The Interaction between the Bank of England's Forecasts and Policy, and the Outturn

by C.A.E. Goodhart[1]
Deputy Director, Financial Markets Group
London School of Economics
May 2004

I. Introduction

There are long, (and often variable), lags between a change in interest rates and its effect on real output and inflation. Hence policy should be based on forecasts, (King 2000). So the eventual out-turn, e.g. for output and inflation, is a complex combination of the skills of the forecaster, the response of the policy-makers to the forecasts (and to their other, possibly private, sources of information), and the impact of shocks which were unforeseen at the time of the forecast. The aim of this paper is to try to disentangle this mixture in the particular case of the Bank of England, and thereby to assess the skills of the forecasters, the adequacy of the response of the monetary authorities, and the time path of shocks which were unanticipated at the time of the original forecasts.

[1] My thanks are due to O. Aspachs for excellent research assistance and to C. Bean and G. Wood for helpful comments and suggestions.

For most countries this exercise is, alas, impossible. Official forecasts are not published in many, perhaps most, cases. In other cases, where forecasts are published, they are described as `staff forecasts', and there is a careful distinction drawn between such `staff forecasts' and the beliefs about the future of the policy-makers themselves, e.g. in the ECB or FOMC. In yet other cases the conditional assumption about the future path of interest rates on which the forecast is based is not revealed, so no one can tell whether changes to subsequent forecasts (and to the out-turn) are due to policy shifting from its previous assumed path, or to an (unanticipated) shock to other inputs to the forecast, (e.g. Bank of Canada).

Fortunately these problems do not exist in the UK, at least not to the same extent. The forecasts for output and inflation are not only published, but, even though the more mechanical work in their production is done by the staff, the forecast is officially that of the Monetary Policy Committee itself.[2] Moreover, the conditional assumed path for interest rates over the two year horizon of the published forecast, (i.e. no future change) is made abundantly clear.

[2] Of course some of the nine members may have individual reservations and qualifications, some of which are at times reported in the Inflation Report, (notably in Table 6B in previous issues of this Report).

There is another complication that, almost always, arises in the assessment of forecast accuracy. This is that some of the actual data, e.g. for output, are subject to continuous subsequent revision.[3] Fortunately for macro-economic research workers in the UK, the Bank has now provided spread sheet (Excel) data on real output values for each generation of estimates from 1961 to 2001 Q3, (see Bank of England Quarterly Bulletin, Spring 2001, p. 42, `Building a real-time database for GDP(E)' and its website, www.bankofengland.co.uk/statistics/gdpdatabase). This allows the research worker to choose which generation of estimate to use, but does not resolve the question of what actually is the best choice. This choice, in some large part, relates to the question of what the forecaster is trying to forecast; is she trying to forecast the first `flash' estimate, which is known to be estimated with a large and erratic error, containing both much noise and bias; or the likely estimate after about one year; or the likely eventual estimate after some 5/10 years. In practice, early estimates have consistently tended to be revised upwards over time, but the scale of bias is unknown, and the Office for National Statistics has been trying to reduce the scale of the bias.

My own belief, though others may think differently, is that forecasters are trying to estimate the out-turn that will be perceived in the data shortly after the `flash estimates' have settled down, say some two or three quarters (6-9 months) after the first estimate becomes available. So I have used the Bank website data to construct the series of output growth shown in Table 1. This is compared with the latest series of output growth available at end 2003. An earlier version of this paper was done with the latest series for output growth, rather than the

[3] See Statistics Commission, (2004), Revisions to Economic Statistics, Vols 1, 2 and 3.

contemporaneous data. This did not change the results significantly, in contrast to the exercises done by Orphanides (1998) when examining US policy in the 1970s. Fortunately the data for RPI(X), which forms our inflation data series, have not been subject to such revisions; the first reported outturn figure remains unchanged.

Most forecasters in the UK, outside the Bank, such as the National Institute, base their forecasts on their best guesstimates of future official policies, notably for interest rates and fiscal policies. These usually involve an expectation that interest rates and fiscal policies will change in future; whereas the Bank assumes not only that interest rates will remain unchanged (at the level announced just after the MPC meeting before the Inflation Forecast is revealed), but also that fiscal policy remains as set out in the latest Budget. Any assessment of the accuracy of such external (i.e. non-Bank) forecasts should, in principle, take account of the deviations in actual policy from that on which the initial forecast was based. But since the forecasts for future (monetary and fiscal) policies are subject to continuous change from one forecast to another, (and in some cases not clearly expressed), this would be a tedious and complex exercise which is rarely, if ever, undertaken. Hence deviations between forecast and outcome are some complicated combination which cannot be easily disentangled of forecast error, policy revision and unforeseen shock. As I hope to demonstrate in Section 3, it is considerably easier to make a separation between these factors in the case of the MPC of the Bank of England.

The operation of, and the justification for, the constant interest rate assumption are not generally well understood, (despite my own best efforts, e.g. Goodhart (2001 and 2004a)). It is, therefore perhaps, worthwhile to provide a short reprise of such operations. The forecasts are presented quarterly in February, May, August and November. The work on the forecasts starts in the previous month, and is then based on the interest rate set by the MPC at that month's meeting (e.g. at the January MPC meeting for the February forecast), and is assumed unchanged over the (reported)[4] two-year horizon of the forecast. The time-path for output, inflation, etc., from this forecast, based on last month's interest rate, (conditionally assumed unchanged), is then a key input into the MPC meeting just prior to the Inflation Report and its published forecast.

If the forecast based on last month's interest rate shows inflation to be too high (low), then there will be pressure on the MPC to raise (lower) interest rates to return inflation to target, (from its start in May 1997 until November 2003, the target was to achieve an annual growth of RPIX of 2.5%). If interest rates are thereby changed by the decision of the MPC at this

---

[4] An unchanged nominal interest leads, eventually, to Wicksellian instability. So for longer forecasts, which are often done in the Bank, the unchanged interest rate assumption is replaced, at some point after the two-year horizon, with a (stabilising) Taylor-type reaction function assumption.

A further problem of the constant interest rate (CIR) assumption is that this usually differs from the future time path of official rates expected by the market. This then involves the forecasters in the Bank having to assume (e.g. for the purpose of estimating exchange rate movements) that the market has to adjust to systematic errors over time. While this is not a comfortable, nor elegant, procedure, there is considerable evidence that money markets have not, in practice, been good predictors of future official interest rates; for the USA, see Diebold and Li (2003), Duffee (2002), Carriero et al. (2003), Rudebusch (2002) and Rudebusch and Wu (2004); for Japan, see Thornton (2004).

Partly because of such problems, the Bank also reports a forecast based on existing money market rates in the Inflation Report (IR). Some members of the MPC may give as much, or more, weight to this forecast as to the CIR forecast. It would be interesting, and desirable in principle, to do the same exercise for the MMR exercise as is done here for the CIR forecast. But that would involve a major additional research exercise to recover the money market future implied rate path on each forecasting occasion, and the implied central point estimates for inflation and output growth. While the Bank of England may have sufficient resources for this exercise, it is beyond my own capabilities.

meeting, the forecast is then immediately re-worked to incorporate this new level of short-term interest rates, which then again is assumed to be left unchanged over the eight quarter horizon of the forecast.

When on the MPC, I construed my obligation to achieve the Chancellor's remit as being to set interest rates so that the (median) forecast for inflation in the final half-year of the two year forecast period (i.e. seven and eight quarters hence, t+7, t+8) closely approximated to 2.5%. Others, e.g. Vickers (1999) have publicly denied that there was ever such a clear, or maintained, rule of thumb; certainly interpretations of how best to deliver the Chancellor's remit varied amongst MPC members. That said, my own empirical study of the MPC's forecasts in `What is the Monetary Policy Committee trying to achieve' (2004a) shows that these have remained closely consistent with my own approach. The modal forecasts of RPIX forecast at t+7 and t+8 from Q3 1997 till Q3 2003 have averaged 2.5 and 2.6 respectively with standard errors of 0.2 in both cases, (compared with outcomes for the same period averaging 2.4 with an SE of 0.4). At t+7, the maximum modal forecast was 2.80 (1998 4) and the minimum 2.19 (2001 3); for t+8, the figures are 2.90 (1999 1&2) and 2.35 (2000 2).

One caveat needs to be stated. The period, 1997-2003, was one of extraordinary stability in the UK economy, (Benati 2003). Shocks were relatively mild, and necessary interest rate adjustments (to hit the 2.5% target) small. If really large supply-side shocks were to affect the UK economy adversely, the speed of return to the inflation target, and the extent of short-term interest rate adjustment would, indeed, then depend on the marginal rates of substitution and transformation between output and inflation, as set out in Bean (2003); and the analysis and resulting forecasts would be laid out in the necessarily accompanying MPC letter to the

Chancellor. But so far, no letter has needed to be written, and the process has remained comfortably as described above.

The remainder of this paper is set out as follows. In Section 2 we describe our data base, and report some, relatively simple, characteristics of the Bank's forecasts. In Section 3 we use the Bank/MPC forecasts to try to disentangle forecast error, unanticipated shocks and policy response, and to assess how successful the forecasters/policy makers have been. Section 4 concludes.

II. The Data and some Characteristics of the Forecasts

Forecasts for future inflation (RPIX) have been made in the Inflation Report by the Bank since 1993 Q1. Initially they were for the current quarter (t = 0), (remember that the forecast is completed in the middle month of each quarter), and the next six, or seven, quarters (t = 6, t = 7). Then in 1995 Q3, the forecast horizon was extended to, and has remained as, eight quarters (t = 8). The Inflation Report itself, intentionally, does not publish point figures; instead it gives a probability distribution, which in the case of the inflation forecast is colloquially named `Rivers of Blood' from its regular red colour and river-delta shape. Of course, the associated central tendencies, the mode, median and mean exist, and after a short delay (whose objective is to focus attention on the distribution, not the point forecast(s)), these are made publicly available by the Bank on its website (www.bankofengland.co.uk). Initially, before 1995 Q1, the distribution was assumed to be symmetrical, so all three central tendencies were identical. Thereafter, a measure of skew, (as well as of uncertainty), is reported, together with separate figures for the mean, median and mode. We use the modal forecast throughout. In practice, see Goodhart (2004a), the skews in the forecast have been quite small, so there would not, we believe, be much difference if we used the mean or median instead. As already stated, the actual data, for the RPI(X) series, taken from standard ONS series, once published are not revised. These data are shown in Table 2 below. The forecasts relating to each consecutive out-turn date are shown horizontally. Thus the forecast at t = 8 for 2003 Q3 (2.45) was made in 2001 Q3, at t = 7 (2.23) in 2001 Q4, and for t = 0 (2.85) in August 2003, and compares with the out-turn of 2.80.

Although the Bank, obviously, made forecasts of the associated predicted (growth rates of) real GDP, it did not publish them in its Inflation Report until it was granted operational independence in May 1997; so the first published forecasts, (for the distribution of the growth of real GDP in the Inflation Report), date from 1997 Q3. Although it may be possible at some future date for researchers to get hold of (so far) unpublished details of the Bank's internal forecasts for earlier years, in this case I have preferred to work with the existing published forecast data, despite the resulting short time series. These forecasts are shown in Table 1 in exactly the same format as for inflation, except that we also show the series for both the contemporaneous, and the latest available output data. As indicated earlier we shall focus on the relationship between the contemporaneous and the forecast output series.

The other data series that we utilise is that for official short-term interest rates. This is taken from standard sources. A chart of the path of interest rates since 1983 is given below.

[Insert Chart 1]

The main quality that most forecasters seek is accuracy and lack of bias. Thus the most common analytical data provided are the measures of Mean Average Error (MAE), Root Mean Squared Error (RMSE) and bias, i.e. the average deviation of out-turn from forecast (and the significance of such bias). These data are provided on a regular basis by the Bank on its website.[5]

---

[5] An example from the Bank is:

RPIX Inflation Errors

	Average Error	Average Absolute Error	Sample Size

One-year-ahead errors			
Constant rate mode	0.1	0.3	20
Constant rate mean	0.0	0.3	20
Market rate mode	0.0	0.3	18
Market rate mean	0.0	0.3	18
Two-year-ahead errors			
Constant rate mode	-0.3	0.4	16
Constant rate mean	-0.4	0.5	16
Market rate mode	-0.3	0.4	14
Market rate mean	-0.3	0.4	14

I have some doubts whether such measures represent a fully satisfactory depiction of the accuracy of the forecasts. If the series being forecast, i.e. the rate of growth -the % change - in prices (RPI) and output (GDP), are stationary (IO) over the relevant time period, and the mean-reverting forces, whether from fundamentals or policy measures, have been quite strong, than a forecast that inflation (real growth) will remain at its trend level will be relatively accurate, even it provides no useful prediction whatsoever of the fluctuations of the forecasted variable around its mean trend.

Consider Chart 2 below. Forecast 1 is just a constant growth rate; forecast 2 tracks the fluctuations of the variable under consideration exactly, except for a constant bias. In terms of bias, forecast 2 is, by construction, worse, and one can set it so that it is identical to forecast 1 in terms of accuracy (MAE or RMSE). Yet in terms of giving some indication of where the economy is heading, relative to trend, the latter forecast (2) is surely more helpful.

[Insert Chart 2]

There is some (slight) evidence that the forecasts imply a closer adherence to (average past) trends than the outturns exhibited. This is indeed largely inevitable. The expectation of a variable will be more stable than its actual value, since shocks are by definition unpredictable. Even so, in a period of mean reversion to a stable trend, a forecast can be accurate while possessing zero predictive power, e.g. as compared with a constant.

In Table 3 below we show data for the mean values, and standard deviations, of the outturns and forecasts for both our series.

[Insert Table 3]

Note that the modal forecast for RPI is almost perfectly in line with outturn for the Bank, but that the variance around the mean is lower in the more distant forecasts (t = 7/t = 8), though not so at the shorter horizon.

There is a rather curious pattern in the forecasts of output, though this could be due to the short sample and particular features of the period, (e.g. uncomfortably high real exchange rates, expected to depreciate slowly over time). This pattern is that near-term forecasts (t = 0 till t = 4) tend to underestimate actual growth, (even more so for subsequent revised figures for real growth), but from t = 4 onwards the forecasters became more optimistic (on average) about growth prospects, so by the end of the horizon (t + 7, t + 8) the prediction was normally for growth to be at, or slightly above, its longer-run trend. Again, as with inflation, as the horizon lengthened, the variance of the forecast declined. The forecasters consistently tended to predict the economy reverting to slightly above trend growth at the longest horizons. Effectively the forecasters tend to predict a reversion to trend growth, for GDP and inflation, at distant horizons, with increasing divergence from the trend as the horizon shortens. The trend for inflation is forecast pretty accurately, especially after 1993; less so the trend for output. This naturally leads on to the question of whether the forecasts have predictive power when a constant term is added to the regression.

The regression for RPI was,

$$\text{Actual} = a + b\ \text{Forecast}_{(t + I)},$$

and the results were, (p values in brackets):-

[Insert Table 4]

Similarly the regression for Output Growth was:-

$$\text{Actual} = 0 = a + b\ \text{Forecast}_{t+i};$$

the results were, (p values in brackets),

[Insert Table 5]

The results of these regressions at first glance appear dire. The R^2 values for the RPI regression (Table 6) are below 0.2 at longer horizons until the forecast made at t = 1, and the b coefficient below 0.5 until t = 0. Similarly the Bank's forecast for output growth has an R^2 and b values of virtually zero until t = 1.

To put it bluntly, the Bank does not appear to be able to provide <u>any predictive guide at all</u> to the fluctuations of output growth, or inflation, around its trend over a year in advance; it is only really in the last couple of quarters before the outturn that the forecasts have any predictive value for fluctuations around the trend.

But how should we interpret such apparent predictive `failure'? Does it imply that the forecasts are just `no good' until near the outcome date; and hence that such forecasts should be abandoned, thereby saving resources? If the forecasts were forecasts for the weather, i.e. a variable whose outcome cannot be affected by the forecasters' own action, the above condemnation would stand. Forecasts at horizons greater than t = 4 would be a waste of time; it would be just as good to assume that the average weather pattern will prevail.

This, however, is not the case for forecasts of output growth and inflation. The purpose of the forecast is to inform policy-makers on how to vary their instruments, short-term interest rates in the case of the MPC, so as to drive the output gap and the deviation of inflation from target down to zero. The purpose of forecasting, certainly at the Bank and also, though perhaps to a lesser degree, among private sector forecasters, is to inform policy so as to drive output growth (or gap) and inflation back to its (desired) trend level. If this is done perfectly, then the value of R^2 at the forecast date should be zero, not unity! If the resultant policy change is overdone, the b values would be negative. The less that the forecast (correctly) induces a policy response, the closer will the expected values of R^2 and b return to unity. If there is no policy response at all to the forecast, we are back effectively to our weather forecasting simile. All this is perfectly well known in theory and in principle, (e.g. Tobin 1970; Buiter 1984). It is quite rare, however, to see a documented, empirical example in practice.

Why then do we see the forecasts increasingly exhibiting the ability to predict fluctuations around the trend as the horizon shortens? A possible answer, of course, is that lags, which are themselves subject to uncertainty, in the transmission mechanism make it impossible, and/or undesirable (for a variety of reasons which we will not restate here) to use interest rate policy to offset short-term shocks. If interest rates could be effectively used contemporaneously and instantaneously to affect output and inflation, (as is assumed in many

<u>models), then the R^2 of forecasts should be zero at all horizons, including t = 0.</u>

The question of what one might expect for the b coefficient is more complicated.[6] Suppose that y(t) = a + bx(t) + e(t), where x is the (unconditional) forecast, y the outturn, and e an unobserved shock, so that a=0 and b=1 (ie these are unbiased forecasts). Now assume that policy is set in order to ensure x(t) = y*. Then indeed y(t) = y* + e(t), which might lead one to expect that a=y* and b=0. However, notice that y(t) = a + bx(t) + e(t) with a=0 and b=1 should fit the data just about as well, as indeed does any linear combination of the two regressions. The point is that x(t) and the constant become almost perfectly collinear, so when b rises (falls) the coefficient a declines (rises), and the standard errors on the coefficients increase. This is exactly what we find in our regressions.

One basic message is that the shorter (longer) the lag before the instrument affects the objective variable, the shorter (longer) is the horizon over which deviations from trend should become reasonably predictable.

The normal empirical finding is that the lag before interest rates affect output is shorter than that for inflation. So, what we should see is that longer horizon forecasts for inflation are rather better, by our criteria of R^2 and b coefficient closer to unity, than for output growth. Whilst the differences between the forecasting characteristics (for inflation and output

---

[6] I am indebted to C. Bean for this analysis.

growth) are not strong, they do tend in the direction hypothesized. With the Bank forecasts, all the coefficients for inflation, out to t = 8, are positive, and most are weakly significantly different from zero. In the output forecast, the coefficients on the output forecast, b, are mostly negative until t = 2. Similarly the R^2 values for inflation are low, around 0.1 until t = 2, (but this at least is better than the value of less than 0.1 for output until t = 1.

To conclude, and summarise this Section, the traditional measures of forecasting accuracy, e.g. MAE, RMSE, unbiassedness, can be met well enough, especially during periods of stability, by forecasting that the relevant variables will return to their average trend. This is, in effect, what the forecasters at the Bank did at the longer horizons since 1993. If one instead, as here, examines the more testing criteria, whether the forecasters could predict the fluctuations around the trend, the results demonstrate virtually zero ability to do so, until the horizons become rather short, t = 3 or lower, too late to take countervailing action.

But that latter qualification is crucial. If no countervailing action is possible, (as with forecasts of weather, earthquakes, etc.), then failure to forecast fluctuations is pure failure. But if counter-vailing action is possible, then the initial (ex ante, prior to the MPC decision) forecast has the key role of informing policy actions. Those policy actions should offset deviations from target (desired trend), eliminating predicted deviations, until the lags in the transmission mechanism make that impossible; so that the ex post forecasts (prepared after the resulting MPC decision), which is what are published in the Inflation Report, and what we show here, <u>should</u>, at the longer horizons, show no correlation between current fluctuations (from target) in output growth and inflation and prior longer-term predictions of those same variables. Thus our results in this Section, of R^2 and b coefficients of approximately zero for output growth until t = 3, and low for inflation forecasts until short horizons could be seen as evidence of the optimal inter-play of forecasting and policy response, not as evidence of lousy forecasting ability.

We turn next to a study of the interaction of forecasts, unforeseen shocks and the policy response in greater detail in Section III.

III. The Interplay of Forecast, Policy Response and Shocks

In the attempted quantification in this Section, we have two enormous advantages. First the forecast time pattern of short-term interest rates is always known, i.e. that it should remain constant at the level set at the latest MPC meeting, until the end of the forecast period. Second, the MPC commissioned, and published under their own aegis, an assessment of The Transmission Mechanism of Monetary Policy (pamphlet, Bank of England, 1999)[7], which gave, p. 12, pictorial representations of

(i) Chart 1 - Effect on real GDP, relative to base, of 100 basis point increase in the official rate maintained for one year

(ii) Chart 2 - Effect on inflation rate, relative to base, of 100 basis point increase in the official rate maintained for one year

[7] For a similar exercise for the Euro-zone, see McAdam and Morgan (2004).

No doubt such assessments differ between members of the MPC, and over time, but this study does provide a rough and ready rule of thumb for quantifying what effect MPC members thought that they would have on inflation and output, when they contemplated interest rate changes. However, the pamphlet gives a pictorial representation, not a numerical quantification. I have attempted to translate such pictures into approximate mean effects in Table 6 below by eye. Moreover, the exercise above involved a one year change in interest rates, whereas in this exercise I am considering the effect of a change maintained for the full two year horizon of the forecast. That does not affect the estimates of the effect on RPI, since the lags appear to be so lengthy[8], but it does require an adjustment to the estimates for the effect on output growth. The roughly calculated effects on GDP of an interest rate change lasting just one year are shown in brackets in Table 6, while the, again roughly estimated, effects of such a change held throughout the whole two-year forecast horizon are shown in the row above. Furthermore interest rates can be, and sometimes are, changed each calendar month, (at that month's MPC meeting, generally on the Thursday after the first Monday of each month), and not just at the quarterly MPC meeting associated with the forecast and Inflation Report. So there is a need to allocate the effect of each month's change to a starting quarter. This also is shown in Table 6.

[8] The Bank of England has introduced a new quarterly model, (BEQM, see News Release on April 22, 2004), in which the responses to interest rate changes of inflation (somewhat quicker) and of output (somewhat larger) are slightly different from those used in this paper. See the article on `The new Bank of England Quarterly Model', accompanying the News Release, and available on its website, especially Charts 1 and 2, p. 5.

In Table 6, I set out the rule of thumb effects of interest rates out to t = 7, not to the longest forecast horizon of t = 8. This is because I take this initial forecast, at t = 8; as the initial starting point, or datum. Changes from one forecast round to another in this initial forecast are a complex mixture of revisions in forecasting technology, views about the interpretation of residuals in the equation, shocks and policy responses during the last three months, and I do not want to get involved in unscrambling that.

[Insert Table 6]

That said, the forecasts, at t = 8, have not varied much over time. As shown in Table 3 above, the Bank's modal forecast for inflation (Ave 2.6, S.E. 0.2) and for output growth (Ave. 2.6, S.E. 0.3) have remained very close to the (ex post) trend. Moreover that has been possible without the MPC feeling obliged to make large, or larger than average, changes in interest rates at those MPC meetings which occur towards the end of each forecasting round. This period has been one of remarkable stability. In our main time-period, 1997-2003, the forecasters have usually seen the economy reverting close to trend at the longest horizon reported. Thus almost all of the action from unforeseen shocks to the economy occurs in the interval between the initial forecast, at t = 8, and the final outcome, when it is known, in t = 0; and this is what we shall now focus upon.

So I take the sum of all interest changes in the months in each quarter, (n.b. as set out in the bottom of Table 6), and then used the rules of thumb at the top of that same Table to allocate the effect of such changes onto subsequent quarters for inflation, (Table 7) and output, (Table

8). Note that the longest forecast horizon did not become t = 8 until 1997 Q3. Prior to that they usually stopped at t = 7 (see Table 1); which explains why column 7 of Tables 7 and 8 is blank until 1997 Q3.

[Insert Tables 7, 8, 9 and 10]

Tables 7 and 8 then show, from 1994 Q3 onwards the ‘rule of thumb’ effects of policy, in the guise of interest rate changes, on the outcomes for inflation and output. So we know, or can estimate, first, the initial, longest horizon forecast, second, the outcome (subject to the previous qualifications about output), and third, the intervening policy response. The remainder, the residual, will represent primarily the unforeseen shocks that will have affected the UK economy in the intervening period, (the forecasting technology in the Bank remained much the same over the whole period).

We show this for inflation in Table 9 and for output in Table 10. Table 10 only starts in 1999 Q3 because forecasts were only published from 1997 Q3 onwards, so the forecast at t = 8, made in 1997 Q3, relates to 1999 Q3. A positive value for ‘policy change’ implies that the sum of the effects of interest rate changes between t = 8 and t = 0 was expansionary (on inflation/output). We show, in column 2, the difference between the outcome, for RPIX (Table 9) and output growth (Table 10) and the concurrent forecast at t = 0. As already noted, for output growth this difference has quite a large average value, 0.22, an even larger Standard Error (0.37) and some residual first order auto-correlation. The forecasters find it hard to predict current growth, even in the middle month of the quarter itself. Whereas for inflation the difference at t = 0 was on average tiny, and randomly distributed. Then we show the difference between the forecasts at t = 8 and t = 0. This difference has a strong first-order positive auto-correlation (0.51, p = 0.004 for inflation; 0.42, p = 0.06 for output). We can then divide this into the accumulated policy response (as estimated) and therefore the residual forecast change, primarily from intervening unforeseen shocks. Again both the policy responses, and the unforeseen shocks, show strong first-order positive autocorrelation. For inflation, the patterns of auto-correlation are shown in Table 11; and for output in Table 12.

[Insert Table 11 and Table 12]

It is probably easiest to read off what was happening from Table 10 for output changes. Start with 1999 Q3. The forecast made in August 1997 largely failed to see the adverse effects of the 1997/98 Asian crisis, and so the residual forecasting change (from Q3 1997 to Q3 1999) was a large reduction in output of 1.7, offset by the expansionary effect of policy over the same period of 0.36. As forecasts were made, subsequent to 1997 Q3, the impact of the Asian crisis was increasingly factored in (small negative forecast changes), whilst the accumulated policy response became for a short period over-done, so that the subsequent growth of output, i.e. at end 1999 and the start of 2000, temporarily overshot trend. By 1999 Q1 the conclusion of the Asian crisis and the start of the dot.com boom began to be seen, so that the t = 8 forecasts for 2001 showed strong output predictions. Indeed the dot.com boom drove output above forecast for a time at the end of 2000, start of 2001. This led appropriately to a reversal of policy, where the accumulated effects became negative (tightening), with effect from Q1 2000.

The dot.com bubble burst in 2000/2001 with the result that out-turns then systemically fell below the earlier t = 8 forecasts[9] ever since 2001 Q1, by as much as 0.95% in 2002 Q2. Thus the intervening forecast changes, the unanticipated shocks, were persistently (and strongly autocorrelated) negative. The policy response was, perhaps, a bit slow to catch on to the change in conditions, with accumulated tightening effects predominantly until 2001 Q3. Thereafter, however, the policy response was, correctly, expansionary, offsetting some, but by no means all, of the unanticipated shocks.

Note that the policy change offsets (i.e. has the opposite sign to) the unanticipated forecast change in 14 of the 17 observations, a rather good record. What appears to be less praiseworthy, however, is that the policy response offset appears to be only partial. Regressing the policy change on the forecast change in the equation over our period, 1999 Q3/2003 Q3:-

Policy Change = a + b Forecast Change

we find $\underset{(0.11)}{a = 0.13}$ $\underset{(0.11)}{b = -0.26}$ $R^2 = 0.27$

The other main problem is that the forecast deviations from actual (the forecasting errors) are strongly positively auto-correlated, even after internalising the policy response. We show the pattern of such forecast errors in Table 13. Whether one looks across the Table, i.e.

[9] Though this was also partly due to the forecasters persistently tending to predict a considerable acceleration in output growth towards the end (i.e. t = 7, t = 8) of most forecast periods.

consecutive forecast errors relating to the same

[Insert Table 13]

outcome date; or down the Table, forecast errors at the same horizon relating to consecutive outcome dates, the pattern of similar signs, positive following positive, negative following negative recurs. This is shown below:-

First order auto-correlations

First order auto-correlations of the forecast errors going downwards:

T=	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
	0.80	0.70	0.76	0.75	0.73	0.74	0.64	0.39	0.35

First order auto-correlations of forecast errors going horizontally:

T=	**8/7**	**7/6**	**6/5**	**5/4**	**4/3**	**3/2**	**2/1**	**1/0**
	0.950	0.957	0.968	0.957	0.955	0.930	0.917	0.892

Data: Bank forecasts errors of the GDP.

The decline, going horizontally, i.e. successive similar errors in forecasting the same output growth, (from about +0.95 to about +0.90), is less marked than the decline going downwards. In this latter case, for successive forecast errors at the same horizon, the auto-correlation falls from about +0.8 to about +0.4.

If the Bank forecasters have made an initial forecast error, they will tend to repeat that over time, despite the Bank policy makers on each occasion tending to make a correctly signed, but small, policy response to offset the apparent deviations from target.

Let us turn next to the patterns of the inflation forecasts, policy responses and forecast errors. The initial forecast for RPIX has been on average slightly above the outcome, both over the full period and since operational independence in 1997 Q2, as already reported in Goodhart (2004a). The outcomes, however, have closely matched the target value of 2.5%; so the average value of column 5 has been negative (-0.25, S.E. 0.4 over full period, F.P.; -0.22, S.E. 0.36 since operational independence, OI). Inflation was probably initially overestimated, until Q2 1996, because of an expectation of a greater pass-through (than actually occurred) onto domestic prices of the sharp devaluation of end 1992. The other main period, when prospective inflation was initially over-forecast, was between 1998 Q3 and 1999 Q2. This reflected a feeling in 1996 and early 1997 (before OI) that Chancellor Clarke had failed to raise interest rates enough. With a combination of a subsequent strong rise in rates (note that the negative policy response in these quarters exceeds the unanticipated shocks) and the deflationary effect of the Asian crisis, this mini-surge in inflation was halted.

The negative association between the policy response and the unanticipated forecast change remains, but somewhat less clearly marked than for output; the signs are opposite 22x, similar 12x, (one sign is zero 2x, over FP; opposite 14x, similar 9x, zero 2x, under OI). I would attribute the lower frequency of correct offsetting to the greater difficulty of doing so when the relevant lags are longer, and hence it is harder to predict how to adjust to offset in-coming shocks.

That said, a similar regression, to wit, Policy Change_t = a + b Forecast Change_t,

has almost as strong and effective offsetting effect as with output: Thus

a = 0.01 (0.76)	b = -0.16 (0.06)	$R^2 = 0.10$	FP
a = 0.01 (0.83)	b = -0.26 (0.07)	$R^2 = 0.14$	OI

The strength of the correct counter-vailing policy response has, apparently, increased since OI. The difficulty of forecasting shocks, that need offsetting, may well be the explanation of the low R^2.

Table 14 gives the pattern of forecast errors. Simple inspection reveals that these also are positively auto-correlated, both downwards (forecasts of the same horizon for consecutive outcome periods) and horizontally (consecutive forecasts for the same outcome period), though not as strongly as with output.

[Insert Table 14]

As before we show this numerically for the first order autocorrelations.

First order auto-correlations Bank RPI

First order auto-correlations of the forecast errors going downwards:

T=	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
	0.434	**0.356**	**0.530**	**0.626**	**0.686**	**0.583**	**0.551**	**0.306**	**-0.162**

First order auto-correlations of forecast errors going horizontally:

T=	8/7	7/6	6/5	5/4	4/3	3/2	2/1	1/0
	0.882	**0.850**	**0.818**	**0.838**	**0.857**	**0.829**	**0.833**	**0.666**

Data: bank forecasts errors of the RPI

Both sets of auto-correlations are lower than in the previous case for output errors. Perhaps this difference, between output and inflation errors, has occurred because the mean-reverting tendencies, (including the policy response), for inflation during this period has been stronger (than for output); so a forecast that inflation will revert to target has been systematically wrong less frequently.

So there are large and persistent changes to the forecasts made for the target variable (both inflation and output) for any particular date between the first occasion on which that variable/date was forecast (i.e. at the longest horizon t = 8) and on the occasion of the final forecast for that variable/date in the middle of its current quarter. This is quantified in Columns 8 (the final column) of Tables 9 and 10. Intervening policy changes (quantified in Column 7) serve to offset a sizeable proportion, but not all, of the unanticipated forecast errors, so the actual forecast change between t = 8 and t = 0 (Column 5) is still positively correlated with, but varies less than, the unanticipated changes to the forecast.

This is consistent with the hypothesis that (auto-correlated) forecast errors drive the autocorrelation in interest rate changes. There may, however, be other reasons for such latter auto-correlations, (also known as gradualism, or stepping); we explore the possible contributions of such alternative explanatory factors in a separate paper (Goodhart 2004b).

IV. Conclusions

The record of the Bank forecasters in predicting output growth and inflation is good by the standard criteria of MAE, RMSE and unbiassedness. Looking at this more closely, however, reveals that, since 1993, this has been because these forecasters have predicted that these variables would remain close to trend/target, and this has been broadly what has occurred. If, instead, the criterion is whether the forecasters can predict deviations around the average trend/target, then the results have been dire. In equations of the form Outcome = a + b Forecast, the values of R^2 and of b have been approximately zero (rather than one) until the horizon has become fairly short (two, or three, quarters, or less).

Superficially this may seem to represent forecast failure, but this would only be so if the forecasting process could not itself influence policy, which then drives the variables back to their desired target. Indeed long-horizon values of R^2 of zero may reflect an optimal forecast/policy procedure. Only when the lag length is such as to make it impossible/undesirable to use the instrument to drive the objectives back to target should we see the values of R^2 and b returning towards one.

We then use our knowledge of the forecast path of interest rates (constant from the current level), together with a rule of thumb for the transmission mechanism of interest rates, to decompose the changes between the initial Bank forecast and the forecast at t = 0 (or outcome) into the cumulative effective policy response and the unanticipated change over time to the initial forecast. We show that the policy response is usually correctly signed (i.e. offsets the unanticipated forecast change), but is too small on average to offset such shocks perfectly.

Bibliography

Bank of England, (2004), `The new Bank of England Quarterly Model', April, http://www.bankofengland.co.uk/mpc/qtlymodel.pdf.

Bean, C., (2003), `Asset Prices, Financial Imbalances and Monetary Policy: Are Inflation Targets Enough?', presented at BIS Conference on Monetary Stability, Financial Stability and the Business Cycle, Basel, Switzerland.

Benati, L., (2003), `Evolving Post-World War II UK Economic Performance', Bank of England Working Paper, July.

Buiter, W.H., (1984), `Granger-Causality and Policy Effectiveness', Economica, 51, (202), May, 151-62.

Carriero, A., Favero, C.A. and I. Kaminska, (2003), `Financial Factors, Macroeconomic Information and the Expectations Theory of the Term Structure of Interest Rates', unpublished manuscript.

Diebold, F.X. and C. Li, (2003), `Forecasting the Term Structure of Government Bond Yields', NBER Working Paper 10048, (October).

Duffee, G.R., (2002), `Term Premia and Interest Rate Forecasts in Affine Models', Journal of Finance, (February), 405-443.

Goodhart, C.A.E., (1999), `Central Bankers and Uncertainty', Keynes Lecture in Economics, 29 October 1998, reprinted in Proceedings of the British Academy, 101, pp 229-271.

Goodhart, C.A.E., (2001), `Monetary Transmission Lags and the Formulation of the Policy Decision on Interest Rates', Federal Reserve Bank of St Louis Review, 83 (4) (July/August), 165-181.

Goodhart, C.A.E., (2004a), `What is the Monetary Policy Committee Attempting to Achieve?', paper presented at the Conference in Honour of C. Freedman, at the Bank of Canada, Ottawa, June 19/20, (2003) forthcoming in published proceedings 2004.

Goodhart, C.A.E., (2004b), `Gradualism in the Adjustment of Official Interest Rates: Some Partial Explanations', Work in progress, Financial Markets Group, London School of Economics, (March).

King, M.A., (2000), `Monetary Policy: Theory in Practice', address to the joint luncheon of the American Economic Association and the American Finance Association, Boston Marriott Hotel, 7 January 2000. See Bank of England website, http://194.129.36.50/speeches/speech67.htm.

McAdam, P. And J. Morgan, (2004), `The effects of Euro Area interest rate changes: evidence from macroeconomic models', National Institute Economic Review, 187, (January), pp 93-103.
Monetary Policy Committee, Bank of England, (1999), `The Transmission Mechanism of

Monetary Policy', pamphlet, Bank of England.

National Institute of Economic and Social Research (2003/4), National Institute Economic Review, Nos 183-190.

Orphanides, (1998), `Monetary policy rules based on real-time data', Finance and Economics Discussion Paper no 98-3, Washington, D.C.: Board of Governors of the Federal Reserve System.

Rudebusch, G.D., (2002), `Term Structure Evidence on Interest Rate Smoothing and Monetary Policy Inertia', Journal of Monetary Economics, (September), 1161-1187.

Rudebusch, G.D. and T. Wu, (2004), `A Macro-Finance Model of the Term Structure, Monetary Policy and the Economy', paper presented at the Federal Reserve Bank of San Francisco Conference on `Interest Rates and Monetary Policy', March 19-20.

Statistics Commission, (2004), Revisions to Economic Statistics; Vol. 1, Report by Statistics Commission; Vol. 2, Review by National Institute of Economic and Social Research; Vol. 3, Annexes, (London: Statistics Commission), (April).

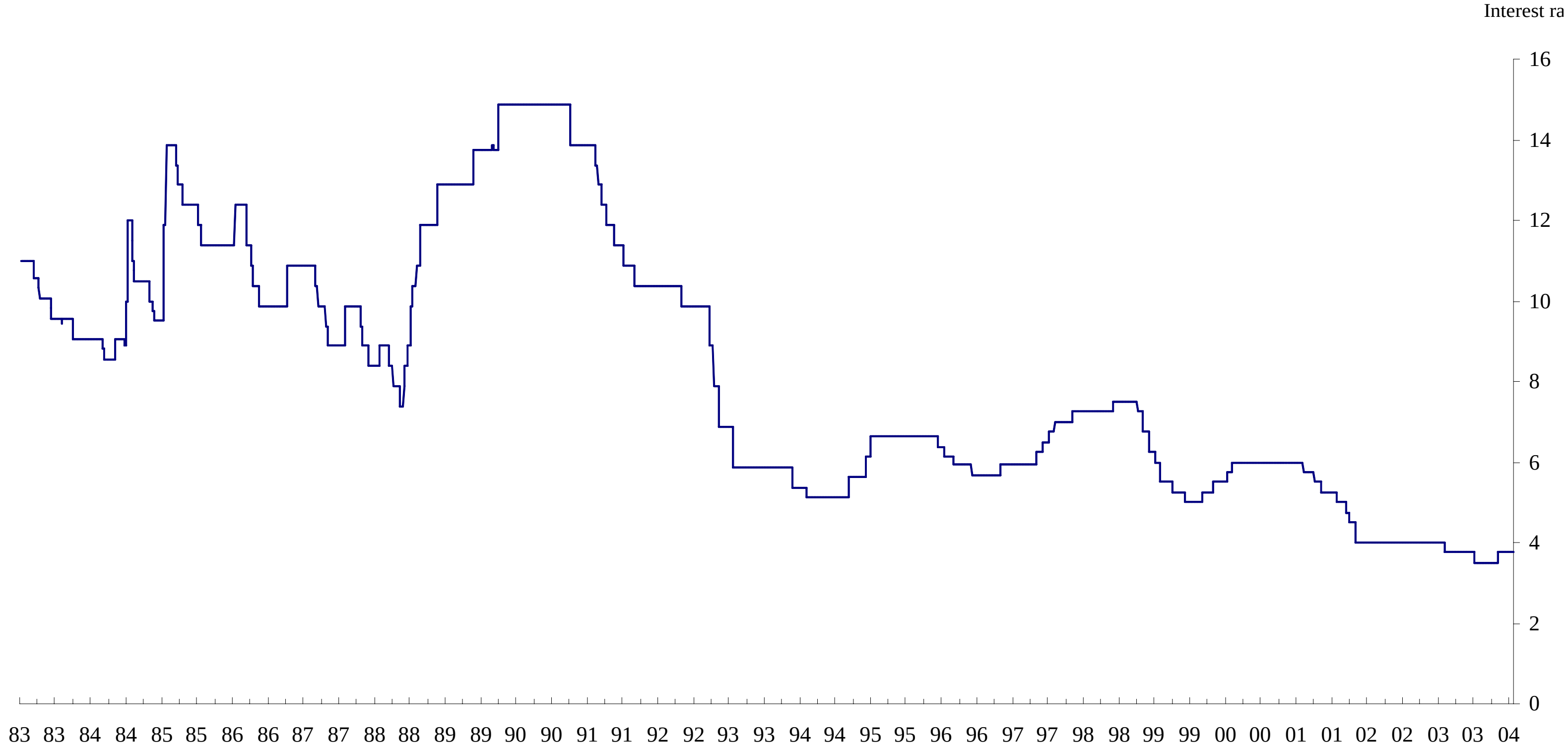
Thornton, D., (2004), `Testing the Expectations Hypothesis: Some New Evidence for Japan', Bank of Japan, Institute for Monetary and Economic Studies, Discussion Paper No. 2004-E-3, February.

Tobin, J. (1970), `Money and Income: post hoc ergo propter hoc', Quarterly Journal of Economics, 84, (May), 301-17.

Vickers, J., (1999), `Economic Models and Monetary Policy', Speech to the Governors of the National Institute of Economic and Social Research (NIESR), 18 March, reprinted in Bank of England Quarterly Bulletin [TBD].

Woodford, M., (2003), Interest and Prices, (Princeton University Press: Princeton, N.J.).

Chart 1



Interest ra
16
14
12
10
8
6
4
2
0
83 83 84 84 85 85 86 86 87 87 88 88 89 89 90 90 91 91 92 92 93 93 94 94 95 95 96 96 97 97 98 98 99 99 00 00 01 01 02 02 03 03 04

Chart 2

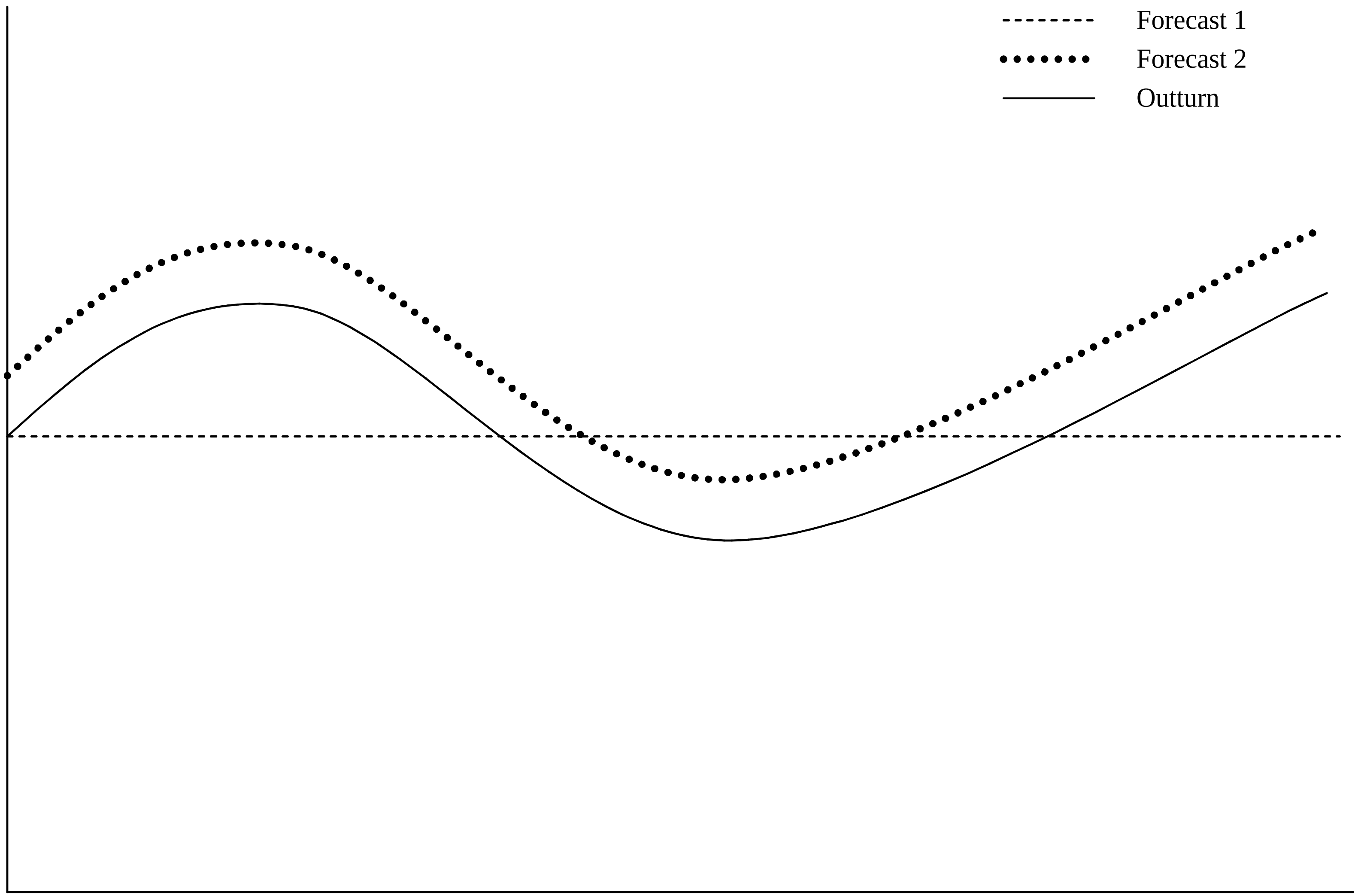


Table 1
Bank Forecast of GDP

	Output % growth 2003 estimate	Output % growth contemp-oraneous	Forecast t = 0	1	2	3	4	5	6	7	8
1997 Q3	3.19	3.89	3.39								
Q4	3.36	3.93	4.02	2.82							
1998 Q1	3.38	2.88	3.04	3.54	2.37						
Q2	2.79	2.47	2.41	2.33	2.84	1.85					
Q3	3.51	2.40	1.99	1.86	1.76	2.11	1.80				
Q4	2.82	2.02	1.95	1.66	1.71	1.64	1.33	1.83			
1999 Q1	2.72	1.70	1.16	1.28	1.41	1.76	1.59	1.41	2.03		
Q2	2.61	1.64	0.79	0.77	1.00	1.19	1.83	1.79	1.64	2.38	
Q3	2.60	2.30	1.32	0.99	0.68	0.84	1.29	2.11	2.15	1.93	2.63
Q4	3.26	2.75	2.50	1.90	1.20	0.83	1.01	1.54	2.27	2.41	2.33
2000 Q1	3.96	3.11	2.92	2.82	2.41	1.49	1.36	1.33	1.69	2.39	2.61
Q2	4.30	3.36	2.94	2.70	2.80	2.58	1.72	1.82	1.65	2.09	2.56
Q3	3.94	2.98	2.56	2.58	2.47	2.51	2.73	1.99	2.24	2.02	2.44
Q4	2.93	2.72	2.73	2.48	2.45	2.24	2.42	2.80	2.58	2.61	2.48
2001 Q1	2.56	3.01	2.86	2.76	2.50	2.57	2.27	2.61	2.92	2.97	2.83
Q2	2.23	2.65	2.25	2.30	2.39	2.51	2.61	2.35	2.70	3.01	3.11
Q3	1.80	2.24	1.62	2.03	2.07	2.31	2.53	2.65	2.38	2.82	3.02
Q4	1.95	1.71	2.09	1.82	2.46	2.22	2.40	2.63	2.70	2.39	2.83
2002 Q1	1.44	1.37	1.37	1.92	1.98	2.68	2.10	2.48	2.81	2.74	2.39
Q2	1.55	1.75	1.35	1.48	1.97	2.26	2.72	2.37	2.51	2.79	2.70
Q3	1.93	2.26	1.82	1.62	1.78	2.05	2.42	2.71	2.62	2.50	2.76
Q4	1.99	2.31	2.29	2.34	2.32	2.43	2.27	2.33	2.48	2.81	2.48
2003 Q1	1.84	2.10	2.53	3.06	2.91	2.95	2.76	2.49	2.24	2.42	2.89
Q2	1.98	1.84	2.38	2.58	3.18	2.75	2.95	2.79	2.66	2.15	2.42
Q3	1.89	1.89	1.59	2.00	2.33	3.17	2.94	3.15	2.69	2.70	2.11

Table 2
Bank Forecast of RPIX

	RPIX % change over 12 months	Forecast t = 0	1	2	3	4	5	6	7	8
1993 Q1	3.50	3.50								
Q2	2.80	3.40	3.40							
Q3	3.30	2.90	3.40	3.00						
Q4	2.70	3.30	3.00	3.20	3.10					
1994 Q1	2.40	2.80	3.60	3.20	3.20	3.40				
Q2	2.40	2.70	3.00	3.50	3.30	3.50	3.40			
Q3	2.00	2.30	2.90	3.10	3.50	3.30	3.60	3.40		
Q4	2.50	2.10	2.60	3.00	3.20	3.40	3.30	3.70	3.30	
1995 Q1	2.80	2.90	1.90	2.70	3.10	3.40	3.40	3.50		
Q2	2.80	2.70	2.80	2.00	3.00	3.40	3.30	3.40	3.60	
Q3	3.10	2.90	3.00	3.10	2.30	3.20	3.40	3.20		
Q4	3.00	3.20	3.00	3.10	3.20	2.40	3.20	3.30	3.20	
1996 Q1	2.90	2.80	3.30	3.20	3.40	2.70	2.80	3.40	3.30	
Q2	2.80	2.70	2.70	3.50	3.50	3.80	2.70	2.40	3.10	
Q3	2.90	2.70	2.50	2.40	3.20	3.40	3.70	2.60	2.40	
Q4	3.10	3.10	2.40	2.30	2.20	3.00	3.20	3.40	2.50	
1997 Q1	2.70	2.70	2.90	2.30	2.30	2.30	2.70	2.90	3.00	
Q2	2.70	2.60	2.40	2.80	2.30	2.20	2.30	2.70	2.80	
Q3	2.70	2.65	2.40	2.20	2.70	2.40	2.40	2.30	2.70	2.80
Q4	2.70	2.60	2.32	2.20	2.20	2.40	2.50	2.40	2.40	2.70
1998 Q1	2.60	2.60	2.51	2.19	2.20	2.30	2.40	2.60	2.40	2.40
Q2	2.80	2.83	2.63	2.42	2.06	2.20	2.50	2.50	2.70	2.50
Q3	2.50	2.51	2.35	2.42	2.27	1.99	2.30	2.70	2.60	2.80
Q4	2.60	2.54	2.56	2.35	2.41	2.19	2.08	2.50	2.80	2.70
1999 Q1	2.70	2.49	2.56	2.69	2.41	2.44	2.18	2.24	2.70	2.90
Q2	2.20	2.48	2.53	2.71	2.82	2.37	2.39	2.25	2.36	2.90
Q3	2.10	2.31	2.40	2.55	2.74	2.86	2.30	2.47	2.37	2.50
Q4	2.20	2.20	2.28	2.36	2.61	2.59	2.77	2.26	2.55	2.42
2000 Q1	2.00	1.93	2.12	2.09	2.20	2.52	2.56	2.69	2.27	2.64
Q2	2.20	1.88	1.98	2.06	1.99	2.23	2.49	2.51	2.56	2.35
Q3	2.20	2.38	1.93	1.95	2.02	1.88	2.25	2.47	2.48	2.47
Q4	2.00	2.36	2.28	2.10	2.05	1.84	1.92	2.23	2.47	2.45
2001 Q1	1.90	1.94	2.33	2.26	2.20	2.32	1.72	2.08	2.35	2.56
Q2	2.40	1.90	1.92	2.22	2.39	2.47	2.48	1.80	2.28	2.43
Q3	2.30	2.31	1.90	1.87	2.19	2.48	2.53	2.53	2.19	2.59
Q4	1.90	2.00	2.17	1.91	1.87	2.19	2.62	2.53	2.56	2.53
2002 Q1	2.30	2.14	2.03	2.17	1.91	2.09	2.18	2.68	2.53	2.58
Q2	1.50	2.02	1.87	1.85	1.91	1.94	2.18	2.37	2.70	2.56
Q3	2.10	1.84	2.08	1.96	2.06	1.96	2.03	2.27	2.46	2.72
Q4	2.70	2.64	2.25	2.24	2.11	2.06	2.13	2.16	2.42	2.56
2003 Q1	3.00	2.77	2.73	2.25	2.18	2.13	2.08	2.32	2.39	2.55
Q2	2.80	3.09	2.90	2.72	2.25	2.05	2.13	2.15	2.41	2.53
Q3	2.80	2.85	2.90	2.98	2.72	2.31	2.09	2.18	2.23	2.45

Table 3

			Out-turn	Forecast at Horizon in Quarters									Number of Obs
				0	1	2	3	4	5	6	7	8	
1	Bank RPI(X)	Mean St Dev	2.5 0.4	2.6 0.4	2.5 0.4	2.5 0.5	2.5 0.5	2.6 0.5	2.6 0.5	2.6 0.5	2.6 0.3	2.6 0.2	* about 40
2	Bank GDP	Mean St Dev	2.45 0.7	2.2 0.8	2.2 0.7	2.1 0.6	2.1 0.6	2.1 0.6	2.3 0.5	2.4 0.4	2.5 0.3	2.6 0.3	about 20

* To be more precise, for the forecast of RPIX at t=0 there were 43 obs; at t=4 39 obs; at t=6 37 obs; at t=8 24 obs.

Table 4
Predictive Ability of Forecasts for RPI

I. Bank : Regression: Actual = a + bForecast(t+i)

Data set: Bank RPI Forecast

i=	a (p-value) St. Er.	b (p-value) St. Er.	Rsq.	DW	Time Period
0	0.488 (0.04) 0.232	0.801 (0.00) 0.089	0.66	2.20	1993:Q1 2003:Q3
1	1.31 (0.00) 0.300	0.47 (0.00) 0.116	0.29	1.20	1993:Q2 2003:Q3
2	1.61 (0.00) 0.311	0.36 (0.00) 0.121	0.18	0.80	1993:Q3 2003:Q3
3	1.92 (0.00) 0.302	0.22 (0.06) 0.117	0.08	0.79	1993:Q4 2003:Q3
4	1.96 (0.00) 0.289	0.20 (0.07) 0.111	0.08	0.66	1994:Q1 2003:Q3
5	1.83 (0.00) 0.311	0.25 (0.03) 0.118	0.11	0.71	1994:Q2 2003:Q3
6	1.77 (0.00) 0.355	0.27 (0.04) 0.133	0.10	0.68	1994:Q3 2003:Q3
7	1.40 (0.00) 0.439	0.41 (0.01) 0.163	0.11	0.82	1994:Q4 2003:Q3
8	1.52 (0.25) 1.297	0.32 (0.52) 0.501	0.01	0.87	1997:Q3 2003:Q3

Table 5

GDPActual = a + b Forecast (t+i)

.i=	a (p-value) St. Er.	b (p-value) St Er.	Rsq.	DW	Time Period
0	0.71 (0.00) 0.21	0.77 (0.00) 0.09	0.75	1.09	1997:3 2003:3
1	1.15 (0.00) 0.35	0.57 (0.00) 0.15	0.38	0.84	1997:4 2003:3
2	1.81 (0.00) 0.39	0.24 (0.19) 0.18	0.07	0.47	1998:1 2003:3
3	2.41 (0.00) 0.42	-0.05 (0.77) 0.19	0.00	0.43	1998:2 2003:3
4	2.71 (0.00) 0.46	-0.19 (0.35) 0.20	0.04	0.43	1998:3 2003:3
5	2.95 (0.00) 0.58	-0.29 (0.25) 0.25	0.07	0.45	1998:4 2003:3
6	3.23 (0.00) 0.82	-0.39 (0.26) 0.34	0.07	0.45	1999:1 2003:3
7	3.03 (0.01) 1.10	-0.28 (0.53) 0.43	0.02	0.46	1999:2 2003:3
8	1.90 (0.21) 1.45	0.17 (0.75) 0.55	0.00	0.35	1999:3 2003:3

Table 6
Assumed Effects of Interest Rate Changes on

GDP
Quarters after Change

0	1	2	3	4	5	6	7	8	
0	0.12	0.21	0.3	0.35 (0.32)	0.35 (0.30)	0.29 (0.24)	0.25 (0.12)	0.16 (0.03)	1% change
0	0	0.1	0.1	0.09 (0.08)	0.09 (0.07)	0.07 (0.05)	0.06 (0.03)	0.04 (0.01)	¼% change

RPI
Quarters after Change

0	1	2	3	4	5	6	7	8	
0	0	0	0.04	0.11	0.18	0.25	0.32	0.3	1% change
0	0	0	0.01	0.03	0.05	0.06	0.08	0.07	¼% change

Interest Rate Changes in Months applied to Quarters

Dec - Feb	Q1
Mar-May	Q2
June - Aug	Q3
Sept - Nov	Q4

Table 7

Effect on RPIX										
Date	Interest Change	0	1	2	3	4	5	6	7	Sum
1993 Q1	-1.00									
Q2										
Q3										
Q4	-0.50									
1994 Q1	-0.25									
Q2										
Q3					-0.02			-0.25		-0.27
Q4	0.50				-0.01	-0.06				-0.07
1995 Q1	0.50					-0.03	-0.10			-0.13
Q2							-0.05	-0.12		-0.17
Q3					0.02			-0.06		-0.04
Q4	-0.25				0.02	0.06				0.08
1996 Q1	-0.25					0.06	0.10			0.16
Q2							0.10	0.12		0.22
Q3	-0.25				-0.01			0.12		0.11
Q4	0.25				-0.01	-0.03				-0.04
1997 Q1						-0.03	-0.05			-0.08
Q2	0.25				-0.01		-0.05	-0.06		-0.12
Q3	0.75				0.01	-0.03		-0.06	-0.08	-0.16
Q4	0.25					0.03	-0.05		-0.08	-0.10
1998 Q1					0.01		0.05	-0.06		0.00
Q2					0.03	0.03		0.06	-0.08	0.04
Q3	0.25				0.01	0.08	0.05		0.08	0.22
Q4	-0.75					0.03	0.14	0.06		0.23
1999 Q1	-1.25						0.05	0.18	0.08	0.31
Q2	-0.25				0.01			0.06	0.24	0.31
Q3	-0.25				-0.03	0.03			0.08	0.08
Q4	0.50				-0.05	-0.08	0.05			-0.08
2000 Q1	0.50				-0.01	-0.14	-0.14	0.06		-0.23
Q2					-0.01	-0.03	-0.23	-0.18	0.08	-0.37

Q3					0.02	-0.03	-0.05	-0.31	-0.24	-0.61
Q4					0.02	0.06	-0.05	-0.06	-0.38	-0.41
2001 Q1	-0.25					0.06	0.09	-0.06	-0.08	0.01
Q2	-0.50						0.09	0.12	-0.08	0.13
Q3	-0.25							0.12	0.16	0.28
Q4	-1.00				-0.01				0.16	0.15
2002 Q1					-0.02	-0.03				-0.05
Q2					-0.01	-0.06	-0.05			-0.12
Q3					-0.04	-0.03	-0.09	-0.06		-0.22
Q4						-0.11	-0.05	-0.12	-0.08	-0.36
2003 Q1	-0.25						-0.18	-0.06	-0.16	-0.40
Q2								-0.25	-0.08	-0.33
Q3	-0.25								-0.32	-0.32

Table 8

		Effect on GDP							
Date	Interest Change	0	1	2	3	4	5	6	7
1997 Q3	0.75	0.03	0.03		0.07	-0.09		-0.07	-0.06
Q4	0.25	0.01	0.09	0.05		0.09	-0.09		-0.06
1998 Q1			0.03	0.15	0.07		0.09	-0.07	
Q2				0.05	0.21	0.09		0.07	-0.06
Q3	0.25	0.01			0.07	0.26	0.09		0.06
Q4	-0.75	-0.03	0.03			0.09	0.25	0.07	
1999 Q1	-1.25	-0.04	-0.09	0.05			0.09	0.21	0.06
Q2	-0.25	-0.01	-0.15	-0.15	0.07			0.07	0.18
Q3	-0.25	-0.01	-0.03	-0.26	-0.21	0.09			0.06
Q4	0.50	0.02	-0.03	-0.05	-0.37	-0.26	0.09		
2000 Q1	0.50	0.02	0.06	-0.05	-0.07	-0.44	-0.25	0.07	
Q2			0.06	0.10	-0.07	-0.09	-0.44	-0.21	0.06
Q3				0.10	0.14	-0.09	-0.09	-0.36	-0.18
Q4					0.14	0.18	-0.09	-0.07	-0.31
2001 Q1	-0.25	-0.01				0.18	0.18	-0.07	-0.06
Q2	-0.50	-0.02	-0.03				0.18	0.14	-0.06
Q3	-0.25	-0.01	-0.06	-0.05				0.14	0.12
Q4	-1.00	-0.03	-0.03	-0.10	-0.07				0.12
2002 Q1			-0.12	-0.05	-0.14	-0.09			
Q2				-0.21	-0.07	-0.18	-0.09		
Q3					-0.30	-0.09	-0.18	-0.07	
Q4						-0.35	-0.09	-0.19	-0.06
2003 Q1	-0.25	-0.01					-0.35	-0.07	-0.12
Q2			-0.03					-0.29	-0.06
Q3	-0.25	-0.01		-0.05					-0.25

Table 9
RPIX Summary Statistics

RPI							
Date	Actual	Dif	Fcast t=0	Dif	Fcast t=7/8	Policy change	Fcast change
1994 Q3	2.00	-0.30	2.30				
Q4	2.50	0.40	2.10	-1.20	3.30	0.07	-1.27
1995 Q1	2.80	-0.10	2.90	-0.60	3.50	0.13	-0.73
Q2	2.80	0.10	2.70	-0.90	3.60	0.17	-1.07
Q3	3.10	0.20	2.90	-0.30	3.20	0.04	-0.34
Q4	3.00	-0.20	3.20	0.00	3.20	-0.08	0.08
1996 Q1	2.90	0.10	2.80	-0.50	3.30	-0.16	-0.34
Q2	2.80	0.10	2.70	-0.40	3.10	-0.22	-0.62
Q3	2.90	0.20	2.70	0.30	2.40	-0.11	0.41
Q4	3.10	0.00	3.10	0.60	2.50	0.04	0.56
1997 Q1	2.70	0.00	2.70	-0.30	3.00	0.08	-0.38
Q2	2.70	0.10	2.60	-0.20	2.80	0.12	-0.32
Q3	2.70	0.05	2.65	-0.15	2.80	0.16	-0.31
Q4	2.70	0.10	2.60	-0.10	2.70	0.13	-0.23
1998 Q1	2.60	0.00	2.60	0.20	2.40	0.00	0.20
Q2	2.80	-0.03	2.83	0.33	2.50	-0.04	0.37
Q3	2.50	-0.01	2.51	-0.29	2.80	-0.22	-0.07
Q4	2.60	0.06	2.54	-0.16	2.70	-0.23	0.07
1999 Q1	2.70	0.21	2.49	-0.41	2.90	-0.31	-0.10
Q2	2.20	-0.28	2.48	-0.42	2.90	-0.31	-0.11
Q3	2.10	-0.21	2.31	-0.19	2.50	-0.08	-0.11
Q4	2.20	0.00	2.20	-0.22	2.42	0.08	-0.14
2000 Q1	2.00	0.07	1.93	-0.71	2.64	0.23	-0.94
Q2	2.20	0.32	1.88	-0.47	2.35	0.37	-0.84
Q3	2.20	-0.18	2.38	-0.09	2.47	0.61	-0.70
Q4	2.00	-0.36	2.36	-0.09	2.45	0.41	-0.50
2001 Q1	1.90	-0.04	1.94	-0.61	2.56	-0.01	-0.60
Q2	2.40	0.50	1.90	-0.53	2.43	-0.13	-0.40
Q3	2.30	-0.01	2.31	-0.28	2.59	-0.28	0.00
Q4	1.90	-0.10	2.00	-0.53	2.53	-0.15	-0.38
2002 Q1	2.30	0.16	2.14	-0.44	2.58	0.05	-0.49
Q2	1.50	-0.52	2.02	-0.54	2.56	0.12	-0.66
Q3	2.10	0.26	1.84	-0.88	2.72	0.22	-1.10
Q4	2.70	0.06	2.64	-0.08	2.56	0.36	-0.44
2003 Q1	3.00	0.23	2.77	0.22	2.55	0.40	-0.18
Q2	2.80	-0.29	3.09	0.56	2.53	0.33	0.23
Q3	2.80	-0.05	2.85	0.40	2.45	0.32	0.08

Table 10
GDP Summary Statistics

GDP							
Date	Actual	Dif	Fcast t = 0	Dif	Fcast t = 8	Policy change	Fcast change
1999 Q3	2,30	0,98	1,32	-1,31	2,63	0,36	-1,67
Q4	2,75	0,25	2,50	0,27	2,33	0,60	-0,87
2000 Q1	3,11	0,19	2,92	0,31	2,61	0,66	-0,97
Q2	3,36	0,42	2,94	0,28	2,56	0,59	-0,31
Q3	2,98	0,42	2,56	0,12	2,44	0,48	-0,36
Q4	2,72	-0,01	2,73	0,25	2,48	0,15	0,10
2001 Q1	3,01	0,15	2,86	0,03	2,83	-0,22	0,25
Q2	2,65	0,40	2,25	-0,86	3,11	-0,21	-0,65
Q3	2,24	0,62	1,62	-0,40	3,02	-0,14	-0,26
Q4	1,71	-0,38	2,09	-0,74	2,83	0,11	-0,85
2002 Q1	1,37	0,00	1,37	-1,02	2,39	0,40	-1,42
Q2	1,75	0,40	1,35	-1,35	2,70	0,55	-1,90
Q3	2,26	0,44	1,82	-0,94	2,76	0,64	-1,58
Q4	2,31	0,02	2,29	-0,17	2,48	0,69	-0,86
2003 Q1	2,10	-0,43	2,53	-0,46	2,89	0,55	-1,01
Q2	1,84	-0,54	2,38	-0,04	2,42	0,38	-0,42
Q3	1,89	0,30	1,59	-0,52	2,11	0,31	-0,83

Table 11

Policy Change:

LAG	AC	PAC	Q	Prob>Q
1	0.7956	0.8309	24.109	0
2	0.4012	-0.6516	30.427	0
3	-0.0289	-0.1565	30.461	0
4	-0.3975	-0.3703	37.06	0
5	-0.5712	0.0997	51.144	0
6	-0.5364	-0.1128	63.993	0
7	-0.3394	-0.0046	69.32	0

Forecast Change:

LAG	AC	PAC	Q	Prob>Q
1	0.4956	0.5107	9.3543	0.0022
2	0.1499	-0.1262	10.236	0.006
3	0.0445	0.1196	10.316	0.0161
4	0.0161	-0.091	10.326	0.0353
5	-0.0211	-0.1294	10.346	0.066
6	0.0412	0.118	10.422	0.108
7	-0.1183	-0.4805	11.068	0.1357

Table 12

(i) Difference Forecast t = 8 less Forecast t = 0

LAG	AC	PAC	Q	Prob>Q
1	0.4236	0.4237	3.6232	0.057
2	0.2411	-0.0584	4.8746	0.0874
3	0.0506	-0.1661	4.9337	0.1767
4	-0.0757	-0.1427	5.0762	0.2796
5	-0.2758	-0.3381	7.1239	0.2116
6	-0.4294	-0.6053	12.539	0.051

of which

(ii) Policy Change:

LAG	AC	PAC	Q	Prob>Q
1	0.8159	0.8268	13.439	0.0002
2	0.3768	-0.883	16.497	0.0003
3	-0.1269	0.0916	16.869	0.0008
4	-0.5186	0.0036	23.551	0.0001
5	-0.6775	0.332	35.908	0
6	-0.5977	0.2028	46.399	0

(iii) Forecast Change:

LAG	AC	PAC	Q	Prob>Q
1	0.5301	0.53	5.6738	0.0172
2	0.3145	-0.09	7.8037	0.0202
3	0.0553	-0.2344	7.8743	0.0487
4	-0.1711	-0.2065	8.6013	0.0719
5	-0.4023	-0.4147	12.958	0.0238
6	-0.517	-0.7485	20.808	0.002

Table 13
GDP Bank

	GDP % change over 12 months	Diffferential between GDP and forecast								
		0	1	2	3	4	5	6	7	8
Q3	3.89	0.50								
Q4	3.93	-0.09	1.11							
1998 Q1	2.88	-0.16	-0.66	0.51						
Q2	2.47	0.06	0.14	-0.37	0.62					
Q3	2.40	0.41	0.54	0.64	0.29	0.60				
Q4	2.02	0.07	0.36	0.31	0.38	0.69	0.19			
1999 Q1	1.70	0.54	0.42	0.29	-0.06	0.11	0.29	-0.33		
Q2	1.64	0.85	0.87	0.64	0.45	-0.19	-0.15	0.00	-0.74	
Q3	2.30	0.98	1.31	1.62	1.46	1.01	0.19	0.15	0.37	-0.33
Q4	2.75	0.25	0.85	1.55	1.92	1.74	1.21	0.48	0.34	0.42
2000 Q1	3.11	0.19	0.29	0.70	1.62	1.75	1.78	1.42	0.72	0.50
Q2	3.36	0.42	0.66	0.56	0.78	1.64	1.54	1.71	1.27	0.80
Q3	2.98	0.42	0.40	0.51	0.47	0.25	0.99	0.74	0.96	0.54
Q4	2.72	-0.01	0.24	0.27	0.48	0.30	-0.08	0.14	0.11	0.24
2001 Q1	3.01	0.15	0.25	0.51	0.44	0.74	0.40	0.09	0.04	0.18
Q2	2.65	0.40	0.35	0.26	0.14	0.04	0.30	-0.05	-0.36	-0.46
Q3	2.24	0.62	0.21	0.17	-0.07	-0.29	-0.41	-0.14	-0.58	-0.78
Q4	1.71	-0.38	-0.11	-0.75	-0.51	-0.69	-0.92	-0.99	-0.68	-1.12
2002 Q1	1.37	0.00	-0.55	-0.61	-1.31	-0.73	-1.11	-1.44	-1.37	-1.02
Q2	1.75	0.40	0.27	-0.22	-0.51	-0.97	-0.62	-0.76	-1.04	-0.95
Q3	2.26	0.44	0.64	0.48	0.21	-0.16	-0.45	-0.36	-0.24	-0.50
Q4	2.31	0.02	-0.03	-0.01	-0.12	0.04	-0.02	-0.17	-0.50	-0.17
2003 Q1	2.10	-0.43	-0.96	-0.81	-0.85	-0.66	-0.39	-0.14	-0.32	-0.79
Q2	1.84	-0.54	-0.74	-1.34	-0.91	-1.11	-0.95	-0.82	-0.31	-0.58
Q3	1.89	0.30	-0.11	-0.44	-1.28	-1.05	-1.26	-0.80	-0.81	-0.22

Table 14

	RPIX % change over 12 months	Differential between RPIX and forecast								
		0	1	2	3	4	5	6	7	8
1993	3.50	0.00								
Q2	2.80	-0.6	-0.60							
Q3	3.30	0.40	-0.10	0.30						
Q4	2.70	-0.60	-0.30	-0.50	-0.40					
1994 Q1	2.40	-0.40	-1.20	-0.80	-0.80	-1.00				
Q2	2.40	-0.30	-0.60	-1.10	-0.90	-1.10	-1.00			
Q3	2.00	-0.30	-0.90	-1.10	-1.50	-1.30	-1.60	-1.40		
Q4	2.50	0.40	-0.10	-0.50	-0.70	-0.90	-0.80	-1.20	-0.80	
1995 Q1	2.80	-0.10	0.90	0.10	-0.30	-0.60	-0.60	-0.70		
Q2	2.80	0.10	0.00	0.80	-0.20	-0.60	-0.50	-0.60	-0.80	
Q3	3.10	0.20	0.10	0.00	0.80	-0.10	-0.30	-0.10		
Q4	3.00	-0.20	0.00	-0.10	-0.20	0.60	-0.20	-0.30	-0.20	
1996 Q1	2.90	0.10	-0.40	-0.30	-0.50	0.20	0.10	-0.50	-0.40	
Q2	2.80	0.10	0.10	-0.70	-0.70	-1.00	0.10	0.40	-0.30	
Q3	2.90	0.20	0.40	0.50	-0.30	-0.50	-0.80	0.30	0.50	
Q4	3.10	0.00	0.70	0.80	0.90	0.10	-0.10	-0.30	0.60	
1997 Q1	2.70	0.00	-0.20	0.40	0.40	0.40	0.00	-0.20	-0.30	
Q2	2.70	0.10	0.30	-0.10	0.40	0.50	0.40	0.00	-0.10	
Q3	2.70	0.05	0.30	0.50	0.00	0.30	0.30	0.40	0.00	-0.10
Q4	2.70	0.10	0.38	0.50	0.50	0.30	0.20	0.30	0.30	0.00
1998 Q1	2.60	0.00	0.09	0.41	0.40	0.30	0.20	0.00	0.20	0.20
Q2	2.80	-0.03	0.17	0.38	0.74	0.60	0.30	0.30	0.10	0.30
Q3	2.50	-0.01	0.15	0.08	0.23	0.51	0.20	-0.20	-0.10	-0.30
Q4	2.60	0.06	0.04	0.25	0.19	0.41	0.52	0.10	-0.20	-0.10
1999 Q1	2.70	0.21	0.14	0.01	0.29	0.26	0.52	0.46	0.00	-0.20
Q2	2.20	-0.28	-0.33	-0.51	-0.62	-0.17	-0.19	-0.05	-0.16	-0.70
Q3	2.10	-0.21	-0.30	-0.45	-0.64	-0.76	-0.20	-0.37	-0.27	-0.40

Q4	2.20	0	-0.08	-0.16	-0.41	-0.39	-0.57	-0.06	-0.35	-0.22
2000 Q1	2.00	0.07	-0.12	-0.09	-0.20	-0.52	-0.56	-0.69	-0.27	-0.64
Q2	2.20	0.32	0.22	0.14	0.21	-0.03	-0.29	-0.31	-0.36	-0.15
Q3	2.20	-0.18	0.27	0.25	0.18	0.32	-0.05	-0.27	-0.28	-0.27
Q4	2.00	-0.36	-0.28	-0.10	-0.05	0.16	0.08	-0.23	-0.47	-0.45
2001 Q1	1.90	-0.04	-0.43	-0.36	-0.30	-0.42	0.18	-0.18	-0.45	-0.66
Q2	2.40	0.50	0.48	0.18	0.01	-0.07	-0.08	0.60	0.12	-0.03
Q3	2.30	-0.01	0.40	0.43	0.11	-0.18	-0.23	-0.23	0.11	-0.29
Q4	1.90	-0.10	-0.27	-0.01	0.03	-0.29	-0.72	-0.63	-0.66	-0.63
2002 Q1	2.30	0.16	0.27	0.13	0.39	0.21	0.12	-0.38	-0.23	-0.28
Q2	1.50	-0.52	-0.37	-0.35	-0.41	-0.44	-0.68	-0.87	-1.20	-1.06
Q3	2.10	0.26	0.02	0.14	0.04	0.14	0.07	-0.17	-0.36	-0.62
Q4	2.70	0.06	0.45	0.46	0.59	0.64	0.57	0.54	0.28	0.14
2003 Q1	3.00	0.23	0.27	0.75	0.82	0.87	0.92	0.68	0.61	0.45
Q2	2.80	-0.29	-0.10	0.08	0.55	0.75	0.67	0.65	0.39	0.27
Q3	2.80	-0.05	-0.10	-0.18	0.08	0.49	0.71	0.62	0.57	0.35