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The United Kingdom's Experience with Inflation Targeting

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Abstract

This paper reviews the first five years' experience with inflation targeting in the United Kingdom. It concludes that inflation performance was not significantly different under inflation targeting than predicted by a VAR model estimated in the period prior to participation in the exchange rate mechanism (ERM). Both short- and long-term interest rates were lower than predicted, however, which is consistent with the interpretation that some gains in credibility were achieved under the inflation targeting regime.

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[1]At the time this paper was written, the second author, a doctoral candidate at Yale University, was a summer intern in the IMF's European 1 Department, where the first author was then a Deputy Division Chief. The authors thank Michael Deppler, Martin Fetherston, Yusuke Horiguchi, and Hossein Samiei for helpful comments and suggestions; any remaining errors are the responsibility of the authors.

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SUMMARY

The United Kingdom adopted an inflation target for monetary policy more than five years ago, in response to the failure of money supply targets and, subsequently of the exchange rate link to the ERM. The framework ushered in a period of moderate inflation—close to the 2½ percent target for most of the period. The incoming Labour government made important modifications in the framework, notably granting operational independence to the Bank of England.

This paper discusses the conduct of monetary policy with inflation targets and the implications of recent changes. The revised framework (in place since May 1997) preserves the transparency features of the U.K. approach to inflation targeting while insulating policy from short-term political considerations, and is thus likely to boost monetary policy credibility.

The favorable inflation performance must be viewed in the context of a trend toward lower inflation in other industrial countries—although the United Kingdom would not likely have shared in that trend had suitable monetary policies not been in place. Inflation targeting was not particularly well received in the markets: market indicators of expected inflation were slow to decline even after the decline in actual inflation became evident.

A vector autoregression (VAR) is used to examine whether the behavior of inflation and other key variables changed with the introduction of inflation targeting. Results indicate that inflation has been consistent with what would be predicted based on past relationships involving cyclical conditions, past inflation, interest rates and exchange rates, but both short- and long-term interest rates have been lower than predicted. This is consistent with the interpretation that credibility gains associated with inflation targeting permitted inflation to decline and long-term interest rates to be lower than predicted despite a significant monetary easing.

I. INTRODUCTION

It is now over five years since the United Kingdom adopted an inflation target for monetary policy. The establishment of the new monetary policy framework in October 1992 was a response to the failure first of money supply targets and then of the exchange rate link to the ERM (George, 1996). In the event, this framework ushered in a period of moderate inflation, with the officially targeted measure Retail Price Inflation (RPIX) staying close to its 2½ percent target and reaching the target in April 1997 (Figure 1). The Labour government that took office at the beginning of May 1997 modified the monetary framework, granting the Bank of England operational independence while preserving the key elements of the existing inflation-targeting framework and also establishing additional elements of accountability in line with this independence.

This paper reviews how the monetary framework worked up until April 1997 and discusses how it has been revised by the new government. It then reviews the experience with inflation targeting: in particular, did it deliver superior inflation or growth performance than previous policy regimes? This experience is examined in the context of a VAR model of the interrelations between monetary policy instruments, inflation, growth, and other variables.

II. HOW INFLATION TARGETING WORKS

Inflation targeting entails establishing a target for inflation and setting policy to achieve it. This process is inherently forward-looking: monetary policy affects inflation only with a lag, which in the United Kingdom has been estimated at 18 months to two years but may be even longer. As a result, inflation targeting can be represented as setting the authorities' inflation **forecast** as an intermediate target (Svensson, 1997): the authorities set monetary policy instruments to bring their medium-term forecast for inflation to the target. The alternative—trying to adjust short-term interest rates to keep inflation continuously on target, despite the lags in their effect—could require larger changes in interest rates to compensate for their limited short-run effectiveness; it could even result in instrument instability, i.e., a situation where official interest rates would need to be adjusted by ever-wider amounts to compensate for shocks and for their own lagged effects (Holbrook, 1972).[2]

The two-year horizon may also be regarded as a shorthand for a feedback rule in which monetary policy responds to deviations of inflation from target and to other variables. A popular simplified form of feedback rule is the so-called Taylor rule (Taylor, 1993) in which the monetary authorities adjust interest rates from their "normal" real level in response both to deviations of inflation from target and deviations of output from potential. The Taylor rule is symmetrical, assuming the authorities are equally concerned over below- as above-target

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[2]At the same time, the time horizon over which policy is being pursued may be reflected in expectations formation and thus, in turn, in econometric estimates of the lags in the effect of policy (see Lane, 1984). The time horizon and other issues are discussed in McCallum (1996).

FIGURE 1
UNITED KINGDOM

RETAIL PRICE INFLATION (RPIX)

(Twelve-month percent change)

Introduction of
inflation targets
Oct. 1992

ukrd20

4%

2.5%
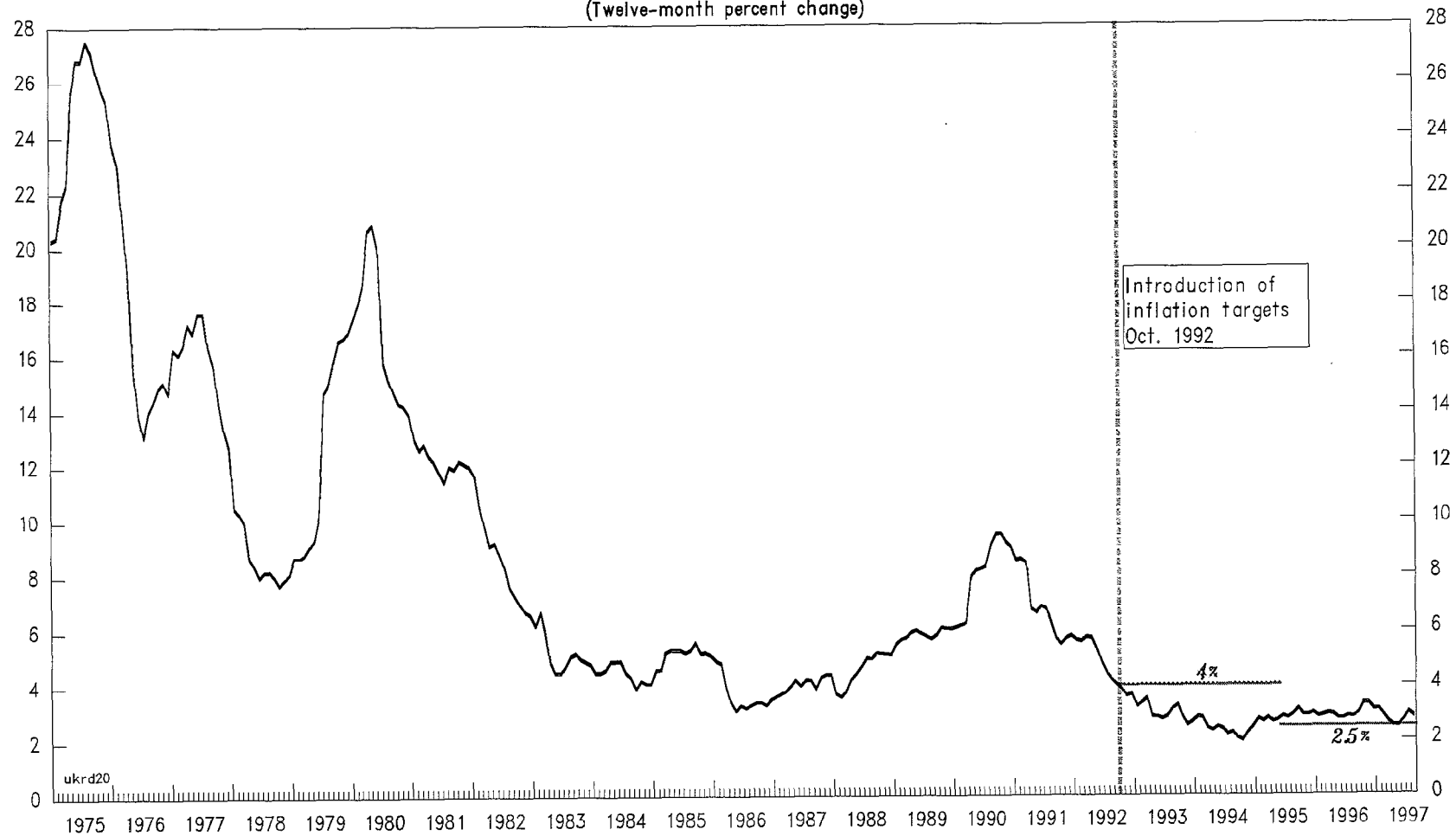
Sources: Office for National Statistics; and Bank of England.

inflation and about above- as below-potential output. Although the Taylor rule is essentially backward looking, under certain conditions an optimal feedback rule for setting interest rates that are forecast to achieve the inflation target is also of this form (Svensson, 1997)—although depending on the coefficients chosen, a Taylor rule may also reflect some additional concern for output variability.

More generally, where the dynamics of output and inflation are more complex, an appropriate rule may include not only a response to past deviations of inflation from target and output from potential (proportional feedback), but possibly also to changes in these deviations (derivative feedback) and to cumulative deviations in the past (integral feedback); for instance, Blake and Westaway (1996) simulated alternative feedback rules in a simple stochastic analytical model, and found that a combination of these three kinds of feedback (in response to past inflation as well as to output) could control inflation with limited output and interest rate variability. Clearly, such a response is still an oversimplification of the behavior of the central bank, which must sift indicators of future inflation and make policy to take account not only of uncertain developments in the economy but also of the uncertain effects of policy.

Due to the forward-looking nature of inflation targeting, it is inherently non-transparent, creating a need for compensating institutional features to enhance the transparency of the policy making process itself. In contrast with monetary policy strategies based on intermediate targets such as exchange rates or monetary aggregates—whose behavior can readily be monitored in the short term—the link between monetary policy and inflation is complex, prolonged, and uncertain.[3] **Inflation targets, the horizon over which they will be met, and the basis on which the appropriate policy to achieve these targets is assessed**, therefore need to be stated clearly, and the monetary authorities' reasoning with regard to the **actions needed to achieve them** must be spelled out. Thus, in the United Kingdom, beginning in 1994, inflation targeting was accompanied by the publication of minutes from monthly monetary policy meetings and quarterly *Inflation Reports* presenting the Bank of England's analysis of inflation prospects.

Another consequence of the forward-looking nature of inflation targets is the need for institutional arrangements to strengthen accountability. This is essential because the usual method of holding the monetary authorities accountable *ex post*—comparing the outturn to the target—is not operative until a couple of years later. Accountability was further complicated in the United Kingdom's original inflation targeting framework, since the central bank was not operationally independent and interest rate decisions remained in the hands of the chancellor of the Exchequer. In that setting, the Bank of England's role was to subject the chancellor to a kind of *ex ante* accountability, by issuing public forecasts of the inflation prospects associated with current monetary policy decisions. Accountability and transparency

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[3]In practice, money supply targets also have an element of ambiguity to the extent that the central banks may choose not to correct fully for departures of monetary aggregates from their targets, particularly when these are attributable to shifts in money demand.

thus focused on the monthly meetings between governor and chancellor, in which the governor would present his advice for changes in policy while the chancellor would present the reasoning underlying his policy decision.

Even with these transparency features, communicating to the public the nature of the problem of forecasting under uncertainty has been a significant challenge for inflation targeting in the United Kingdom (George, 1996). This has been particularly at issue in periods in which inflation itself is on target but forward-looking considerations call for tightening. Under such circumstances, the public may have the impression that the Bank of England is consistently aiming on the low side—an impression that the Bank must dispel in order to maintain public and political support for its policies.

The previous framework's adversarial approach to transparency and accountability had both strengths and weaknesses. A strength of the framework is that it prompted an airing of arguments on both sides of the decision that was taken, promoting greater transparency. The main drawback was the absence of central bank independence. Theoretical arguments in favor of an independent central bank have been based on dynamic inconsistency of optimal policies (Rogoff, 1987, and Fischer, 1995a): an independent central bank with an explicit price stability mandate (or an optimally designed contract) can better resist the temptation to engineer a surprise inflation, which—because such opportunistic behavior will be fully anticipated—is nevertheless futile in raising the level of economic activity.[4] This argument[5] is now supported by a growing empirical literature: for instance, Alesina and Summers (1993) found that countries with independent central banks indeed experienced a significantly lower level and variance of inflation, while there was no significant correlation between central bank independence and output variability.[6]

In this light, the key drawback of the inflation targeting framework prior to April 1997 is that, in the absence of central bank independence, it did not insulate monetary policy decision-making from short-run political manipulation, especially as political horizons shortened in the runup to a general election. Another potential drawback was that the resulting emphasis on disagreement between policymakers could give confusing signals to the markets, undermining confidence in the price stability objective; however, the experience in the United Kingdom seems to contradict the latter possibility, to the extent that there was no significant unfavorable market reaction to instances in which the minutes of monthly monetary

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[4]This assumes that fully anticipated monetary policy has no real effects.

[5]There are, of course, counter-arguments: for instance, McCallum (1995) notes that even without independence, the monetary authorities may recognize the futility of implementing time-inconsistent policy; and that even with independence and a formal contract for the central bank to deliver on inflation targets, the government can choose not to enforce the contract.

[6]Other studies have found more mixed results; see e.g., Fischer, 1995b.

policy meetings reported disagreement between governor and chancellor.[7] At the same time, the additional transparency signified by the willingness to reveal such disagreements may have helped enhance credibility.

The new government's decision to grant the Bank of England operational independence changed the requirements for accountability. Under the new rules, the Bank of England is responsible for implementing a monetary policy aimed at the inflation target, with some qualifications: the Bank must also "without prejudice to this objective, support the policy of the government, including its objectives for growth and employment"; exchange rate policy remains in the hands of the government—not a major constraint with a freely floating exchange rate, but one that could limit the Bank's ability to use foreign exchange market intervention as an instrument of monetary policy. Finally, the government reserves the right under extreme circumstances to override the Bank's monetary policy decisions. The inflation target itself is set by the government in each annual budget, with the expectation that it would be kept stable. The target was initially set at 2½ percent, compared with the previous target of "2½ percent or less"—which in practice had been interpreted as a point target slightly below 2½ percent. Monetary policy decisions are made in monthly meetings of a Monetary Policy Committee (MPC) chaired by the governor and consisting of five Bank of England senior staff members and four outsiders.

The revised monetary policy framework preserves some features of the previous framework, but seeks to strengthen transparency and accountability consistent with the new assignment of responsibilities. The minutes of the monthly monetary policy meetings are still published, but now present the views of the MPC and, in principle, would report any internal differences of view. The Bank of England also continues to publish a quarterly *Inflation Report*, which is no longer an assessment of the implications of policies pursued by the chancellor but rather a presentation of the view of the MPC.

To these elements have been added strengthened *ex post* accountability to the chancellor: if inflation deviates from its target by more than 1 percentage point, the governor is required to write an open letter to the chancellor accounting for the deviation and stating what action is being taken to correct it; if inflation continues to be off-target three months later, another letter is required. This arrangement of open letters, while not contradicting the two-year horizon, has quite a different flavor—since with forward-looking policy, transient shocks to inflation would not necessarily warrant any corrective action and three months is likely to be far too early to assess the adequacy of any such action on the basis of the inflation outturn. The two-year horizon is no longer made explicit in the chancellor's remit to the Bank of England, although it has been re-emphasized in the Bank's public documents and is clearly understood and accepted by monetary policymakers.

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[7]See Lane and Samiei, 1997.

In conclusion, the 1997 revisions to the monetary policy framework are likely to bolster monetary policy credibility, as central bank independence insulates policy from short-term political considerations. It preserves the transparency features of the existing system while adding stronger accountability. However, the relationship between this accountability and the inherently forward-looking nature of inflation targeting still needs to be clarified.

III. THE EXPERIENCE WITH INFLATION TARGETING

The United Kingdom's experience with inflation targeting has been generally favorable: despite an easing of interest rates after sterling's exit from the ERM, inflation declined to close to the target. This must also be set against a trend of lower inflation elsewhere (Figure 2)—although it is unlikely that the United Kingdom would have shared in that trend if suitable monetary policies had not been in place. Another key question about inflation targeting is whether the framework itself, with its transparency features, had any identifiable benefits—in terms of credibility, in particular—beyond those that would have been obtained by pursuing the same policies in a secretive manner. Previous studies addressing these issues are discussed in the second part of this section, and new empirical work presented in Section IV of this paper.
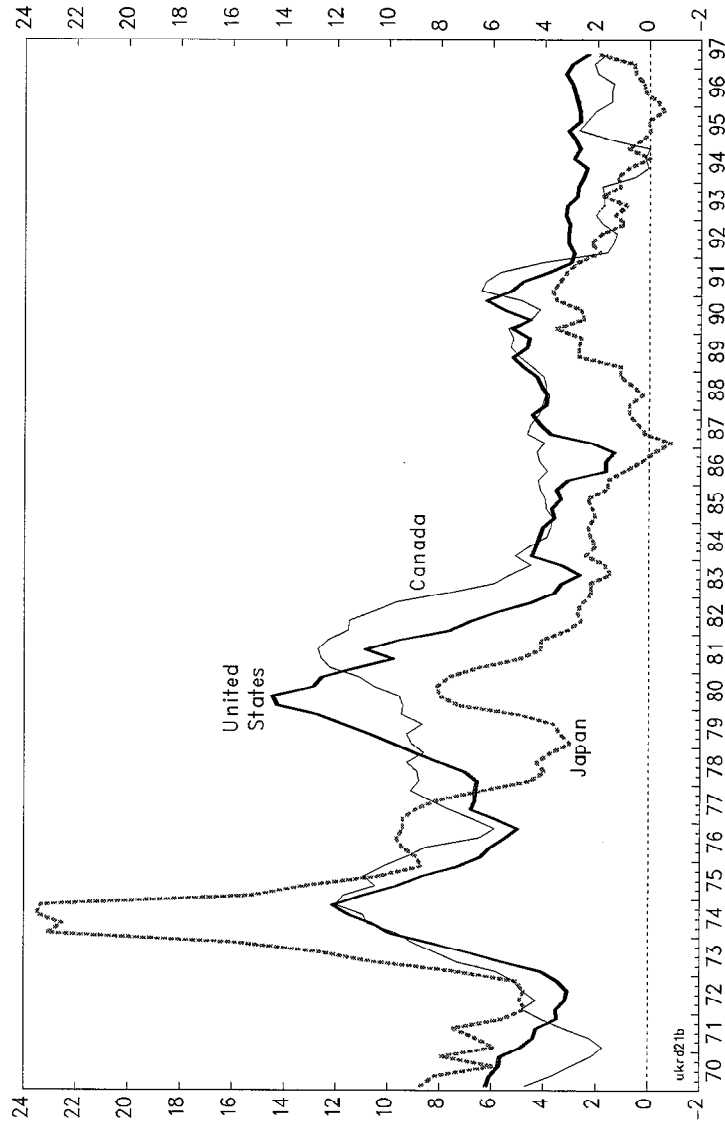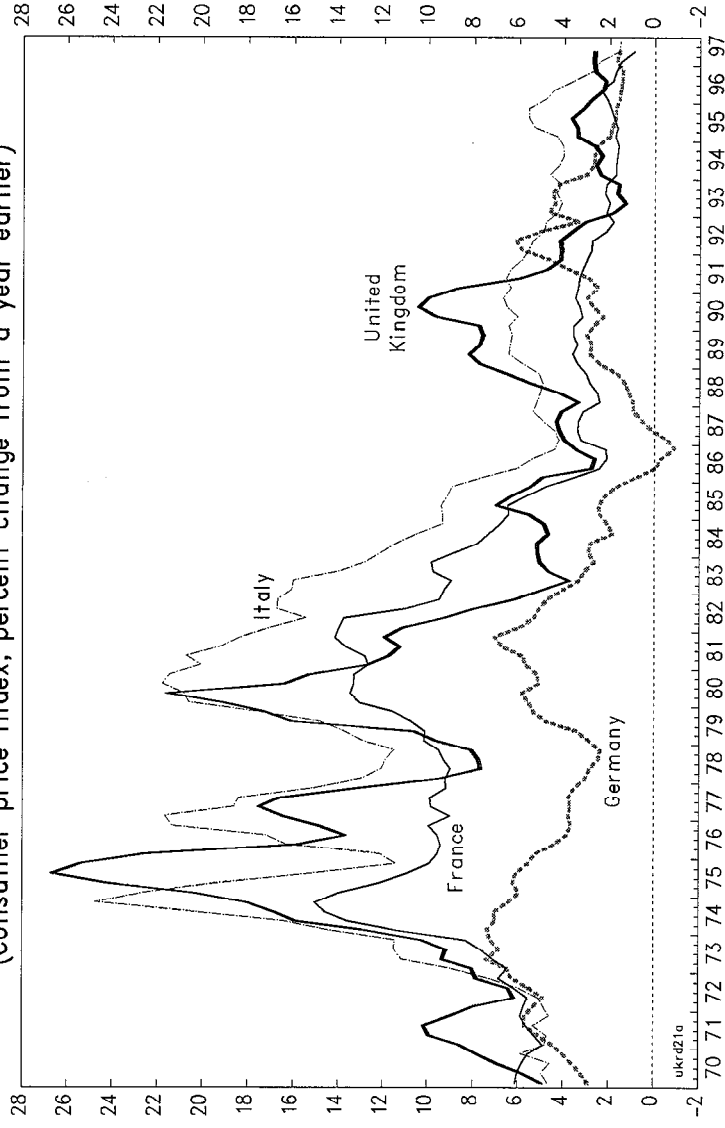
Indicators

Although inflation targeting has delivered favorable inflation performance, its introduction did not have a particularly warm reception in the markets. Expected inflation (measured as the differential between index-linked and non-indexed bond yields) declined from the inception of inflation targeting through 1993, but then rose sharply during 1994, and by April 1997, was still over 4 percentage points (Figure 3), indicating that the inflation targets had yet to gain credibility.[8] At the same time, long-term interest rate differentials against Germany declined in the early months of inflation targeting, then rose in early 1994 (both movements partly reflecting global interest rate trends). The spread trended mildly upward during late 1994 through 1996, and was around 180 basis points in April 1997. After the announcement of the revised monetary framework in May 1997, both yield spreads over Germany and implied expected inflation declined; by September 1997, spreads over Germany were below 100 basis points (in part reflecting convergence plays focused on possible participation in EMU), while implied inflation was still around 3½ percent, indicating still incomplete credibility for the 2½ percent target.

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[8]Svensson (1993) examines the credibility of inflation targets based on a comparison of index-linked bond yields with nominal yields adjusted for the maximum inflation rate in the target range. On this basis, he found that Canadian and New Zealand inflation targets were credible only after the first couple of years and Sweden's (at that time) not yet credible. Since the United Kingdom had a point inflation target from 1995 onward, his method is the same as a comparison of the implied expected inflation rate with the inflation target, which indicates incomplete credibility up to the present.

FIGURE 2
UNITED KINGDOM

INTERNATIONAL COMPARISONS OF INFLATION PERFORMANCE
(Consumer price index, percent change from a year earlier)

Source: IMF, International Financial Statistics.

FIGURE 3
UNITED KINGDOM

MARKET INDICATORS OF MONETARY CREDIBILITY
(In percent)

LONG-TERM INTEREST RATE DIFFERENTIALS AGAINST GERMANY
(Ten-year bond yields)

Italy

United Kingdom

France

October 1992

ukrd22a

1990 1991 1992 1993 1994 1995 1996 1997

INDEX-LINKED BOND YIELD AND IMPLIED INFLATION EXPECTATIONS

October 1992

Expected inflation 1/

Index-linked bond yield

ukrc22b

1990 1991 1992 1993 1994 1995 1996 1997
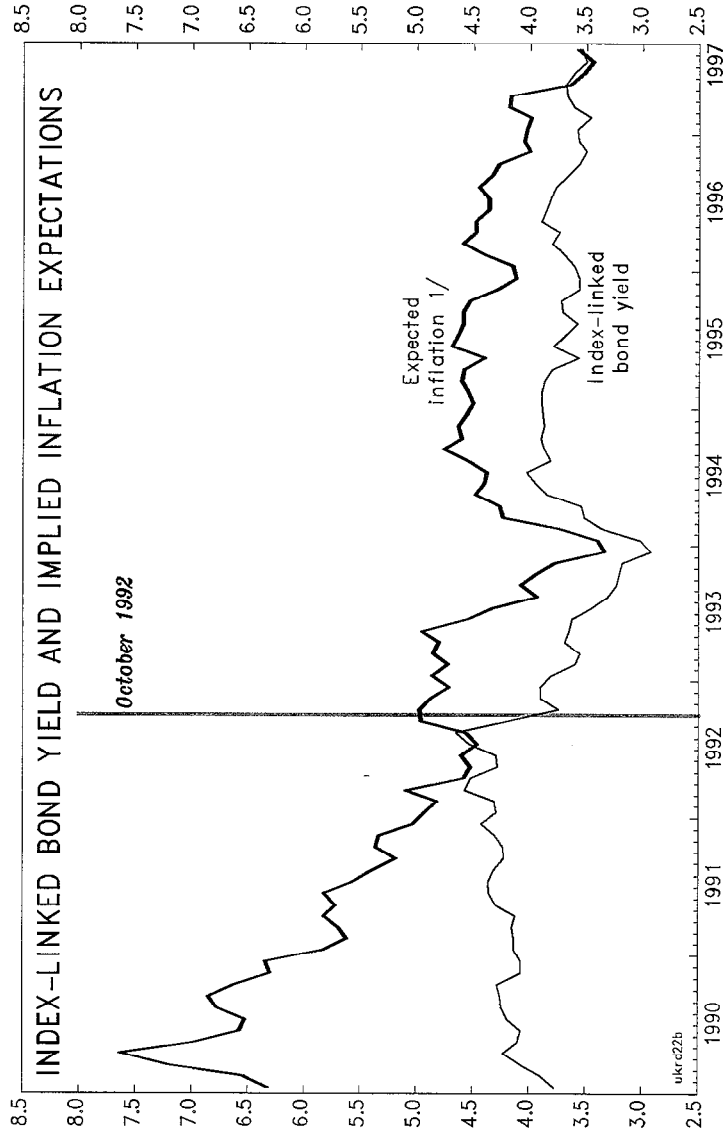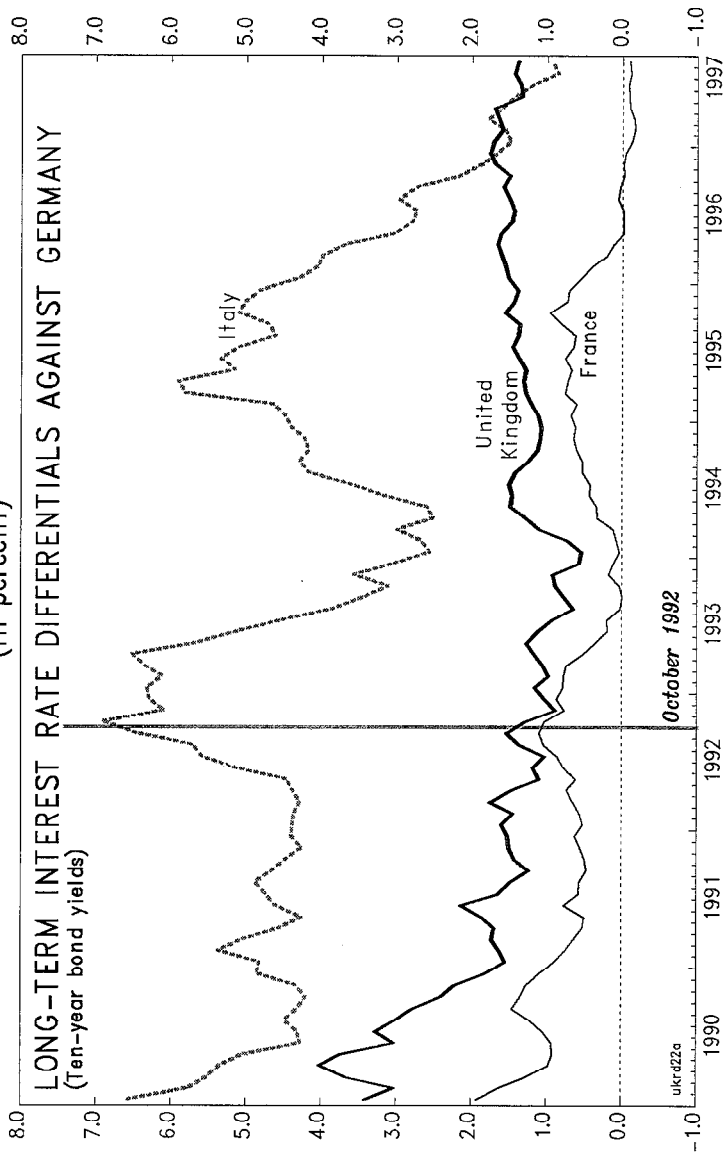
Sources: Office for National Statistics; and IMF, Research Department.

1/ Difference in yields on 7.75% Treasury loans (2012–15) and 2.5% Treasury index-linked bonds (2016).

The introduction of inflation targeting was initially associated with an easing of policy (Figure 4). Short-term interest rates declined sharply from their ERM levels, then stayed in the neighborhood of 6 percent—with variations that were modest by historical standards—for most of the inflation targeting period. The most recent movement in rates was the 125-basis-point increase in official interest rates (in four consecutive 25-basis-point monthly increments during May through August 1997, followed by a final 25-basis-point increase in November 1997).

The decline of inflation during the earlier part of the inflation targeting period appears to some extent to reflect the early 1990s recession (Figure 4, bottom panel), in which sterling's participation in the ERM in turn played an important role. The recession resulted in a large output gap which (according to staff estimates) was only closed in the second half of 1997, and this may have continued to exert downward pressure on inflation. The logic of the two-year time horizon discussed above likewise implies that the inflation performance during the first two years of inflation targeting—the period during which inflation declined—should be attributed mainly to policies followed during the ERM period.
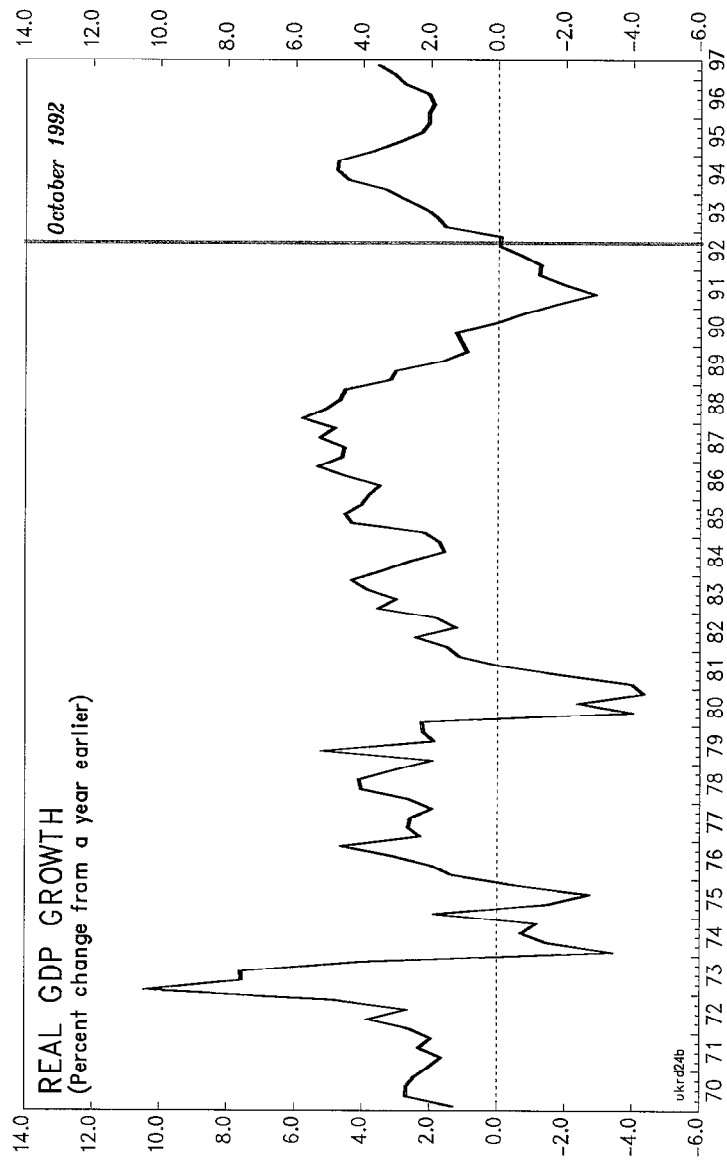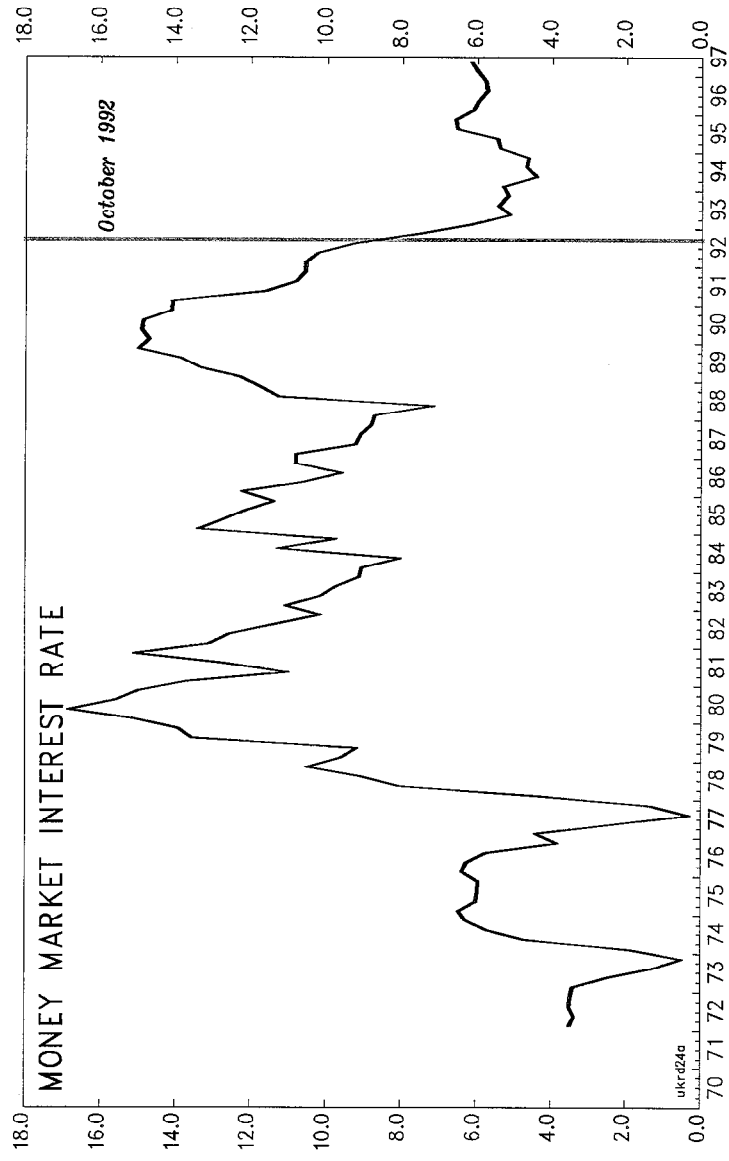
Previous studies

The implications of inflation targeting for monetary policy credibility needs to be examined further, since, of course, market-based indicators do not provide the whole picture. If the greater transparency associated with inflation targeting did enhance credibility, this might be expected to result in lower and less variable inflation than would result from pursuing the same policies in a non-transparent manner, without any increase in output variability—analogous to the implications of central bank independence discussed above. The same reasoning would suggest that disinflation could be achieved with a smaller cost in terms of output. Several studies have examined these issues for the United Kingdom and/or other inflation targeting countries.

The effect of inflation targeting on the output sacrificed through disinflation was investigated by Debelle (1996) in the context of Australia, Canada, and New Zealand, countries that backed up inflation targeting with quite different amounts of institutional change. He examined "sacrifice ratios," measured as the reciprocal of the ratio of the decline from peak to trough of centered moving average of inflation to the change in deviation of output from trend over the same period.[9] These ratios were shown to be similar in Australia and New Zealand, but higher in Canada. Such a comparison would not be meaningful for the inflation targeting experience in the United Kingdom, where inflation targeting started in a recession and achieved its objective—the 2½ percent target—at the end of that parliament, the period over

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[9]Mayes and Chapple (1995) present a critique of the sacrifice ratio, noting that it is a short-run concept—since if inflation has a deleterious effect on the economy, long-run sacrifice ratios should be negative—so the choice of time horizon is crucial (and in many cases arbitrary).

FIGURE 4
UNITED KINGDOM

MONETARY POLICY AND GROWTH

MONEY MARKET INTEREST RATE

October 1992

ukrd24a

70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97

0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0

REAL GDP GROWTH
(Percent change from a year earlier)

October 1992

ukrd24b

70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97

-6.0 -4.0 -2.0 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0

Source: Office for National Statistics.

which the target was specified; given that the output gap was closed over the period, this would imply a negative sacrifice ratio.

If inflation targeting is indeed viewed as a change in regime from discretionary policy, it might be associated with different empirical relationships among key economic variables. Debelle (1996) examined whether inflation targeting changed the way inflationary expectations were formed. He examined the relationship between survey measures of inflation expectations and lagged actual inflation in Australia, Canada, and New Zealand, using an autoregressive (AR) model. He found that the structure of this autoregressive process changed in New Zealand but not in the other two countries. Thus, the effect of past inflation on inflation expectations was essentially unchanged for Australia and Canada, changing only for New Zealand, where inflation targeting was accompanied by extensive institutional changes.

Some empirical studies have examined the influence of inflation targeting on the interaction of a larger set of economic variables. Ammer and Freeman (1995) compare the experiences of New Zealand, Canada, and the United Kingdom. They estimate a vector autoregression equation for inflation, GDP, and short-term interest rates over the pre-inflation targeting period, then examine whether these variables behaved differently under inflation targeting than would have been predicted by their previous relationships—as would be implied by the hypothesis that inflation targeting boosts credibility. Their results showed that all three of these variables were lower than predicted by the VAR; taken at face value, these results signify that inflation targeting delivered lower inflation with easier monetary policy, but at the cost of a larger slump in output. The authors note, however, that the failure of long-term interest rates to decline further contradicts the hypothesis that credibility gains were a major part of this story; they point instead to the effect of the recession already under way at the inception of inflation targeting in the United Kingdom.

A more recent study by Huh (1996) goes further in examining the out-of-sample forecasting ability of VARs over the inflation targeting period in the United Kingdom. Huh estimated VARs for GDP growth, unemployment, RPIX inflation, trade weighted sterling, short-term interest rate, and long-term interest rate. He estimated the equations for the period up until sterling's ERM entry (October 1990), and then examined out-of-sample forecasts for two subsequent periods: the ERM period and the inflation targeting period. He found inflation below the level forecast from the VAR during ERM period, but not significantly so under inflation targeting. The striking difference about the inflation targeting period is that short-term interest rates were below forecast, which he suggests may indicate that inflation targeting was associated with greater anti-inflationary credibility for a given track record of inflation. For comparison, he applies the same model to France and United States, finding no similar overprediction of interest rates in same framework. His conclusions are tentative: he notes that the post-sample prediction results suggest credibility gains from inflation targeting, but this conflicts with the persistence of relatively high inflation expectations as reflected in both survey and market measures.

In the next section, the VAR forecasting analysis of inflation targeting will be extended further, both using a longer sample period and further refinements in the econometric approach, in order to shed more light on the inflation targeting experience.

IV. VAR ANALYSIS

This section further examines the possible benefits of inflation targeting by using the out-of-sample predictions of a VAR to assess whether key economic variables behaved differently in the inflation targeting period than would have been predicted on the basis of their previous relationships. A Vector Autoregression (VAR) was estimated to describe the interrelationship among GDP growth, unemployment, inflation, the nominal effective exchange rate, and short- and long-term interest rates. One issue that may be examined is whether the transparency features associated with inflation targeting enhanced credibility, delivering lower inflation, as well as lower expected inflation as reflected in long-term interest rates, for a given stance of monetary policy—or alternatively, the same inflation performance at a lower cost in terms of output loss.

As mentioned in the previous section, this approach has been followed in some previous studies, notably by Huh (1996). The analysis presented here seeks to advance the work of the previous studies discussed, both by using data for the longer period of inflation targeting experience now available and by incorporating in the Bayesian estimation framework a more plausible set of assumptions about the time-series properties of the variables included (see Appendix I).

A VAR was estimated using quarterly data for the United Kingdom for 1975-I through 1990-III—thus excluding both the inflation targeting and ERM periods from the estimation period. Real GDP, the consumer price index, and the nominal effective exchange rate were differenced, while the interest rates and the unemployment rate were included in their levels.[10] After experimenting with alternative specifications, the lag length was selected as two. Bayesian estimation methods were used to deal with the overparameterization problem associated with the large number of variables included in the VAR (see Appendix I).

Figure 5 shows out-of-sample prediction errors for the estimated VAR in two sub-periods: the ERM period 1990-IV through 1992-III; and the inflation targeting period 1992-IV through

[10]The choice of differencing was based on theoretical consistency and previous empirical findings. Short-term interest rates were represented by the overnight rate; long-term rates by yields on long-term bonds (for United Kingdom, 3.5 percent War Loan; for France series on 7–10 year bonds compiled in IMF Research Department; for Italy IFS long bond series); prices by Consumer Price Index (Retail Price Index in the United Kingdom). Other variables were real GDP (non-oil GDP for United Kingdom); nominal effective exchange rates; and the official unemployment rate (claimant unemployment in United Kingdom). Data from IFS and other sources.

FIGURE 5
UNITED KINGDOM
PREDICTION ERRORS OF VAR
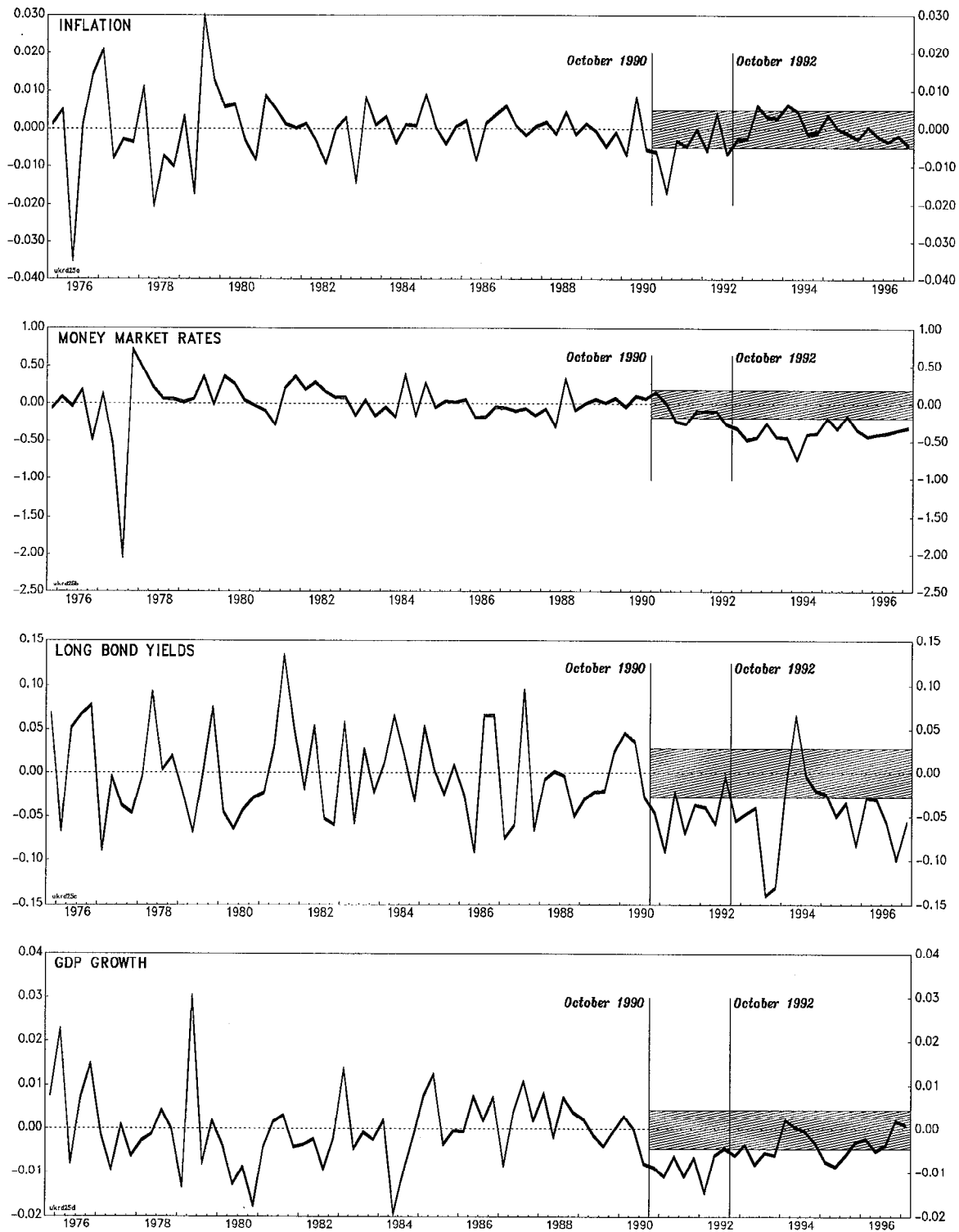
Source: Staff calculations (see text).

1997-I. Two-standard-error bands are also shown, indicating observations for which individual prediction errors are significant. Table 1 shows mean prediction errors for each period and the corresponding standard errors, indicating whether the changes in regime—first to ERM participation and then to inflation targeting—resulted in structural change that led key variables to be systematically above or below what would have been predicted based on past relationships.[11]

The results indicate that during the inflation targeting period, inflation did not differ significantly from the predictions of the VAR. At the same time, short-term interest rates were significantly lower than would have been predicted based on the previous values of other variables in the model. Real output growth was not significantly different from predicted on average—significantly slower than predicted by the model in the early part of the inflation targeting period, converging to rates predicted by the model as time went on. Long-term interest rates were also significantly lower, on average, than predicted by the model; a possible interpretation is that although inflation targeting did not result in an improvement in inflation performance, it did increase credibility.

These implications of inflation targeting contrast with those of the ERM period. During that period, inflation was significantly lower than predicted by the VAR. At the same time, short-term interest rates were in line with the model's prediction, but long-term interest rates were lower; and growth was significantly slower than predicted. This is consistent with a standard interpretation of the ERM experience: that while it lasted, it resulted in lower inflation and improved monetary policy credibility at the cost of lower growth.[12]

It is useful to put these results in perspective by comparing them with results for similar VAR equations estimated for the same periods for France and Italy.[13] France is chosen for comparison because it remained within the ERM when the United Kingdom exited;[14] and Italy

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[11]Prediction errors for the other two variables (nominal effective exchange rate and unemployment) not shown.

[12]These results do not change noticeably if the 1989–90 period of shadowing the ERM is included in the prediction rather than the estimation period.

[13]Huh (1996) showed results for France and the United States, as well as the United Kingdom.

[14]France rather than Germany is chosen for comparison due to the effects of unification.

Table 1. United Kingdom: Out-of-Sample Prediction Errors

(Mean prediction errors, with corresponding standard errors)

	Growth	Unemployment	Inflation	Exchange Rate	Short Rate	Long Yield
United Kingdom						
(A) 1990-IV to 1992-III	-0.008583 (0.002205)	0.011165 (0.004369)	-0.004937 (0.002392)	0.006720 (0.009867)	-0.118679 (0.088845)	-0.045682 (0.013480)
(B) 1992-IV to 1997-I	-0.003551 (0.002047)	0.001863 (0.004077)	0.000132 (0.002129)	0.008418 (0.010256)	-0.384737 (0.084312)	-0.047134 (0.013745)
France						
(A) 1990-IV to 1992-III	-0.003335 (0.001445)	0.008368 (0.004885)	-0.001640 (0.001522)	-0.010124 (0.003987)	0.071409 (0.021154)	-0.019239 (0.011710)
(B) 1992-IV to 1997-I	-0.007035 (0.001476)	0.020832 (0.004669)	0.004661 (0.001618)	-0.007119 (0.003802)	-0.086616 (0.021253)	-0.055350 (0.013183)
Italy						
(A) 1990-IV to 1992-III	-0.006074 (0.001404)	-0.013817 (0.009127)	-0.006153 (0.002469)	0.004545 (0.004770)	0.021613 (0.021369)	0.031432 (0.012206)
(B) 1992-(v TO 1997-I	-0.008459 (0.001415)	0.024602 (0.009957)	0.001015 (0.002534)	-0.014892 (0.004828)	-0.136754 (0.021814)	-0.018144 (0.013445)

Source: Calculations by staff (see text).

because it left the ERM but did not adopt full-fledged inflation targeting[15]—although the Banca d'Italia, unlike the Bank of England, was formally independent from 1993 onward.

The results for France are shown in Figure 6, with average prediction errors in Table 1. During the period since September 1992, inflation in France was significantly above the predictions of the estimated VAR. Short-term interest rates were on average significantly lower than predicted, although this reflected a shift from higher than predicted in the year or so before and after September 1992, followed by much lower-than-predicted rates in more recent periods. Long-term interest rates were also significantly below the predictions of the model on average, again reflecting wide variations in both directions. Finally, growth was lower than predicted on average. The inflation results are quite different from those for the United Kingdom, while the interest rate results are more similar, suggesting that the latter but not the former may be partly attributable to international trends.

In Italy, as in the United Kingdom, during the post-September 1992 period, inflation was in line with the VAR predictions (Figure 7). Short-term interest rates were significantly lower than predicted. Long-term rates were also lower on average but not significantly so, with wide (and significant) deviations in both directions that largely reflected political and fiscal uncertainties. At the same time, growth performance was significantly worse than predicted. This suggests that in Italy, as in the United Kingdom, the exit from the ERM did not result in a worsening of inflation performance compared with what was predicted by previous relationships. However, in the Italian case, this cannot be attributed to inflation targeting, but is more likely due to the severity of the recession—although in Italy, the cyclical pattern was different, with a recovery from the recession during 1993–95 followed by a renewed slowdown in 1996–97. The decline in long-term interest rates in the latter part of the period might be interpreted as reflecting in part the credibility benefits of central bank independence (in 1993) followed by a more explicit focus of monetary policy on inflation (from mid-1995 onward), but is more likely to be attributable to prospects of the lira's ERM re-entry in November 1996 and shifting expectations regarding Italy's EMU prospects

The results for France and Italy thus shed further light on the United Kingdom's experience—notably the fact that inflation stayed in line with predictions and long-term interest rates were below predicted levels despite monetary easing. The fact that this pattern was not found for France suggests that it was not solely a reflection of international trends. However, the fact that it was partly shared by Italy (although in Italy, the deviation of long-term interest differentials from predictions was not significant) suggests that it may not be mainly attributable to inflation targeting.

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[15]For several years, Italy has had inflation targets used to guide wage agreements and fiscal plans. Beginning in mid-1995, the central bank announced that it would base interest rate decisions on whether actual inflation crossed a stated threshold but this announcement did not introduce any of the transparency and accountability features characteristic of inflation targeting.
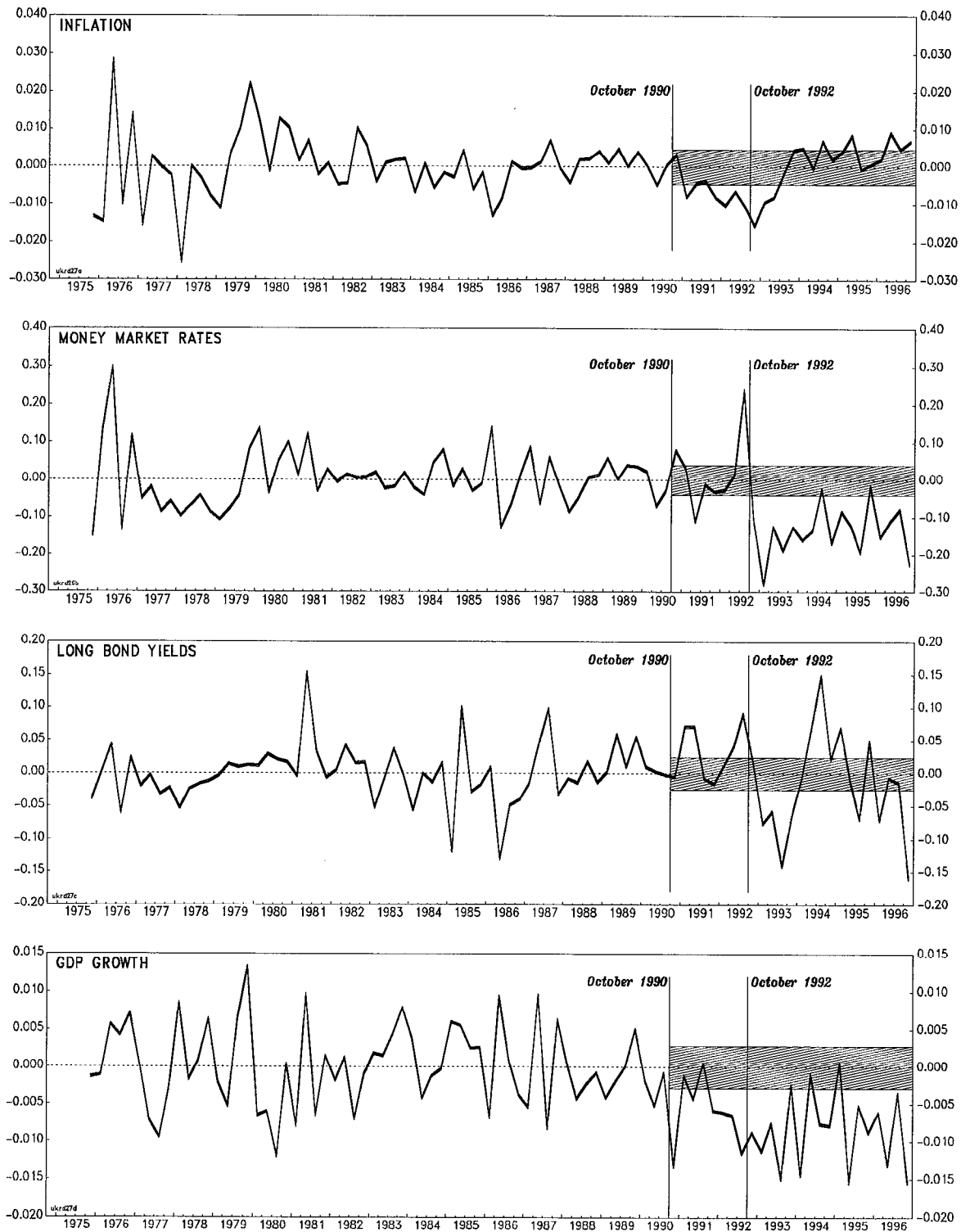
FIGURE 6
FRANCE

PREDICTION ERRORS OF VAR
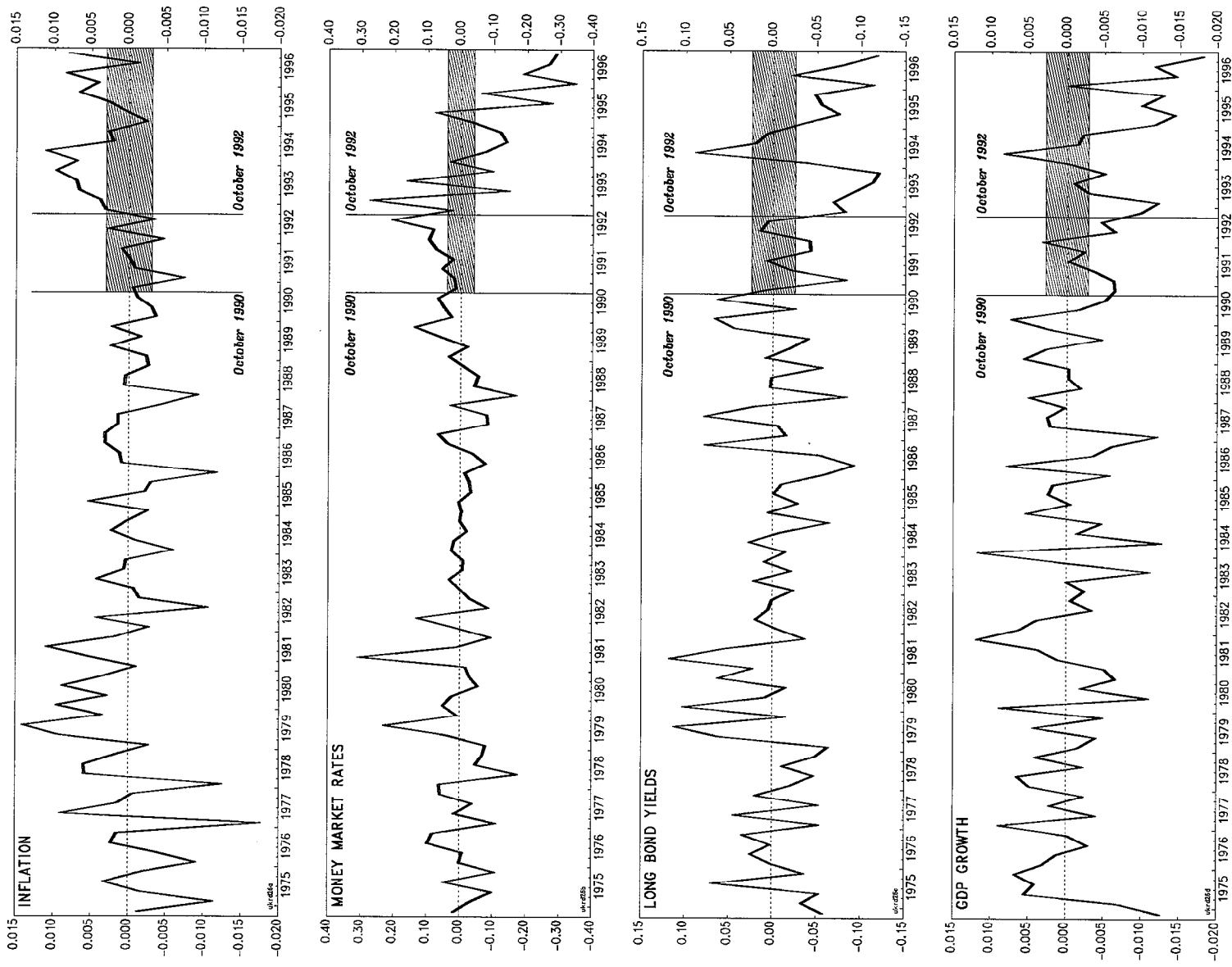
Source: Staff calculations (see text).

FIGURE 7
ITALY

PREDICTION ERRORS OF VAR

Source: Staff calculations (see text).

V. CONCLUSION

Although inflation targeting was originally adopted in the United Kingdom *faute de mieux* after the breakdown of other intermediate targets, it has delivered consistently good inflation performance. In particular, it has been associated with declining inflation, despite lower short-term interest rates than in the preceding period. The VAR analysis presented in this paper confirms results in previous literature, suggesting that inflation has been consistent with what would be predicted based on past relationships involving past inflation, cyclical conditions, interest rates and exchange rates, but both short- and long-term interest rates have been lower than predicted. This result may be attributable partly to credibility gains from inflation targeting, which may have permitted inflation to continue to decline and long-term interest rates to be lower than predicted despite a monetary easing (as reflected in lower-than-predicted short-term interest rates). In contrast, it seems likely that had no new monetary framework been specified, credibility might have deteriorated in the aftermath of the ERM crisis.

Since the May 6, 1997 decision to grant the Bank of England operational independence, market indicators have suggested substantial further gains in credibility, as reflected in long-term interest rates and differentials—although expected inflation implied by indexed bond yields suggest that credibility still needs to be consolidated. These indicators suggest that the revised monetary framework, with an independent and accountable central bank, is expected to deliver improved inflation performance.

Econometric Method

Vector autoregressions (VARs) were estimated for real GDP growth, the unemployment rate, inflation, a trade-weighted nominal exchange rate index, and short- and long-term interest rates. All data are quarterly. The VARs were estimated using the data for 1975-I through 1990-III (i.e., up until sterling's ERM entry in October 1990. Out-of-sample forecasts were then examined for two periods: (a) the ERM period, 1990-IV through 1992-III; and (b) the inflation targeting period, 1992-IV through 1997-II.

Real GDP, the price level and the exchange rate were differenced to render these series stationary (implicitly assume that these series are difference stationary), while interest and unemployment rates were assumed already to be stationary.[16] Stationarity was particularly important since the VAR was to be used to generate forecasts relatively far out of sample (up to 26 quarters). In the presence of roots in the neighborhood of unity, small errors in the point estimates would imply large forecast errors further away from the sample period.[17]

With six series included in the VAR and 63 observations to estimate the model, there is a potential problem of overparameterization. This is a familiar problem in VARs, which may be addressed using Bayesian methods developed by Litterman, Sims and others.[18] These techniques involve specifying a prior distribution of the variables included in the VAR; the most widely used prior is the so-called "Minnesota prior" (also known as "Litterman prior"), according to which the set of time series may be characterized as a set of independent random walks (consistent with empirical studies of univariate macroeconomic time series). One must also specify a hyperparameter λ controlling the tightness of the prior (i.e., the strength of the researcher's belief that the actual distribution of the time series variables corresponds to the prior distribution specified).

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[16]Any departures from these assumptions would be reflected in the estimated coefficients of the VAR, although the initial degree of differencing affects the formulation of the prior (as discussed below).

[17]To illustrate this point informally, assume that x_t is generated from:

$$x_t = x_{t-1} + \epsilon_t .$$

If our estimated model is

$$x_t = \alpha + \rho x_{t-1} + e_t ,$$

the 1-step ahead forecast error is

$$(1-\rho)x_t - \alpha + \epsilon_{t+1}$$

If the estimated ρ is not *exactly* equal to 1, this forecast error grows without bound, as x_t grows without bound. This problem occurs if x_t attains levels far from those attained in the sample period that was used to estimate ρ, which will happen with high probability for large t.

[18]See, e.g., Litterman (1986) for an overview of forecasting with Bayesian VARs.

In deriving the results in this chapter, the prior used is similar to the Minnesota prior, with two modifications. First, the fact that some of the series have already been differenced is taken into account. Second, it is recognized that a random walk is unlikely to be an appropriate characterization of the series that are not differenced (viz the unemployment and interest rates).[19]

Specifically, the prior distribution of the VAR coefficients is specified as follows. Let C_{ijl} be the VAR coefficient on y_{jt-l} in the equation for y_{it}. The prior distribution of a differenced series' own lag coefficients is then given by

$$C_{iil} \sim N(0, (\lambda/l)^2) \qquad \text{if series } i \text{ is differenced}$$

where λ is the hyperparameter controlling the tightness of the prior. The mean of the prior implies that the levels are a random walk. Also, as with the Minnesota prior the variance of the coefficients shrinks with the lag length. The series that are not differenced are believed to be stationary, although near-unit roots are not unlikely. Therefore, a flat (improper) prior is imposed on the first own lag coefficient:

$$C_{ii1} \sim N(0, \infty) \qquad \text{if series } i \text{ is in levels}$$

Coefficients on own lags of order $l > 1$ are treated in the same way as the coefficients on the differenced series' own lags of order l-1:

$$C_{iil} \sim N(0, (\lambda/(l-1))^2) \qquad \text{if series } i \text{ is in levels and } l > 1$$

Thus, the mean of the prior for nondifferenced series represents an unrestricted AR(1). The prior for all other coefficients is of the same structure as for the Minnesota prior:

$$C_{ijl} \sim N(0, (\lambda \theta \hat{\sigma}_i / l \hat{\sigma}_j)^2) \qquad \text{for all} \quad i \neq j$$

where $\hat{\sigma}_i$ and $\hat{\sigma}_j$ are OLS estimates of the standard errors of the VAR disturbances in equation i and j. (This is included to make the prior invariant to changes in units). θ is a second hyperparameter controlling the prior variance of interaction coefficients. As θ and λ increase, the prior becomes 'flatter' and in the limit the BVAR is equivalent to an OLS VAR. Finally, the prior on the VAR intercepts is flat and prior covariances among different parameters are set to zero.

The choice of hyperparameters and lag length can be regarded as model selection problem. These are selected by conditioning on the hyperparameters and the lag length with the highest posterior probability (rather than averaging over different values weighted by their likelihood). These posterior probabilities are approximated by the posterior odds information criterion

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[19]Compare to otherwise very similar analysis in Huh (1997), where all the variables are differenced and the Minnesota prior is also imposed, implying that their differences follow a random walk.

PIC, a model selection criterion developed by Phillips (1996). Unlike for Schwarz's BIC, the approximation of PIC remains asymptotically valid under fairly general regularity conditions that include non-stationary data.

Posterior inference is conducted conditional on the selected hyperparameter values and lag length. Out of sample forecasts are obtained as conditional expectations from the VAR with the posterior mean of the autoregressive coefficients plugged in. For one-step ahead forecasts, this approach leads to the optimal predictor under mean squared error loss, for larger forecast horizons it can be regarded as an approximation. Forecast errors and forecast error summary statistics are then calculated from the actual observations. To assess the validity of the model during the EMS and inflation targeting periods, the observed forecast errors are compared to their posterior predictive distribution under the entertained model. This method of model checking has become a frequently used tool in applied Bayesian analysis (cf. Gelman *et al.*, 1994, Chapter 6). The posterior predictive distribution is easily obtained by means of Monte Carlo simulation. VAR coefficient matrices and covariance matrices of the VAR innovations are drawn from their joint posterior distribution (see Schorfheide, 1997, for the exact form of this posterior distribution) and trajectories of future observations are simulated conditional on the last observation of the estimation sample period. For each simulated trajectory forecast, errors and summary statistics are computed in exactly the same way as it was done with the historical data. From this predictive distribution, Bayesian "confidence intervals" and calculated "p-values" are derived to measure how far the observed forecast errors and summary statistics lie in the tail of their predictive distribution.

REFERENCES

Alesina, Alberto and Roberta Gatti, 1995, "Independent Central Banks: Low Inflation at No Cost?" *American Economic Review—Papers and Proceedings*, Vol. 85, No. 2 (May), pp. 196–200.

Alesina, Alberto and Lawrence H. Summers, 1993, "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence," *Journal of Money, Credit, and Banking*, Vol. 25, No. 2 (May), pp. 151–162.

Ammer, John and Richard T. Freeman, 1995 "Inflation Targeting in the 1990s: The Experiences of New Zealand, Canada, and the United Kingdom," *Journal of Economics and Business*,47, No. 2 (May),pp. 165–192.

Blake, Andrew P. and Peter F. Westaway, 1996, "Credibility and the Effectiveness of Inflation Targeting Regimes," *The Manchester School*, Vol. 64 Supplement 1996, pp. 28–50.

Debelle, Guy, 1996, "The End of Three Small Inflations: Australia, New Zealand, and Canada," *Canadian Public Policy*, Vol. 22, No. 1 (March), pp. 56–78.

Fischer, Stanley, 1995a, "Central-Bank Independence Revisited," *American Economic Review—Papers and Proceedings*, Vol. 85, No. 2 (May), pp. 201–206.

————1995b, "Modern Central Banking. In *The Future of Central Banking*," edited by Forrest Capie, Stanley Fischer, Charles Goodhart, and Norbert Schnacht, (Cambridge: Cambridge University Press), pp. 262-308.

Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin, 1994, *Bayesian Data Analysis*, (New York: Chapman&Hall).

George, Eddie, 1996, "Inflation Targeting—The British Experience," *Central Banking*, Vol. 6, No. 4 (Spring), pp. 109–115.

Green, John H., 1996, "Inflation Targeting: Theory and Policy Implications," *Staff Papers*, International Monetary Fund, Vol. 43, No. 4 (December), pp. 779–795.

Holbrook, Robert, 1972, "Optimal Economic Policy and the Problem of Instrument Instability," *American Economic Review*, Vol. 62, pp. 57–65.

Huh, Chan, 1996, "Some Evidence on the Efficacy of the U.K. Inflation Targeting Regime: An Out-of-Sample Forecast Approach, Board of Governors of the Federal Reserve System", Discussion Paper No. 565 (September).

Lane, Timothy, 1984, "Instrument Instability and Short-Term Monetary Control," *Journal of Monetary Economics,* Vol. 14, pp. 209–224.

Lane, Timothy, Alessandro Prati and Mark Griffiths, 1995, "An Inflation Targeting Framework for Italy," IMF Paper on Policy Analysis and Assessment 95/4 (Washington: International Monetary Fund).

Lane, Timothy, and Hossein Samiei, 1997, "Does Public Disagreement on Monetary Policy Unsettle the Markets" IMF Working Paper 97/63 (Washington: International Monetary Fund).

Litterman, Robert B., 1986, "Forecasting with Bayesian Vector Autoregressions—Five years of Experience," *Journal of Business and Economic Statistics,* No. 4, pp. 25–38.

Mayes, David and Bryan Chapple, 1995, "The Costs and Benefits of Inflation: A Critique of the Sacrifice Ratio," *Reserve Bank of New Zealand Bulletin,* Vol. 57, No. 4 (March), pp. 9–21.

McCallum, Bennett T., 1995, "Two Fallacies Concerning Central-Bank Independence," *American Economic Review—Papers and Proceedings,* Vol 85, No. 2 (May), pp. 207–211.

————1996, "Inflation Targeting in Canada, New Zealand, Sweden, the United Kingdom, and In General," NBER Working Paper, No. 5579 (May).

Phillips, Peter C.B., 1996, "Econometric Model Determination," *Econometrics,* No.64, pp. 763–812.

Rogoff, Kenneth, 1987 "Reputational Constraints on Monetary Policy," *Carnegie-Rochester Conference Series on Public Policy,* No. 26, pp. 141–181.

Schorfheide, Frank, 1997, *Bayesian Vector Autoregression and Dynamic Stochastic General Equilibrium Model Priors,* manuscript, (Yale University).

Svensson, Lars E.O., 1993, "The Simplest Test of Inflation Target Credibility," NBER Working Paper, No. 4604 (December).

———— 1997, "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets," *European Economic Review,* Vol. 41, No. 6, pp. 1111–1146.

Taylor, John, 1993, "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy,* Vol. 39, pp. 195–214.