of generally high inflation. A major reason is that a quantitative characterization of policy helps to recover structural parameters describing the economy’s price and output determination. For example, the decomposition of euro area inflation over 1973–1998 by Smets and Wouters (2001) with a structural model requires specification of a policy rule, so that estimation can disentangle policy-rule parameters from behavioural parameters describing pricing and spending decisions. In a full-system estimation exercise such as undertaken in that paper, it may not be feasible to model all historical breaks in policy regime, so information about the quantitatively most important breaks in policy behaviour is useful. The estimates in the present paper indicate which are the quantitatively most important shifts in policy and so can aid future work on structural modelling of the UK economy.

2. Goodhart and Taylor on interest rate rules

Goodhart (1989, pp. 330–331) pointed to an ‘unhelpful dichotomy, between the theory and the reality of Central Bank operations’. On the one hand, he observed that both J.M. Keynes and Milton Friedman, when discussing ‘practical policy matters concerning the level of short-term interest rates… had no doubts that these were normally determined by the authorities, and could be changed by them, and were not freely determined in the market…’ However, as he also noted, in analytical work, both positive and normative, these authors and many others (including users of the traditional IS-LM model) represented the monetary policy decision as entailing the choice of money growth rate. This was also true of much work on empirical monetary policy reaction functions, e.g. Barro (1977).

While, as Goodhart and his fellow MPC members noted, ‘for each path of the official rate given by the decisions of the MPC, there is an implied path for the monetary aggregates’ (MPC, 1999, p. 169; see also Goodhart, 1997, p. 254), the characterization of actual central bank policy as a money-growth reaction function obscures many of the issues facing policymakers. Central bankers’ decisions in practice typically are concerned with whether to change the level of short-term nominal interest rates in the face of new information on the state of the economy. A decision to leave the nominal interest rate unchanged will, in general, not imply that money growth will be constant, since the rate of money growth consistent with a given setting of nominal interest rates will differ depending on the particular pattern of shocks hitting the economy. The money growth rate can therefore not be treated interchangeably with the nominal interest rate as the central bank’s choice variable.

Irrespective of whether the choices of instrument and reaction functions made by central banks were wise ones, it was unsatisfactory that much work in monetary economics prior to the 1990s failed to characterize actual central bank practice accurately. For empirical work, as discussed in Section 1, estimation of structural economic parameters often requires that monetary policy behaviour be modelled as realistically as possible. For judgements on the optimality of actual historical policy, it is again important to characterize actual policy adequately. For example, an evaluation of the relative merits of a fixed money growth rule and the interest rate-oriented policies followed by actual monetary policymakers requires that the latter be modelled with reasonable accuracy. Only then can one have an analytical framework that deduces the price level and output dynamics that arise from interest rate-based monetary policies.

In many respects, however, much of the pre-1990s literature on monetary policy fell short of providing such a framework.[4] Much of the literature, as noted above, concentrated on reaction functions in which the money growth rate was the dependent variable. And when central banks' concern with interest rates was recognized in formal modelling, it was represented as the pursuit of rigidly pegged nominal interest rates, as in Poole (1970). UK monetary economists might have been expected to have a more realistic perspective, in light of Johnson's (1972, p. 233) observation that 'the tradition of British central banking and monetary theory… identified monetary policy with the fixing of the level of interest rates'. However, UK authors often represented this policy in macroeconomic models by the setting of interest rates at fixed levels irrespective of the state of the economy, just as Poole did. Kaldor (1982), for example, represented UK monetary policy graphically as a fixed nominal interest rate, with the nominal money supply provided perfectly elastically at that rate. As a characterization of monetary policy at the monthly or quarterly frequency, this seems inadequate. As Goodhart (1987, p. 253) put it, 'I would dispute [the] repeated claim that the UK authorities have operated (implicit) interest rate targets… I cannot recall a period of open-loop fixed targets in the UK in the last 18 years, during which I was personally involved…' Rather, Goodhart regarded it as more appropriate to model policy as '*closed-loop* targets for short-term interest rates, in which these were varied in response to contingent outcomes for exchange rates, the growth of the monetary aggregates, etc.' Indeed, it was this type of monetary policy reaction function that Goodhart used in his empirical work, e.g. Goodhart and Bhansali (1970).

To Goodhart, then, the appropriate representation of actual central bank policy was neither a money-growth based reaction function nor a policy of rigid interest rate pegging; it was instead an interest rate reaction function according to which short-term rates were adjusted in a manner intended to provide macroeconomic stability. Different formulations of interest rate rules, of course, will have different degrees of success in delivering this stability, and Goodhart increasingly turned his attention to the appropriate form of the interest rate reaction function. Such a rule would capture the advantage stressed by Poole (1970) of not allowing money demand shocks to produce variability in output and inflation, by allowing the money stock, but not nominal interest rates, to rise in the face of a permanent fall in velocity. By the same token, the rule should not be one that allows runaway money growth, as would occur for example if the central bank attempted to hold real interest rates below their natural value. In July 1992, Goodhart proposed one scheme for setting interest rates:

> I have sometimes wondered whether, starting from zero inflation and 3 per cent nominal interest rates, there should not be a presumption that such interest rates should rise by 1½ per cent for each 1 per cent that inflation rises above zero, and that the Governor should be asked, say twice a year, to account for any divergence from that "rule".' (Goodhart, 1992, p. 324).

An important property of such a rule, Goodhart noted, was that ‘in order to raise real interest rates, nominal interest rates must be raised significantly more than the prior increase in the annualized rate of growth of the RPI…’

Concurrently with Goodhart’s proposal, Taylor (1993) showed that the behaviour of the US federal funds rate (the nominal interest rate used by the Federal Reserve as its policy instrument) was well described by the simple formula:

$$R_t = (r^* + \pi^*) + 1.5(\Delta_4 p_t - \pi^*) + 0.5\tilde{y}_t \qquad (1)$$

In equation (1), the nominal interest rate R_t is annualized and expressed as a fraction, $\Delta_4 p_t$ is annual inflation, and $\tilde{y}_t$ is the output gap (defined as $\tilde{y}_t = y_t - \bar{y}_t$, where y_t is log real GDP and $\bar{y}_t$ its potential level). π^* is the target for annual inflation, and r^* is the steady-state value of the real interest rate.

Taylor thus found that US monetary policy in practice conformed closely to the sort of rule regarded as desirable by Goodhart—namely, a nominal interest rate rule with a response of 1.5 to inflation. Relative to Goodhart’s proposal, however, the rule also includes an output gap response. One might wonder why there was no such response in Goodhart’s proposed rule. A first reason may have been the difficulty in settling on a measure of real aggregate demand that is available on a timely basis and that can be measured reliably. Neither the accuracy of ‘real-time’ estimates of GDP, nor how to express GDP data relative to an estimate of their ‘natural’ level, are trivial issues, especially for the formulation of monetary policy, as stressed in Orphanides (1999). Another reason for Goodhart’s omission of an output gap term may have been an expectation that a policy of stabilizing inflation would itself tend to keep output close to potential. This is consistent with the Governor of the Bank of England’s (2001, p. 126) characterization of inflation targeting as ‘to keep overall demand in the economy growing broadly in line with supply-side capacity’ . It is also consistent with the observation that the most serious output gap variations in the UK in the postwar period have been the result of policies that led to large increases in inflation (such as the Barber and Lawson booms), or have been a consequence of monetary policies that tried to rein in inflation after periods of excess demand (as in the early 1980s and early 1990s downturns). From this perspective, a separate response to the output gap in the interest rate rule may not be required, as inflation targeting would facilitate output gap stability.

In any case, Taylor’s work has inspired much research on interest rate rules, and moved monetary economics in the direction sought by Goodhart. In particular, Ireland (2001) notes that, ‘Following the publication of Taylor’s (1993) original essay… monetary economists have come to appreciate that most central banks…

conduct monetary policy by managing short-term nominal interest rates rather than some measure of the nominal money supply; in addition, monetary economists have come to appreciate that most central banks… systematically adjust their nominal interest rate instruments in response to output and inflation.'

In empirical work, rules such as equation (1) can be thought of as a simple approximation of actual policy behaviour, attempting to represent a complex process with a small number of parameters. In theoretical and policy-simulation work, a rule like (1) can be compared to the performance of other schemes, such as optimal rules, which use a wider information set.[5] In this light, it should be emphasized that it is not essential to the logic of the rule that the coefficients in (1) be 1.5 and 0.5. Indeed, experiments with interest rate rules in a variety of models have frequently supported higher values of one or both feedback coefficients in (1).[6] One reasonably general result is that it does seem desirable to have a (long-run) coefficient on inflation in the rule exceeding one, which helps to ensure that the Taylor rule delivers inflation equal to its target value (π^*) on average (see Taylor, 1999b). As noted above, Goodhart (1992) stressed this as an important property of an interest rate rule, and Woodford (2001) labels it 'the Taylor principle'.

Taylor's original paper emphasized the visual match of rule (1) with actual US interest rate behaviour. There have subsequently been attempts to fit Taylor rules to data using formal econometric procedures; CGG (1998, 2000) and Judd and Rudebusch (1998) do so for the US, and CGG (1998) also report estimates for the UK, Japan, France, Italy, and Germany. The principal departure these studies have found from equation (1) is strong support for a large positive coefficient on the lagged dependent variable. In money demand studies, the lagged dependent variable coefficient is often treated as indicating costs of adjusting money balances, but as central banks can adjust interest rates easily in short periods, the adjustment-cost interpretation is not applicable to estimated interest rate rules. Rather, the lagged interest rate coefficient has been interpreted as a 'smoothing' parameter, and an interest rate equation that includes such a term can be regarded (if it is dynamically stable) as one whose long-run solution is of the form given in equation (1).

The remainder of this paper reports estimates of the UK monetary policy reaction function. It is important first to note an econometric issue that affects the interpretation of the results. This issue is whether it is legitimate to interpret the coefficients in econometrically estimated versions of (1) as policy reaction parameters. The estimates below avoid simultaneity problems by using instrumental variables (IV) estimation whenever current or expected future values of variables appear in the estimated equations. Even so, there are potential identification problems. For example, in the degenerate case where the central bank controls inflation perfectly, the resulting low variability of inflation may lead to insignificant estimates of the policy response to (expected) inflation. Fortunately, the data used in this paper do seem to provide sufficient variation in inflation and the other explanatory variables to avoid this problem (see Nelson, 2000).

One feature of the present study that should be mentioned is that I make no attempt to interpret the intercept terms of the estimated policy rules. A standard approach is to interpret the estimated (long-run) constant term as composed of the sum of the steady-state real interest rate, r^*, and an 'inflation target', π^*—just as it is in equation (1). Typically, analysis of the constant term has proceeded by fixing the value of either r^* and π^* *a priori*, and then deducing the implied inflation target or equilibrium real rate; see Judd and Rudebusch (1998, pp. 7–8) for a discussion.

I do not follow this approach for two reasons. First, as I discuss further in Section 4, policymakers in the 1970s relied heavily on devices other than monetary policy to control inflation. The UK policymaking environment in the 1960s and early 1970s, which Charles Goodhart's work helped to change, was a 'Radcliffean' one in which the importance of monetary policy for inflation outcomes was greatly underestimated.[7] It is therefore unlikely that, for such periods, analysis of the estimated monetary policy rule is sufficient to deduce the policymakers' implicit 'target' for inflation. Instead of trying to disentangle either π^* or r^* from the estimated constant term, I simply report the ex-post real interest rate for each of the regimes for which I estimate policy rules.

The second reason why I do not attempt to interpret the intercept is that the variables I use, notably GDP, are revised data. And I use detrended output series obtained from trends fitted to the entire 1971–1998 period. Thus, the output gap data are not the 'real-time' data available to policymakers when they were making their decisions.

As noted above, the analysis in Orphanides (1999) suggests that differences between the real-time and final data can have important consequences for the analysis of policy rules. In evaluating their consequences for the results in the present paper, it is important to note that Orphanides' key finding for US data is that 'the bulk of the problem is due to errors in the measurement of potential output. As is now evident, real-time estimates of potential output [in the 1970s] severely overstated the economy's capacity relative to the recent estimates...' For the UK, a similar overstatement appears to have occurred in the 1970s (Nelson and Nikolov, 2001a). Official targets for real GDP growth were announced in the early and mid-1970s that seem, in retrospect, to reflect over-estimates of the UK's potential growth rate and/or the amount of spare capacity in the economy.

If the bulk of the difference between final and real-time data consists of one-sided and infrequently corrected errors about the output gap level, then my use of final data will mainly affect the intercept terms of the policy rules that I estimate, rather than the estimated response coefficients.[8] Again, this is a reason against undertaking a structural interpretation of the intercept terms, and concentrating instead on the estimated slopes. Nelson and Nikolov (2001a) construct a quarterly real-time UK output gap series beginning in 1965. Below I check my estimates of quarterly reaction functions that use final data with estimates obtained using real-time output gap data, and verify that the policy reaction coefficients are not materially different.

3. Estimates

This section provides estimates of interest rate policy reaction functions for the United Kingdom. Throughout, R_t is measured by the Treasury bill rate[9] (expressed as an annualized fraction), $\Delta_4 p_t$ is the annual percentage change in the Retail Price Index (spliced into the RPI excluding mortgage interest payments, RPIX, in 1974), and $\tilde{y}_t$ is measured by the residuals from a 1971 Q1–1998 Q4 regression of log real GDP, y_t, on a linear and a quadratic trend.[10]

Results using the full 1972–1997 sample indicated that response coefficients exhibited considerable non-constancy (see Nelson, 2000), consistent with several breaks in monetary policy regime. Accordingly, the estimates reported here are for specific subsamples corresponding to different policy regimes: (*a*) July 1972 to June 1976: from the first full month of a floating exchange rate to the end of the pre-monetary targeting period; (*b*) July 1976 to April 1979: the monetary targeting period that preceded the election of the Conservative Government;[11] (*c*) May 1979 to February 1987: the period beginning with the election of the Thatcher Government; (*d*) March 1987 to September 1990: informal stabilization of the sterling/ Deutschemark exchange rate; (*e*) October 1990 to September 1992: membership of the ERM (a period for which I attempt no reaction function estimates); and (*f*) October 1992 to April 1997: the period of inflation targeting in the UK prior to the Bank of England receiving operational independence.

Other divisions of the 1972–1997 period are possible, of course, and some alternatives are discussed below. But, especially compared to the US, many of the regime changes in the UK are notable for having been made explicit through public announcements—including those in 1976, 1979, 1990, and 1992—and it seems worthwhile to exploit this historical information rather than use statistical criteria to determine the dates of regime changes. Let us proceed, therefore, to examine more closely the first regime, 1972–1976.

3.1 1972 to 1976

The first specification which I estimate for the 1972–1976 regime is a backward-looking Taylor rule with lags of inflation, the gap, and the interest rate:

$$R_t = \kappa + \Sigma_{i=1}^{j} a_i \, \Delta_4 p_{t-i} + \Sigma_{i=1}^{j} b_i \, \tilde{y}_{t-i} + \Sigma_{i=1}^{j} c_i R_{t-i} + e_t \,. \qquad (2)$$

Here e_t is a white noise disturbance. The presence of lags of R_t allows for interest rate smoothing. The long-run inflation and output responses are $w_1 \equiv (\Sigma_{i=1}^{j} a_i) / (1 - \Sigma_{i=1}^{j} c_i)$ and $w_2 \equiv (\Sigma_{i=1}^{j} b_i) / (1 - \Sigma_{i=1}^{j} c_i)$. I also estimate a forward-looking rule:

$$R_t = \kappa + a_k E_{t-1} \Delta_4 p_{t+k} + b_0 E_{t-1} \tilde{y}_t + \Sigma_{i=1}^{j} c_i R_{t-i} + e_t \,, \qquad (3)$$

with long-run coefficients $w_1 \equiv a_k / (1 - \Sigma_{i=1}^{j} c_i)$ and $w_2 \equiv b_0 / (1 - \Sigma_{i=1}^{j} c_i)$.. Apart from the smoothing terms, specification (3) differs from (2) by restricting the influence of lagged information on monetary policy decisions to its effect on the conditional expectations of the current output gap, $E_{t-1} \tilde{y}_t$, and future inflation, $E_{t-1} \Delta_4 p_{t+k}$. Below I report estimates of (3) for alternative values of k.

The 1972–1976 sample period consists of only sixteen observations, which might appear insufficient to produce reliable estimates. However, the information content of a data set depends not only on its length but also on the regressors' sample variation. As shown in Nelson (2000), inflation, detrended output, and the interest rate were exceptionally volatile in the four years to 1976, implying that the 1972–1976 sample contains a large amount of information, and explaining why the estimates of (2) given in Table 1 below are precise and interpretable.

[Table 1 about here]

Estimates of (2), using lag length $j = 2$ quarters, are presented in Table 1.[12] The long-run estimated response to inflation is 0.12; while significantly above zero, this is very low in relation to Goodhart's (1992) and Taylor's (1993) coefficient of 1.5. Indeed, if one uses $R_t - \Delta_4 p_{t-1}$ as a rough guide to the real interest rate $R_t - 4 \cdot E_t \Delta p_{t+1}$, the estimate suggests that policymakers permitted each 1 percentage point increase in inflation to reduce the real interest rate by over 80 basis points. In addition, the output response coefficient is large (0.57) and significant.

These results are consistent with descriptions of macroeconomic policy during this period (e.g. Campbell, 1993, p. 471; Goodhart, 1997, p. 403). The Heath Government maintained that it could stimulate output through expansionary monetary and fiscal policies, while holding down inflation through wage and price controls.[13] This reflected a view, initially shared by the Labour Government elected in 1974, that the inflation of the 1970s largely reflected autonomous wage and price movements, and that the appropriate policy response was to influence the prices of specific products, rather than focus on monetary policy.[14] Examples of the non-monetary attempts to control inflation include the incomes policy imposed by the Heath Government in 1972 and the voluntary incomes policy pursued by the Labour Government from 1974; the extension of food subsidies in the March 1974 Budget; and cuts in indirect taxation in July 1974.

In Table 1 I also estimate, by IV, the forward-looking version (3) of the Taylor rule, for horizons $k = 0$ and $k = 1$.[15] The estimates are considerably less precise and interpretable than those of (2). Thus, in the 1972–1976 period monetary policymakers appear to have moved the short-term interest rate mainly in reaction to past behaviour of real aggregate demand and, to a very limited extent, inflation.

All the results so far use revised data. To check the sensitivity of results to this, I reestimated (2) with the lags of $\tilde{y}_{t-i}$ replaced by ${}_t\tilde{y}_{t-i}$, which denotes the data available on the period $t-i$ output gap as of period t.[16] I also replaced the quarterly average series R_t with the end-of-quarter observation R_t^{end}, in keeping with the fact that GDP data for period $t-1$ were generally not available until late in period t. This 'real-time' version of (2) supported a lag-length choice of $j = 2$; moreover, there was no evidence of sizable period t reactions to data on period $t-1$ inflation or the output gap. Accordingly, I found that the following specification was adequate:

$$R_t^{end} = \underset{(0.021)}{0.060} + \underset{(0.211)}{0.454}\, R_{t-1}^{end} + \underset{(0.063)}{0.041}\, \Delta_4 p_{t-2} + \underset{(0.150)}{0.191}\, {}_t\tilde{y}_{t-2}\ ,$$

$R^2 = 0.504$, SEE = 0.0138.

The implied long-run responses implied are reported in Table 1, and are close to the final-data estimates of (2). The main difference is that the gap response is less statistically significant and somewhat smaller using the initial data. This may reflect policymakers' reliance on a variety of measures of economic activity. To the extent that subsequent revisions bring GDP movements more into conformity with other activity measures, the final revised GDP series may be a better index of the activity variables that enter policy reaction functions in real time.[17]

3.2. 1976 to 1979

This regime begins with the announcement of targets for the monetary aggregate, £M3 (Sterling M3), in July 1976, and finishes with April 1979, the last month prior to the election of the Conservative Government. As this regime is shorter than any other that I consider, my estimation uses monthly data, measuring the output gap by quadratically detrended log industrial production.[18]

Results are reported in Table 2, starting with estimates of (2). These give insignificant and wrongly signed coefficients on both inflation and the gap. The table also reports estimates of the forward-looking specification (3) for various choices of k. Neither $k = 0$ nor $k = 3$ deliver interpretable estimates. A specification with three-quarters-ahead inflation ($k = 9$), however, delivers a significant, correctly-signed inflation response, and an insignificant but correctly-signed gap response. As the table also indicates, $k = 12$ instead of 9 delivers similar but somewhat weaker results.

[Table 2 about here]

Clearly, the results are sensitive to the specification chosen, but the best characterization of the period seems to be that interest rates responded to expected annual inflation nine months ahead, with interest rate smoothing and a small output gap response. The long-run inflation response of 0.62 is over four times the estimated 1972–1976 response. Nevertheless, it is important not to overemphasize the tightness of policy over 1976–1979. One reason why I find a rise in the inflation response compared to pre-1976 is that the nominal interest rate was cut aggressively (by over 900 basis points from late 1976 to early 1978) ahead of a fall in inflation from mid-1977 to late 1978. This easing reversed much of the progress achieved in reducing inflation. Reflecting the easier monetary policy, base money growth rose sharply from late 1977; inflation troughed at 7.6 percent in October 1978 and continued to rise until May 1980 (when it reached 21 percent).

Another reason for doubting the tightness of the 1976–1979 policy is the average level of interest rates. Central banks' control over nominal interest rates gives them considerable leeway in the short run in affecting the behaviour of real interest rates. If one measures the real interest rate by $R_t - \Delta_{12} p_{t-1}$, the real rate did not become positive until June 1978; the ex-post real interest rate also only became positive in that month, and averaged –3.14% over 1976–1979. While this is higher than the –5.72% ex-post real rate observed in 1972–1976, it indicates a tendency until 1978 to hold nominal interest rates well below actual and prospective inflation.

3.3. 1979 to 1987

This regime follows the election of the Conservative Government in May 1979 and concludes with the Louvre Accord on exchange rates in February 1987. Throughout this period, monetary policymakers stressed inflation control, and the exchange rate floating was largely permitted. Arguably, the sample should begin in March 1980 with the announcement of the Medium Term Financial Strategy (MTFS) and end in October 1985 with the suspension of £M3 targeting. Large misses of the £M3 target were permitted as early as mid-1980, however, and the MTFS was revamped in 1982. It was also clear before 1985 that policymakers did not regard £M3 overshoots as intolerable, provided other measures of monetary conditions did not indicate that policy was loose.[19] It may therefore be satisfactory to treat 1979–1987 as one regime rather than subdivide it according to the attention given £M3.[20]

The estimation period is 1979 Q2–1987 Q1. Estimates of (2) are reported in Table 3. The estimated long-run response to inflation is 0.34, significantly positive but also significantly below unity. The long-run output gap response is 0.26. Table 3 also reports two versions of forward-looking rule (3). With $k = 0$, the long-run response to the output gap is 0.16; to inflation, 0.38, close to the estimates of (2). The smoothing coefficient is also similar. The output gap response is not statistically significant but its presence in the equation is supported by monthly estimates.[21] Table 3 also shows that a horizon of $k = 1$ delivers similar results to the $k = 0$ case, and that estimates of rule (2) are little changed if real-time output gap data are used.[22]

[Table 3 about here]

These results leave us with an apparent anomaly. Inflation fell over much of 1979–1987, and by February 1987 was down to 3.7%. The results here indicate that this disinflation was achieved with a response of the nominal interest rate to inflation (w_1) below 1.0. Yet analysis of historical periods, such as CGG's (2000) coverage of the US, typically characterizes disinflations as periods where w_1 exceeds unity.

Why, then, did UK monetary policy in the early 1980s achieve disinflation? The answer appears to lie in the high level of real rates. The Taylor rule approach often assumes that the average real rate over a given sample equals its steady-state level, with the latter typically assumed to be 2–4%. For 1979–1987, however, this position seems untenable: ex-post real rates averaged 4.66%, about 750 basis points higher than their 1976–1979 level. Thus while the *movements* of the nominal rate in response to inflation over 1979–1987 were muted, the average prevailing *level* of rates was consistent with restrictive monetary policy. This is recognized by CGG (1998, p. 1054): 'Monetary policy boiled down to keep[ing] real rates steadily high over this period, even when inflation was low during the mid-1980s.'

3.4. 1987 to 1990

The period 1987–1990 consisted of informal linking of the pound to the Deutschemark. This includes not only 'shadowing' of the DM (1987–1988), but also the period 1988–1990 in which UK monetary policy continued to track German policy. For example, in October 1989 the UK 'immediately followed' the Bundesbank's interest rate increase with an equal increase (Lawson, 1992, p. 951).[23]

I estimate on monthly data, March 1987 to September 1990. In the estimated specifications, as in CGG (1998), the UK rate responds to the German day-to-day nominal interest rate R_t^G, annual inflation, and the output gap. The implied backward-looking and forward-looking specifications are (4) and (5) respectively:

$$R_t = \kappa + \phi_G R_t^G + \Sigma_{i=1}^{j} a_i \Delta_{12} p_{t-i} + \Sigma_{i=1}^{j} b_i \tilde{y}_{t-i} + \Sigma_{i=1}^{j} c_i R_{t-i} + e_t , \qquad (4)$$

$$R_t = \kappa + \phi_G R_t^G + a_k E_{t-1} \Delta_{12} p_{t+k} + b_0 E_{t-1} \tilde{y}_t + \Sigma_{i=1}^{j} c_i R_{t-i} + e_t , \qquad (5)$$

Table 4 first gives estimates of (4).[24] There is a sizeable reaction to R_t^G, considerable interest rate smoothing, and a strong output gap response. There is apparently no response to inflation, however. In Table 4 I also reestimate (4) after deleting the inflation term. This is the preferred specification; estimates of (5) suggest that expected future inflation was not important. The results overall indicate that Bundesbank's monetary policy served as UK policy's nominal anchor. But domestic factors continued to be a consideration, indicated by the high degree of domestic interest rate smoothing, and by the positive output gap response.[25]

[Table 4 about here]

The estimates suggest a long-run response of UK to German rates of 1.11. This is nearly double CGG's (1998) estimate of 0.60. CGG's sample period was 1979–1990, so their lower estimate seems to be a result of mixing a regime in which German policy was not a major influence on UK policy (1979–1987) with one in which Bundesbank policy became a dominant consideration (1987–1990). Estimation of (4) over May 1979-September 1990 gives a long-run R_t^G coefficient of 0.578 (standard error 0.268), while R_t^G is not significant if (4) is estimated over 1979–1987.

An important question is why inflation took off in the late 1980s. Judged by the average ex-post real rate of 5.76%, policy appears to have been generally 'tight' in this period, and Stuart (1996, Chart 4) finds that R_t was below Taylor's (1993) recommendation for only two quarters in 1986–1988. Yet annual UK inflation rose over 5 points over 1987–1990. One possibility is that both money growth and interest rates matter for aggregate demand, and that the outbreak of inflation was promoted by rapid money growth. In line with this, base money and broad money growth suggest easy monetary conditions in 1986–1988 (e.g. Congdon, 1992; Stuart, 1996, Chart 3).

3.5. 1992 to 1997

This period begins with the October 1992 shift to inflation targeting after the UK's departure from the ERM, and ends prior to Bank of England independence in

May 1997. I use quarterly data, 1992 Q4 to 1997 Q1. Estimates of (2) are wrongly signed and insignificant. Far more plausible are the estimates of the forward-looking rule (3), particularly with $k = 1$. The Taylor principle is satisfied; indeed, the long-run inflation and gap responses of 1.27 and 0.47 are remarkably close to the (1.5, 0.5) combination used by Taylor (1993) to characterize US monetary policy, and resemble Goodhart's (1992) recommended rule. Estimates on monthly data are similar, with long-run coefficients of 1.472 (s.e. 0.424) on inflation and 0.301 (0.068) on the gap.[26]

[Table 5 about here]

The average ex-post real rate over 1992–1997 was 2.99%, well below 1980s levels. This largely must reflect factors beside monetary policy, such as a global fall in the steady-state real rate. But it is also possible that inflation targeting reduced ex-post real rates by lowering the risk of a sudden inflation outbreak. This suggests inflation can now be controlled without resort to real rates as high as 1980s levels.

4. Conclusion

This paper characterized UK monetary policy from 1972 to 1997 with Taylor-type policy rules. Estimation was on five separate regimes—with quarterly data for regimes of four years or more in length; monthly data otherwise.

Table 6 summarizes the results. In some respects, they are in keeping with standard analysis of the Taylor rule. For example, the 1972–1976 period of extremely high inflation is characterized by a near-zero response of nominal interest rates to inflation, in keeping with the 'Taylor principle' that inflation is only reliably controlled when this response exceeds unity. The low inflation period from 1992 is indeed characterized by a Taylor rule with a response above unity, and the form of the reaction function resembles that outlined by Goodhart (1992).

[Table 6 about here]

On the other hand, I did *not* find that periods of restrictive policy were necessarily characterized by a greater than unitary response of the nominal rate to inflation. Rather, policy tightenings were sometimes manifested in a sharp increase in the *average level* of the real interest rate. While long-run changes in the real rate tend to be due to changes in the economy's structure, monetary policy can influence the real rate heavily in the short run, due to inflation inertia. In particular, tighter monetary policy from 1979 contributed to a dramatic increase in the average real rate. The UK tightening was not reflected in an increase in the estimated inflation response, unlike the corresponding 1979 tightening in the US.

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Table 1: Interest rate reaction function estimates for the UK
Sample Period 1972 Q3 to 1976 Q2

Specification	Long-run coefficient on: Inflation	Long-run coefficient on: Output gap	Smoothing coefficients Σc_i	SEE	Serial correlation lags 1–4: test (p value)
Equation (2), OLS, $j = 2$	0.124 (0.077)	0.570 (0.198)	0.274 (0.213)	0.0106	0.56
Equation (3), IV, $j = 2, k = 0$	–0.073 (0.325)	–0.045 (0.665)	0.683 (0.213)	0.0129	0.45
Equation (3), IV, $j = 2, k = 1$	0.095 (0.201)	0.156 (0.440)	0.577 (0.235)	0.0133	0.84
Equation (2), OLS, $j = 2$, real-time data	0.075 (0.104)	0.349 (0.242)	0.454 (0.211)	0.0138	0.83

Note: Numbers in parentheses are standard errors. For the IV estimates, the instruments are a constant and lags 1–6 of R_t, $\Delta_4 p_t$, and $\tilde{y}_t$.

Table 2: Interest rate reaction function estimates for the UK
Sample period July 1976 to April 1979

Specification	Long-run coefficient on: Inflation	Long-run coefficient on: Output Gap	Smoothing coefficients Σc_i	SEE	Serial correlation lags 1–12: test (p value)
Equation (2), OLS, $j = 2$	–0.996 (0.489)	–1.082 (0.590)	0.231 (0.182)	0.0082	0.05
Equation (3), IV, $j = 2, k = 0$	–1.446 (1.443)	–1.099 (1.428)	0.928 (0.054)	0.0081	0.20
Equation (3), IV, $j = 2, k = 3$	–0.062 (0.068)	–0.812 (2.553)	0.369 (0.202)	0.0087	0.41
Equation (3), IV, $j = 2, k = 9$	0.622 (0.086)	0.111 (0.138)	0.602 (0.101)	0.0073	0.78
Equation (3), IV, $j = 2, k = 12$	0.559 (0.193)	–0.152 (0.312)	0.802 (0.071)	0.0080	0.37

Note: Numbers in parentheses are standard errors. In these regressions, $\Delta_{12}p$, twelve-month inflation, is used instead of $\Delta_4 p$, reflecting the use of monthly data. Correspondingly, j and k here refer to months, not quarters. For the IV regressions, the instruments used are a constant and lags 1–6 of R_t, $\Delta_{12}p_t$, and $\tilde{y}_t$.

Table 3: Interest rate reaction function estimates for the UK
Sample Period 1979 Q2 to 1987 Q1

Specification	Long-run coefficient on: Inflation	Output Gap	Smoothing coefficient c_1	SEE	Serial correlation lags 1–4: test (p value)
Equation (2), OLS, $j = 1$	0.342 (0.063)	0.258 (0.124)	0.337 (0.199)	0.0112	0.22
Equation (3), IV, $j = 1, k = 0$	0.380 (0.058)	0.164 (0.143)	0.373 (0.156)	0.0099	0.68
Equation (3), IV, $j = 1, k = 1$	0.387 (0.078)	0.058 (0.160)	0.483 (0.143)	0.0105	0.75
Equation (2), OLS, $j = 2$, real-time data	0.308 (0.086)	0.118 (0.189)	0.323 (0.238)	0.0122	0.44

Note: Numbers in parentheses are standard errors. For the IV regressions, the instruments used are a constant and lags 1–4 of R_t, $\Delta_4 p_t$, and $\tilde{y}_t$.

Table 4: Interest rate reaction function estimates for the UK
Sample Period: March 1987 to September 1990

Specification	Long-run coefficient on: Inflation	Output Gap	R^G	Smoothing coefficient c_1	SEE	Serial correlation lags 1–12: test (p value)
Equation (4), IV, $j = 1$	–0.036 (0.217)	0.453 (0.120)	1.136 (0.184)	0.518 (0.118)	0.0041	0.16
Equation (4), IV, $j = 1$, inflation omitted	—	0.454 (0.119)	1.109 (0.088)	0.522 (0.115)	0.0041	0.16
Equation (5), IV, $j = 1, k = 0$	–0.094 (0.216)	0.409 (0.126)	1.247 (0.191)	0.522 (0.130)	0.0045	0.48
Equation (5), IV, $j = 1, k = 3$	–0.170 (0.185)	0.405 (0.122)	1.324 (0.183)	0.507 (0.131)	0.0045	0.57

Note: Numbers in parentheses are standard errors. In these regressions, $\Delta_{12}p$, twelve-month inflation, is used instead of $\Delta_4 p$, reflecting the use of monthly data. Correspondingly, j and k index months, not quarters. The instruments used are a constant and lags 1–6 of R_t^G, R_t, $\Delta_{12}p_t$, and $\tilde{y}_t$.

Table 5: Interest rate reaction function estimates for the UK Sample Period 1992 Q4 to 1997 Q1

Specification	Long-run coefficient on: Inflation	Long-run coefficient on: Output Gap	Smoothing coefficient c_1	SEE	Serial correlation lags 1–4: test (p value)
Equation (2), OLS, $j = 1$	–0.323 (0.525)	0.534 (0.138)	0.475 (0.109)	0.0025	0.29
Equation (3), IV, $j = 1$, $k = 0$	0.576 (0.544)	0.597 (0.149)	0.389 (0.118)	0.0029	0.41
Equation (3), IV, $j = 1$, $k = 1$	1.267 (0.468)	0.470 (0.131)	0.288 (0.116)	0.0029	0.45

Note: Numbers in parentheses are standard errors. For the IV regressions, the instruments used are a constant and lags 1–4 of R_t, $\Delta_4 p_t$, and $\tilde{y}_t$.

Table 6: Summary of reaction function estimates

Regime	Long-run inflation response	Long-run output gap response	Smoothing parameter	Ex-post real interest rate
1972–1976	0.12	0.57	0.27	–5.72%
1976–1979	0.62	0.11	0.62	–3.14%
1979–1987	0.38	0.16	0.37	4.66%
1987–1990[1]	0.00	0.45	0.52	5.76%
1992–1997	1.27	0.47	0.29	2.99%

1. German short–term interest rate enters rule with long-run coefficient 1.11.

1. Goodhart (1989) and Minford (1993) provide discussions of UK monetary policy covering the 1970s and 1980s. The pre-1970s period is discussed in Goodhart (1997).

2. Similarly, Muscatelli, Tirelli, and Trecroci (2000) present results for 1975–1996, 1980–1996, and 1985–1996, and so do not consider the inflation targeting period separately. Adam, Cobham, and Girardin (2001) begin their study in 1985, so do not consider the 'Great Inflation' period of the 1970s or the early 1980s disinflation.

3. Post-1997 UK policy behaviour is analyzed in Adam, Cobham, and Girardin (2001), Chevapatrakul, Mizen, and Kim (2001), and Martin and Milas (2001).

4. An early counterexample is McCallum (1981).

5. Chevapatrakul, Mizen, and Kim (2001) and Svensson (2001) criticize the value of Taylor rules due to the limited use they make of information.

6. See (e.g.) Henderson and McKibbin (1993) and the papers in Taylor (1999a).

7. For further discussion and references, see Goodhart (1997, pp. 399–400) and Nelson and Nikolov (2001b).

8. Note that, since I divide the 1972–1997 sample period into several regimes, the mean of the output gap measurement error can change across regimes without rendering inconsistent the estimated slope coefficients in the policy rules.

9. The actual interest rate used by the Bank of England as its instrument has varied over time, and has included Bank Rate (until September 1972), Minimum Lending Rate (1972–1981), and the two-week repo rate (since 1996). The Treasury bill rate has historically moved closely with these instruments, and is available for the entire sample period. For August 1992, the only month for which no observation on the bill rate is available, a value of 9.7 is used. This figure was obtained by assuming a 20 basis point spread above the 91-day rate (the 91-day rate was 20 basis points below the bill rate in both July and September 1992).

10. Quadratic detrending was also used in CGG (1998) and Peersman and Smets (1999). It would be desirable to construct an output gap series that takes into account stochastic variation in potential GDP. Such a procedure, however, may be vulnerable to misspecification of the production function and household preferences.

11. The £M3 growth rate target for 1976/77 was announced on 22 July 1976 (Bank of England, 1976, p. 296). The Conservative Government took office on 4 May 1979.

12. In Nelson (2000) I provide a more detailed presentation of the results, including the individual lag coefficients and experimentation with alternative horizons.

13. Over 1973–1980, the Supplementary Special Deposits Scheme (the 'Corset') was periodically used as a quantitative control on the expansion of banks' balance sheets and therefore of the £M3 aggregate. However, it is likely that this device principally lowered the measured growth in £M3 artificially, without changing base money growth or interest rates, rather than genuinely restricting monetary conditions. The Bank of England (1982) acknowledged that the Corset 'tended to encourage the diversion of banking business into other channels'. See also Minford (1993, p. 423).

14. In keeping with this view, Sir Edward Heath has argued in his *Autobiography* that 'Our policy of expanding demand was essential to growth and employment and, therefore, broadly non-inflationary, on which basis inflation resulted largely from wage settlements' (Heath, 1998, p. 405).

15. The inclusion of regressors dated t+1 or later in principle introduces moving-average patterns into the equation's error term; however, autocorrelation in the estimated residuals for these equations (as well as those for the other subsamples) does not appear to be significant.

16. The real-time output gap data come from Nelson and Nikolov (2001a).

17. This statement refers only to the *fluctuations* in the gap series; it does not preclude the possibility that errors in the *mean* of the output gap led to policy mistakes.

18. Quarterly averages of this series have a correlation of 0.90 with the detrended output series over 1971 Q1–1998 Q4, and of 0.77 over 1976 Q3–1979 Q1.

19. See, for example, the accounts of this period in Goodhart (1989, p. 303; 1997, p. 408) and Minford (1993, pp. 409–412).

20. To check this, I added lagged annual £M3 growth relative to target as a regressor to (2), reestimating over the period in which £M3 targeting was officially in force (1979 Q2–1985 Q3). The £M3 term had long-run coefficient 0.159, s.e. 0.114, with

the other long-run coefficients w_1 = 0.331 (0.084) and w_2 = 0.239 (0.181), similar to the estimates in Table 3. One reason why £M3 growth does not enter is that policymakers attempted £M3 control through overfunding, a technique designed, as discussed in Goodhart (1992), not to affect short-term nominal interest rates.

21. On monthly data from May 1979 to February 1987, the preferred IV estimates are:

$$\underset{(0.006)}{R_t = 0.023} + \underset{(0.032)}{0.097}\, E_{t-1}\Delta_{12}p_t + \underset{(0.021)}{0.036}\, E_{t-1}\tilde{y}_t + \underset{(0.072)}{0.729}\, R_{t-1}.$$

Six lags of each variable plus a constant served as instruments. The long-run responses are w_1 = 0.359 (0.062), and w_2 = 0.133 (0.081).

22. The real-time data estimates of equation (2) in Table 3 are obtained from a regression of R_t^{end} on ${}_t\tilde{y}_{t-1}$, ${}_t\tilde{y}_{t-2}$, lags 1–2 of $\Delta_4 p_t$, and two lags of itself.

23. The 1987–1988 period is distinguished by foreign exchange intervention by the UK authorities to stabilize the sterling/DM rate. But as Lawson (1992, p. 785) notes, this intervention was 'fully sterilized'. The intervention policy would thus not affect UK interest rates, and so is consistent with a constant interest rate rule for 1987–1990.

24. Because the Nelson-Nikolov (2001a) real-time output gap data are quarterly while the estimates in this section use monthly data, I do not estimate 1987–1990 rules with real-time data. As documented in Stuart (1996), Nelson and Nikolov (2001a), and elsewhere, errors in real-time UK GDP data were large in 1987–1988. Stuart's (1996) Chart 4 suggests, however, that the real-time error is well approximated by one-sided mismeasurement of the level of the output gap—much like the 1970s real-time errors, which I found made little difference to UK reaction function estimates.

25. Adam, Cobham, and Girardin (2001) argue that US interest rates entered the UK monetary policy reaction function in the late 1980s. To test this, I reestimated (4) adding the period t US federal funds rate as a regressor, with lags 1–4 of each variable and a constant as instruments. The long-run funds rate coefficient was insignificant (0.162, s.e. 0.211), while the long-run R^G coefficient on was essentially unchanged (1.141, s.e. 0.170), as were the inflation and output gap coefficients.

26. On monthly data from October 1992 to April 1997, the preferred IV estimates are:

$$\underset{(0.005)}{R_t = 0.007} + \underset{(0.263)}{0.620}\, E_{t-1}\Delta_{12}p_{t+3} + \underset{(0.031)}{0.127}\, E_{t-1}\tilde{y}_t + \underset{(0.091)}{0.579}\, R_{t-1}$$

Six lags of each variable and a constant served as instruments.